The Role of the Package as an Information Resource in the Supply Chain

A case study of distributing fresh foods to retailers in Norway

by

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Abstract

The objective of this study is to investigate the role of the package as an information resource in a supply chain context. The package is a physical resource that is designed in accordance with principles of packaging technology. This study concentrates on the package regarded as a logistics resource. This role of the package involves functions regarding how packages carry goods, provide utility in relation to logistics activities, and facilitate communication. In this study focus is directed to communicative aspects of using packages.

Within logistics and supply chain management studies regarding using packages have mainly been directed towards how packages carry goods. In a supply chain the package may be therefore be regarded as a core logistics resource since it facilitates the provision of products to an end user. This view is also based upon that when goods are packed, the goods themselves are concealed, and therefore it is packages, and not the goods themselves that need to be accounted for. In addition, packages serve a vital purpose as a marketing resource in a retail setting and when informing about products in a purchasing situation.

The use of the package as an information resource is described as an interplay between, the package, information and the transformation of goods. This interplay is used to structure the frame of reference and to design the research process. Empirical findings are based on four cases concerning the distribution of four fresh food products to Norwegian retailers. The studied products are 1) seasonal strawberries, 2) low-fat milk, 3) packed fresh fish, and 4) bananas from Costa Rica. These four products are studied in the supply chains of two Norwegian distribution networks; 1) BAMA, a distributor of fresh fruits and vegetables, and 2) TINE, a producer and distributor of predominately dairy products.

In a supply chain consisting of different actors, informational needs vary. Descriptions of packages impact on how information is provided and used for different purposes. The main findings of this study involve how the package through playing a vital role embedded in the core flow of goods facilitates information exchange and the transformation of information about goods adapted to user needs. The package is a logistics resource that mediates between variations in actor needs and different logistics activities in a network of supply chain actors.

Key words: packages, information, transformation of goods, fresh foods, supply chain

"Our language can be seen as an ancient city: a maze of little streets and squares, of old and new houses with additions from various periods; and this surrounded by a multitude of new boroughs with straight regular streets and uniform houses."

Ludwig Wittgenstein, Philosophical Investigations (1953:8)

Acknowledgements

Taking a PhD meant for me moving towards and explore un-chartered frontier. Although the terrain has been a somewhat "rocky road", the experiences encountered through this study have left me richer both in professional terms, and in terms of personal development. The main theme of this study was conceived with the help of Marianne Jahre. Entering a logistics project when personally having a background in marketing, she was concerned that the theme must be logistical. She suggested focusing on packaging combined with communications, an area I had accumulated interest for within marketing. Through this study Marianne has as co-advisor of this study been a continuous source of guidance and inspiration in numerous ways, not only those directly related to this dissertation. Thank you Marianne for your many roles in supporting this work.

This study was founded in the "cradle" of the NELOG Project where Marianne Jahre has been the project leader. NETLOG may be regarded as a group of researchers at different levels, from PhD students to professors; working to develop and use what became labelled as the "4 resource entities" model. 7 companies were involved in the project: UNITOR, BAMA, Kitron, Posten, Norsk Hydro, Tomra and TINE. A special thanks goes to the people at BI and industry that in different ways were involved in the involved in the NETLOG project. Thanks goes among these people to Atle Nordli that kept me aware during this study that "logistics" included other approaches than that used in NETLOG.

How can one complete a doctoral study without good friends? All the "netloggers" have been considered as friends during this study! I shared my office with Fahad Awaleh for almost most of the duration of this work. We have joked with and argued together, also spent considerable time discussing "this&that", of course, including our ongoing research work. Thanks also to some "outsiders"; to my friend Tore Hoel for directing me in the direction of a doctoral study while I still lived in Alta in Northern Norway in the late 1990-ies. Thanks also to my friends Lance Rosasen and Bill Andersson who gave me inspiration during the more than five years this work lasted. I especially appreciate the many trips to the indoor salt-water pool at Badanstalten in Strömstad in Sweden including the pizza lunch with you guys. I even managed to take this trip once with Fahad and his cousin. I also got married in the duration of this study, and special thanks goes to my wife Feven for lifting me through the final months of this work.

Having chosen a research theme, this study then took me for instance to a fish factory in Hammerfest (the northernmost city in the world), a banana vessel docked in Hamburg, a dairy farm at Fetsund close to Oslo, a strawberry field at Nes in Hedmark. I have accompanied a truck driver delivering fruits and vegetables to supermarkets in Oslo, seen numerous terminals and warehouses, how goods packages are handled, labelled, and how labels are used. I have met informants in their offices. Many of these have willingly provided tours of their production and goods handling facilities facilitating observations that have been important for this work. Thanks goes to all these informants! I especially want to thank Svein Egil Hoberg of BAMA Gruppen and Egil Sørseth of TINE who provided the linkage to these informants securing the empirical basis of this study.

An especially rewarding part of this study has been learning how to write conference papers, and eventually papers for academic journals. Being a PhD student has allowed me to participate in numerous conferences worldwide, inspiring my writing and allowing me to meet new colleagues, to create a network of professional contacts. This network I now use and develop in a "snowballing" manner to develop new international research projects.

Special thanks goes to my main advisor through this study, Lars-Erik Gadde. There is no doubt without your guidance, Lars-Erik, and all the time you put into helping me on this work, this dissertation could not have been completed. It has been a great experience working on this thesis, like an apprentice working with the skilled master. Thank you Lars-Erik for leading me to a language to describe and analyse the role of the package as an information resource in the supply chain.

Per Engelseth Oslo, October 2006

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Part One: Research Foundations

1. Introduction

1.1 Packages as Logistics Resources

This thesis is about packages. The package is a logistics facility that is primarily used to contain goods. In this function it is an important logistics resource (Paine 1982, Ballou 1987, Twede and Parsons 1997, Johansson et *al.* 1997). There are two dimensions of the logistics role of the package. The first is the up-front part visible to end-users, while the other in the upstream part of a supply chain is more hidden to consumers. In a retail setting an abundance of goods are available for purchase by consumers. In this environment goods are made visible through consumer packaging. These packages are vital in order to facilitate the provision of goods to a consumer in a self-service environment. As such, packages play a logistics role in conjunction with retailing. However, prior to this use of the package in a retail setting, goods have been distributed in the upstream part of the supply chain. In these operations different types of packaging such as boxes, pallets, and containers are normally used to carry goods.

While the most obvious function of a package is as a physical resource used to distribute goods, packages also play a role as an information resource. An important aspect of logistics is concerned with informing different actors how to carry out and coordinate activities in a supply chain providing goods to the end user. Packages carry information about goods. This informational role is vital to consumers in a retail setting, but is also of importance in the upstream part of the supply chain, where goods are controlled against documents through labels and tags carried on packages. Furthermore, documents used to control goods include information regarding packages. This thesis focuses on the informational aspects of packages.

1.2 Previous Studies on Packages

The packaging focus applied in this study has been motivated through the statement of Ballou (1987) that in a supply chain, "…it is the package that must be dealt with, and the product itself may be of secondary concern…" because "…it is the package that has the shape, volume, and weight, whereas the product inside may not have the same characteristics." Accordingly, it is packages and not products that predominantly represent the core physical resource elements in the supply chain. Goods are to varying degrees concealed when packed, which again leads to a proposition that it is not the

goods, but rather the packages enveloping goods, that need to primarily be taken into account in a flow of goods. This underpins the vital logistics role of the package in the supply chain.

Package design and the use of the package are interdependent features of packaging. Package design is most important at the retail end, while logistics in interplay with packaging is more concerned with its use (Johansson et *al.* 1997). How packages are used in a supply chain, represents a logistics management issue influencing the flow of goods. Johnsson (1998 p. 7) states that: "Without a package that supports a logistics system and without a logistics system that supports the package it will be difficult to create an efficient logistics system." A focus on packaging integrated with logistics is called for by Johnsson (1998), and according to Twede and Parsons (1997 p.21), "…once one thinks in terms of what a package must do – rather than what it is made from – new package ideas begin to emerge." This means that package design may become better adapted to their use, thereby more efficiently fulfilling their vital logistics purpose. This study, therefore, investigates the use of packages; how package design influences logistics activities. Therefore, this study is based on a fundamental view that knowledge regarding using packages in a supply chain should influence packaging technology.

In spite of the importance of packages within logistics and supply chain management, packages are seldom studied as a focal resource in a supply chain. The package, it seems, is taken for granted in logistics and supply chain management research. One reason for this may be attributed to packaging being a field of research separate from logistics. "Packaging" is mainly regarded as a technical field of research concerned primarily with developing form features of the package (Heskett et *al.* 1973, Paine 1981, Lumsden 1998). To account for how packages are used in a supply chain, a logistics approach to packaging has been coined as "packaging logistics" (Johansson et *al.* 1997, Johnsson 1998, Klevås 2005). This logistics approach focuses on the *use* of the package to carry goods in a supply chain. This line of study within logistics should be regarded, however, as still in its "infancy".

In logistics literature, Twede (1992) carried out a detailed case study illustrating the logistics use of packages in a supply chain contributing to the development of a basic framework for analysing the logistics use of packages. Mathisson-Öjemertz and Johansson (2000) account for the impact of package form together with supply chain configuration on the materials handling efficiency in the automotive industry. Lee and Lye (2002) studied in detail the efficiency of manual packaging including scanning goods

labelled with barcodes. They found that features of package form impact on goods handling efficiency and provide guidelines for the design of efficient packaging lines. Jahre and Hatteland (2003) show in a case study how packaging represents an integrated system with packages having various roles in relation to other logistics resources in a network. Jahre and Fabbes-Costes (2005) take the study by Jahre and Hatteland (2003) a step further by focusing on adaptation of packaging in relation to standardising the physical features of packages. Klevås (2005) carried out a case study at IKEA regarding packaging organisation, involving all aspects of packages, designing, form, and use and its impact on efficiency. According to Klevås (2005) packages have "…a great impact on the performance of the logistics system and product development process." This study also underlines the importance of the inter-dependence of the package, the goods contained in a package, and using the package when carrying out logistics activities.

The package may, based on these studies, be viewed as a resource element that impacts on how logistics activities are carried out in the supply chain. These previous studies, however, are mainly concerned with how physical features of packages impact on logistics activities. This study aims at directing the attention to how the package is in addition an information resource in the supply chain.

1.3 The Package as an Information Resource

The role of the package as an information resource is analysed in a supply chain context. This context provides structure and setting for the transformation of goods from raw materials to end products for consumers. In the supply chain actors in cooperation seek to provide "…the right goods and services to the right place, at the right time, and in the desired condition, while making the greatest contribution to the firm" (Ballou 1999 p. 6). The package plays an important role as a physical resource and as a facility that contributes to this logistics mission. In this respect, the package is commonly perceived mainly as a physical resource since it protects and improves the handling of goods in the processes of transforming goods, classified by Alderson (1965), as transformations in relation to time, place, and form features through a flow of goods.

In this transformation process information plays an important role. Information links different actors together and links actors to the flow of goods. Information directs the transformation of goods from its raw material state to an end product. The physical flow of goods is accordingly dependent on a supporting flow of information. In logistics literature it is widely covered how information exchange facilitates the transformation of goods

(e.g. Heskett et *al.* 1973, Lambert et *al.* 1998, Gadde and Håkansson 2001: 71-75, Christopher 2005:285). However, the contribution of the package to these information processes is only accounted for to a limited degree (Johnsen 1998).

The role of the package as an information resource is many-faceted and involves how packages carry information in the form of markings, print, labels, or electronic tags. This represents a role as an information resource that is closely linked with the physical features of a package. When goods are transformed through logistics activities, this is dependent on the identification of goods by linking information carried on packages with information provided from an information system. In addition, documents are used to describe goods, including descriptions of the packaging. This involves using the package as an information resource that is more detached from the physical presence of the package. Documents informing about packed goods may be used to carry out logistics activities, but information about goods may also be used for other purposes. Packages therefore represent a part of message or information content that may be visualised as used for different purposes both within and may also transcend the boundaries of the supply chain.

The most visible functions of the package are related to its use in the flow of goods. The study, however, widens the perspective to also include the package's role in the flow of information. In the flow of goods, packages carry information. These features are also of importance when transforming goods from raw materials into a finished product. In the flow of information, goods are informed about, and when goods are packed, the package is a part of the information content concerning goods. Packages are resources that, accordingly, are evident both in the flow of goods and in the flow of information. This means that in order to analyse the use of the package as an information resource, it is essential to see how packages are used as containers of goods and carriers of information in a flow of goods as well as its role as information content or messages often communicated using documents. This study concerning the use of the package as an information resource, therefore, takes into consideration both the use of packages in the flow of goods as well as its use in the flow of information.

1.4 Purpose of Thesis and Outline of this Study

The overall aim of the study is to explore the role of the package as an information resource in a supply chain. The basic framework of the study is illustrated as interplay between resources in figure 1.1 below:

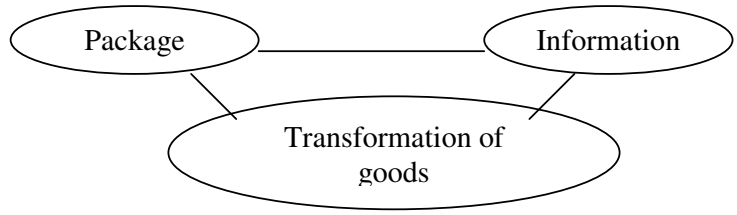

Fig. 1.1 The interplay between the package, information and the transformation of goods

An exploration of the role of the package as an information resource needs to depart from the flow of goods. Within this flow, the main mission is to transform goods from raw materials to end products. These transformations rely on various types and sources of information. As indicated in Section 1.3, packages may play various roles in these information processes. Accordingly, the exploration of the role of the package as an information resource builds on investigating the interplay between the transformation of goods, the information required in these transformations, and the role of the package in these processes.

This study is based on four cases concerning the distribution of four fresh food products to Norwegian retailers. Accordingly, the aim of the study is the use of the package as an information resource in a supply chain context by accounting for how the package, information, and the transformation of goods interplay with each other. The studied products are 1) seasonal strawberries, 2) low-fat milk, 3) packed fresh fish, and 4) bananas from Costa Rica. These four products are studied in the supply chains of two Norwegian distribution networks; 1) BAMA, a distributor of fresh fruits and vegetables, and 2) TINE, a producer and distributor of predominately dairy products.

According to Lamming at *al.* (2000) a study of supply chains should take into account how product characteristics influence the distribution of goods. Given that the empirical evidence is only regarding fresh foods, logistics and supply chain management literature regarding this field of industry has been influential. This literature has revealed how the distribution of foods is prone to time limitations, uncertainty regarding supply, the weakly developed management proficiency of raw-material producers (farmers and fishing), vulnerability to damage during transport and storage, and the need to carry out strict quality controls (Caixeta-Filho 1999, Van der Vorst et *al.* 2002. Hämeri and Pálsson 2003). According to Gupta et *al.* (2003), specificities of

distributing fresh foods should influence the design and use of logistics planning techniques. The analysis of the use of the package as an information resource is accordingly limited by the empirical findings to regarding this use in four different and interrelated fresh foods supply chains.

This thesis consists of three parts. In the first part, Chapters 2 and 3 consist of the frame of reference and the design and method of the study. The frame of reference provides the analytical foundation of the study. In the following chapter on research, design and method, this frame of reference is used to describe and discuss the implications of the design and methodology.

The second part consists of the empirical findings. Here the frame of reference is used to structure a description of how the package is used as an information resource to distribute the four studied products; two cases concerning BAMA and two cases concerning TINE.

The third and final part analyses the findings and provides the overall conclusions of this research project. In Chapters 6 through 8 the frame of reference together with the empirical findings, provide the basis for analysing research data. This is based on the research issues described in Section 2.4.2. Chapter 9 provides a more overall analysis of the research findings in a concluding discussion. Figure 1.2 below shows an outline of this thesis:

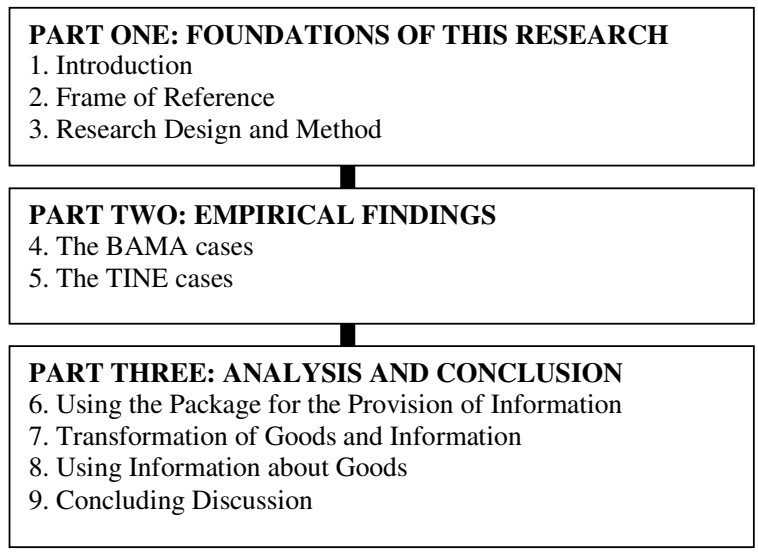

Fig. 1.2 Outline of the study

2 Frame of Reference

The frame of reference provides the theoretical foundations for formulating research issues. This has enabled the research process, involving collecting data, constructing the case narrative, and analysing the information to be executed. The framework has been developed in an emergent manner, as described in Chapter 3 concerning the research design and method. The framework is centred on the main elements of the unit of analysis described in Chapter 1. Section 2.1, is accordingly about the core feature of the supply chain represented by the transformation of goods. This provides the basis for reasoning why the package is used as an information resource, namely to place a product in the hands of an end user. Section 2.2 relates the transformation of goods to information. This involves the dual aspects of information about goods being *provided to* and *used by* supply chain actors. In Section 2.3, the role of the package as an information resource, based on the physical properties of the package, is discussed. In Section 2.4, a research model is used to study the interplay between the elements in the focal interplay shown in figure 1.1. This section concludes with a presentation of the research issues.

2.1 Transformation of Goods

To understand how the package is used as an information resource, it is essential to consider how goods are transformed in the supply chain. The transformation of goods may be described as the flow of goods from a point-of-origin to a point-of-destination. Transformation in the flow of goods involves changing the properties of the goods from an original state as "conglomerate resources" (Alderson 1965) into a state where the goods are literally placed in the hands of an end-user as a finished product. This fulfilment of end-user needs represents in accordance with Ballou (1999) the mission of logistics. The flow of goods is viewed in accordance with Arlbjørn and Halldorsson (2002), as the "core" of logistics. This means that the flow of goods is the principle feature of logistics to which the other aspects of logistics are related.

The flow of goods is embedded in the supply chain context. Logistics is described by Lambert et *al.* (1998b) and by the CSCMP logistics management definition (www.cscmp.org) as a component within supply chain management. The structural and management features of the supply chain are, therefore, regarded in relation to the transformation of goods. By directing attention to how goods are transformed, this study focuses explicitly supply chain business processes regarding "physical distribution"

understood as regarding the entire the flow of goods. This choice was made because the physical transformation of goods is closely related to how packages are used as logistics resources.

Logistics activities are regarded as key supply chain processes which transform the features of the goods which in this study involves packed goods. The transformation of goods is based on this view as described in Section 2.1.1. Firstly, focus is placed on the features of the goods themselves and important aspects of their transformation. This is followed in Section 2.1.2 by a more detailed discussion regarding how goods are transformed through different logistics activities. Finally, Section 2.1.3 deals with the features of the flow of goods involving the actors and managerial aspects that influence how goods are transformed.

2.1.1 Transformation within the Flow of Goods

The structure of a flow of goods may be regarded as linear. It may involve several flows when different material components are combined to create new products. Furthermore, supply chain actors may handle several parallel flows of goods at the same facility. In accordance with Håkansson and Persson (2004) the flow of goods is here viewed as one of several different flows that may be accounted for in a network of supply chain actors. In addition to the transformation of goods pictured as a flow, a flow of information and a flow of title may be identified in the supply chain (Alderson 1965, Heskett et. al 1973, CSCMP Logistics management definition: www.cscmp.org). The flow of title is regarded as contingent to the theme of this study regarding the role of the package as an information resource and is to some degree accounted for in the following section 2.2, which discusses features regarding the flow of information.

Different terms are used to describe the physical entity that is the core object in a supply chain. In a logistics setting the core resource element is usually denoted as “goods”. In addition “products” and “materials” are commonly used terms to describe this core element of the supply chain. In this study these terms need to be differentiated and clarified in order to both create comprehensible empirical findings and to more precisely analyse these findings. The terms goods, products, and materials have in common that they are physical entities which are closely related and also to some degree overlapping in meaning.

Goods, products and materials
“Goods” is chosen as the key term to denote the core logistics object that is transformed in the supply chain. This is the view shared by Alderson (1965),

Bowersox (1969), Heskett et *al.* (1973) and Arlbjørn and Haldorsson (2002) in that a flow of goods is regarded as the "core of logistics". In practice, "goods" are physical materials that eventually will though a flow process become transformed into a product that satisfies user needs.

"Materials" are regarded as an entity closely linked with the technical properties of the goods (Heskett et *al.* 1973, Lumsden 1998). One state of goods is as raw materials, another as materials during production, and finally as finished materials. Materials are accordingly used as a term when regarding different technical specifications of goods. Alternatively the flow of goods may be termed as a "material flow". Based on this understanding, a material flow would place focus on the transformation of the technical properties of the goods.

"Products" on the other hand are primarily understood as that aspect of goods that is involved in transfer of title (Rosenbloom 1995). This form of transfer involves activities related to sales and purchasing. This is normally considered the realm of marketing. A product is the entity that is purchased by customers and, therefore, plays a key role in creating orders from retailers to their upstream suppliers. In addition, since forecasts in practice document anticipation of orders, products also play a key role in forecasting. Products are closely related to the end-user needs and are, therefore, important for reaching marketing objectives to satisfy consumer needs. However, when suppliers distribute products, this physical entity is denoted as "goods". Thus, the final state of "goods" as perceived by the retailer and end-user is regarded as the "product". The empirical findings in this study are organised as fresh foods "product" cases as described in Section 1.4. These cases are consequently organised around a description of the finished state of goods, the entity that is purchased by an end-user at a retail facility.

Goods utility and coordination

The transformation of goods is regarded, in accordance with Alderson (1965), as the provision of time, place and form utility of goods. This involves delivering utility to intermediary actors handling goods and finally to the end-user. Goods utility is regarded as encompassing mainly the transformation of the physical features of goods where the flow of information plays a supporting role and the flow of title plays a contextual role. As such, the needs of the end-user regarding the physical properties of goods are of vital importance in understanding how goods are transformed. These needs of end-user should influence the needs of intermediary goods handling actors.

Important logistics goals in relation to the logistics purpose in a supply chain are according to Heskett et *al.* (1973: 28-29) 1) "materials movement" representing the change of time and location features, and 2) the coordination of discrepancies in volume with respect to supply at one end of the flow of goods with demand for products at the final end. The efficiency of logistics is, however, constrained by limitations of supply and capacity in the supply chain. The transformation of goods must, therefore, be coordinated with the final demand for the product at one end of the flow of goods and supply in the initial stages of the flow of goods, and within the flow the transformation of goods must be coordinated with capacity constraints within the supply chain. How goods are transformed is a compromise between supply, demand, and capacity constraints. In relation to this logistics challenge the degree of supply chain integration represents a logistics tool to improve the efficiency of the transformation of goods into a product, and the product utility as perceived by users.

Goods utility and the role of time, place and form

Time, place, and form features of goods must be transformed in order to meet the different needs of all the various supply chain actors, including divergent roles such as professionals and end-users playing the role of the consumer. Time adds precision to a description of the transformation of goods. This feature of goods is used to describe more precisely when goods are supplied, and when users require goods and products. Time is also used to plan and describe how the supply of goods is coordinated with capacities in the supply chain and with demand for products. When goods are identified at a specific location, this represents a unique state of the goods since it is registered at a specific time. At this specific time, the form and location attributes of goods may be described. Time may in addition also be described as an interval within the flow of goods, such as describing an activity that uses a certain amount of time to be performed. Time may, therefore, be used to describe how goods are transformed and coordinated with capacities in the supply chain, and how long different logistics resources have been used. Time may thus be used as an indicator to describe the timeliness of the transformation of goods. "Timeliness" is understood as the degree of correspondence between the planned timing of the transformation of goods with the experienced timing of activities.

Time, *place* and *form* are used to describe the fundamental features of the state of goods including the transformation of these features of goods. A complete and accurate description of goods and how they are transformed include in this study a detailed description of all these attributes. These are regarded as the main features of utility concerning the provision of goods required by supply chain actors as shown in fig. 2.1 below:

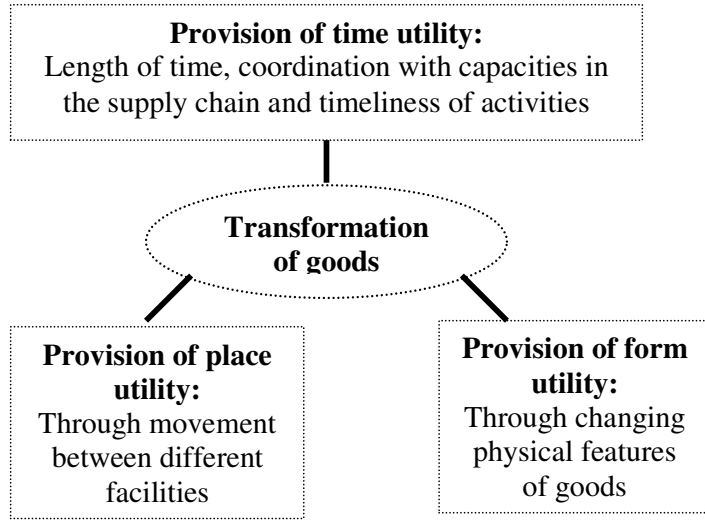

Fig. 2.1. Different aspects of the provision of goods utility through the transformation time, place and form features of goods

The provision of time, place, and form utility regarding goods are of importance in the entire scope of the supply chain. Through the retailer the end-end user finds utility if a product is available on the store shelves and offered at reasonable prices that are perceived as satisfying anticipated consumption needs. All issues ensuring the utility of the final product are of importance throughout the entire scope of the flow of goods. In order to be able to deliver goods to an end-user, time, place, and form features of goods must be transformed thereby providing utility sequentially through various logistics activities carried out by different actors in a coordinated manner.

2.1.2 Logistics Activities

Logistics activities are operations that physically transform goods and thereby provide time, place, and form utility of goods to users through the transformation of these goods. Activities contributing to the transformation of goods may be classified in different manners (e.g. Bucklin 1960, Heskett et *al.* 1973). Logistics activities transform goods, thereby contributing to the provision of time, place, or form utility of goods (Stock and Lambert 2001:313). The following logistics activities are identified and transform goods in different manners:

- Transport: transformation mainly *of location*
- Storage: transformation mainly in *time*
- Production: transformation mainly in *form*
- Materials handling: *interconnecting* the other logistics activities

In the following sections the logistics activities of transport, storage, and production, which transform goods in relation to time, place, and form utility are first described. This is followed by a focus on materials handling and how this activity may be viewed as having an interconnecting function in the transformation of goods.

Transport

Packed goods or unpacked materials need to be moved from a place of origin to a final place of consumption which may be described as a flow of goods. Transport is the logistics activity that provides a transformation of location - "place utility" - within a time-interval – "time utility" (Lumsden 1998:39). There are different means of transport such as road, rail, air, water, and pipeline (Stock and Lambert 2001:322-328). Each has different characteristics regarding speed, protection of the goods, and costs. Motor transport is versatile and flexible, rail offers relatively low cost but covers a limited number of destinations, air transport is the fastest and costliest mode of transport, and water transport consisting of inland and international ocean transport is often the slowest and the least expensive mode of transport.

The efficiency of transport activities involves product-related factors such as the density, stowability, ease or difficulty in handling, and legal responsibility of the goods influencing the cost of transport (Stock and Lambert 2001:314-315). Transport activities may be improved through 1) the design of the transportation system and its methods, 2) the use of labour and equipment, and 3) in the performance of labour and equipment (Stock and Lambert 2001:371). Transport involves routing and scheduling of a firm's vehicles. Individual storage compartments in vehicles need to be efficiently loaded. Within such compartments goods rest idle between loading and unloading. An important aspect of transport is that a vehicle in many cases carries a mixed load of goods. The selection of such mixed loads may reduce inventory and create more efficient material handling (Teulings and Vlist 2001). Geographic and country-related factors may also influence transport, and Pedersen and Gray (1998) show how topography, location factors, transport distances, and limited domestic competition among transport firms increase transport costs in Norway.

While the transformation of location is the key aspect of transport, the efficiency of transport may be measured in relation to the time used to carry out this activity. Improving the efficiency of transport in relation to distributing different types of goods has been sought through "cross docking". Downstream in a supply chain cross docking represents a specific manner of organising different logistics activities to better coordinate supply volumes with demand volumes. Transport planning plays an important role in this mode of distribution. Cross docking involves rapid transfer of goods at a warehouse from one transport vehicle to another at the same docking location (Apte and Viswanathan 2000). In addition cross docking permits frequent delivery of a wider range of different products in an efficient manner and vehicles thus both arrive and leave with full truck loads (Lumsden 1998:73) contributing to transport efficiency (Apte and Viswanathan 2000). Alternatively, goods may be transported in partially full loads for direct transport from a sender location to a receiver location without stops at e.g. intermediating terminals (Lumsden 1998:73). Cross docking involves accordingly a greater degree of "flow through distribution" in cases where the transformation of goods is based upon actual customer orders rather than logistics planning (Baker 2004). Factors influencing the efficiency of cross docking also include places where transport facilities interface other types of logistics facilities, the shape of the warehouse, and how docking locations are placed in relation to each other (Bartholdi and Gue 2004).

Transport often involves exposing the goods to a hazardous environment. Fresh food products are especially vulnerable to damage in relation to time and handling through transport. Problems relating to long-distance transport of food products include deterioration, shrinkage, and loss (Caixeta-Filho 1999). Distributing food products also involves a combination of transport and storage in a cold chain in order to reduce the deterioration of the goods. Salin and Nayga (2003) describe in a case study the use of a "cold chain" for distributing frozen packaged potato products from USA to the Philippines and Thailand, showing that cold chains for distributing food products are organised in various ways in different national contexts. One reason for this was that the infrastructure of cold storage facilities varies between urban and more rural regions of these two developing countries. In addition it is not the cold chain itself that is viewed as the value generator in physical distribution, rather that "…scale and capacity utilization are the keys to efficiency in preserving the value of foods that rely on cold chain infrastructure" (Salin and Nagaya 2003). Transport together with storage in a cold chain may be organized in different manners. Cross docking is one mode of organizing this interplay between storage and transport. A combination of storage and transport influences accordingly the overall efficiency of a supply chain.

Storage

The purposes of storage are according to Stock and Lambert (2001:228-230) 1) to achieve economies of scale regarding distribution in the supply chain, 2) to balance supply with demand, 3) to achieve specialisation in manufacturing, 4) to protect from uncertainties in demand and the order cycle, and 5) to act as a buffer between critical interfaces in the supply chain. Storage provides economies of scale by collecting supplies arriving from transport or production at a facility and then sending these goods downstream at a time that increases the efficiency of the following logistics activities. This feature also involves providing goods for production creating specialised products that require specific raw materials and components where supply may fluctuate.

Storage takes place when goods lie idle at a storage facility such as in a warehouse compartment and involves a limited amount of manual activities. This is an activity that involves the goods mainly resting idle at a specific place. Storage is accordingly a logistics activity that mainly transforms the time features of goods. The storage facility must still be monitored and the environment kept in accordance with the requirements of the goods. When goods are in storage they remain in a compartment as is the case with transport, but this compartment remains at the same location. Inventory storage policies include the minimum and maximum level of stock at a specific storage facility, sales and replenishment rates at this facility, and the combining of different types of goods at a storage facility (Stock and Lambert 2001). Storage may accordingly be described in relation to the different forms of goods contained within a storage facility and the time these goods are contained at this facility.

Storage is carried out at different types of facilities. “Warehouses” facilitate the long-term storage of goods, while “terminals” facilitate short-term storage of goods, and in cases of cross docking, this does not involve any storage activity at all. Storage may also be carried out at production facilities such as a farm or a factory. Here raw materials, or components used in the production process may be stored prior to production. In addition, the then processed material, components or products may be stored before being assigned downstream in the flow of goods. Goods may also be stored at retail facilities. Retailing has similarities with storage at a warehouse with the exception that this is space that also the consumer may venture into. Therefore, retailing may be viewed as in part a logistics activity primarily in relation to its function as a goods storage facility (Ellram et *al.* 1999). Retailing involves goods storage in order to promote products to consumers, providing the end-user with utility by displaying products to shoppers.

A key problem in a supply chain was previously described as the balancing of supply with demand with supply chain capacities and capabilities. Both supply and demand are prone to variation. Storage involves a "buffering" function securing the provision of goods to customers, and this function is used according to Tibben-Lembke and Amato (2001) to coordinate an uneven supply with an uneven demand. Westwood (1999) also shows in a case study how seasonal variations in demand within clothing retail influences the level of stock required, and how storage is used to coordinate. In this case the provision of goods in the high season is constrained by transport and storage capacity limitations. This exemplifies how supply and demand must be coordinated with the capacities of facilities within the supply chain. Storage plays a key role in balancing variations in supply with demand functioning as a reservoir for goods which remain idle for a period of time. This reservoir is used to coordinate logistics activities with specific handling and capacity characteristics. This means that the assignment of goods to other logistics activities should be coordinated to make it possible to efficiently carry out these activities.

Production

Production is an activity that transforms the technical properties of goods. Bucklin (1960) states that production from a distribution perspective is "… activities necessary to create a good with any desired set of specifications." When describing the flow of goods in the supply chain, from the point-of-origin to consumption, the description must also take into account how production transforms the form properties of goods. Production is embedded in the flow of goods and dependent on the other logistics activities, such as transport, storage, and materials handling. Raw materials must be provided, and produced goods need to be transformed downstream in the flow. Production is, therefore, intertwined with the other logistics activities. Describing the provision of goods without accounting for the role of production, would render this description incomplete. Accordingly, production is viewed as a logistics activity related to the transformation of goods.

Production plays often a "focal" role in the flow of goods. Miller and De Matta (2003) view the synchronising of production scheduling as an operational challenge in a supply chain upon which other logistics activities are dependent. "On a short run basis, transportation is often scheduled as required based on the production schedule, inventory requirements of the finishing plant" (Miller and De Matta 2003). Production planning influences the downstream logistics activities as it creates a new and unique supply of goods with which following logistics activities must be coordinated. This impacts the timing of downstream storage, transport and materials handling

after production (Lumsden 1998:24). In fresh food supply chains distinguishing production activities is sometimes difficult since the aim of many fresh foods is to limit the transformation of the form features of the goods. In the case of foods, harvesting, catching, and milking may be regarded as production activities that initiate the transformation of a specific unit of goods in the flow.

Materials handling

Materials handling is the activity that links other logistics activities to each other. According to Arnold (1998:248): "Materials handling is the short-distance movement that takes place in or around a building such as a plant or distribution centre", and according to Stock and Lambert (2001:22) materials handling is "…concerned with every aspect of the movement or flow of raw materials, in-process inventory, and finished goods within a plant or a warehouse." Materials handling consists of receiving goods, identifying goods, dispatching goods for storage, holding goods, picking goods, combining goods for outbound transport, and loading for outbound transport (see: Arnold 1998:305). Stock layout, stock retrieval, warehouse configuration (involving the design of the facility influencing materials handling), and dock design (in relation to inbound and outbound transport) are key issues for warehouse operations (Ballou 1976).

The borderline between materials handling and storage is fuzzy, since some forms of short-term storage may be regarded as materials handling. Different forms of air, sea, and land transport facilities dock at warehouses (Heskett et *al.* 1973:93-94) and transport thus precedes and follows different warehouse or terminal activities. In the supply chain materials handling is an activity that is carried out when goods are received from transport, storage, or production. Different logistics activities then need to closely interplay at a logistics facility such as a warehouse, terminal, farm, or store. Materials handling may, therefore, be seen as having a "bonding" function between different logistics activities (Mathisson-Öjmertz and Johansson 2000), and is accordingly here considered as the interconnecting logistics activity in relation to transforming goods. This view is described in figure 2.2 below:

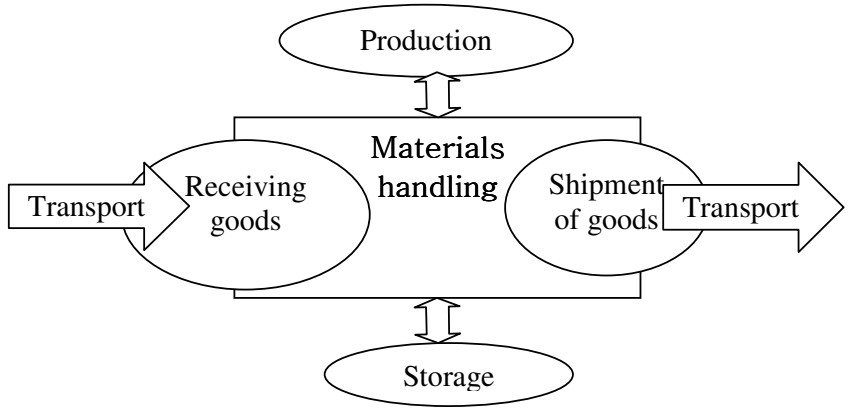

Fig. 2.2 The interconnecting role of materials handling. (arrows show the direction of movement of goods between types of activities)

The arrows in fig. 2.2 represent transport, moving goods from one location in the supply chain to another. Receiving goods and shipping goods are considered materials handling activities carried out in close conjunction with transport. According to Mathisson-Öjmertz and Johansson (2000), the efficiency of materials handling should be seen as an intermediate activity between other logistics activities and logistics facilities. Based on the state of goods delivered to materials handling, combined with how materials handling is carried out, will together influence the subsequent transport, storage and production activities.

Materials handling is an important cost driver in the supply chain representing about 30-75% of a products' final cost depending on the industry (Kulwiec 1985). If we look at the total warehouse costs, order picking on the average represents 65% (Coyle et al. 2003). Aminoff et *al.* (2002) found in a study of 45 Finnish warehouses that picking activities represent 24% and holding goods 30% of the costs. At retailers 75% of the total materials handling time in a store, is related to the handling of packages (Lee and Lye 2002). Materials handling is a costly activity involving complex manual handling of small individual units within a large total volume and within a short time frame. In addition, the forms of the good, such as the packaging containers, influence how all logistics activities are carried out (Davis et *al.* 1998, Mathisson-Öjmertz and Johansson 2000, Jahre and Hatteland 2004, Klevås 2005).

The logistics activities to transform goods in a flow setting may be organised in different manners. In the following section we will see how the supply chain context influences the features of the flow of goods.

2.1.3 Features of the Flow of Goods

How goods are transformed through logistics activities in the scope of the supply chain, is denoted as "features of the flow of goods". This transformation of goods is influenced by supply chain management components and the supply chain network structure (Lambert et al. 1998b). The structure of the supply chain consists of actors using facilities to carry out logistics activities. How supply chain actors and resources are organised in relation to each other, is influenced by supply chain managerial principles. We shall use a model to classify the features of the flow of goods.

A model to classify features of the flow of goods
According to Childerhouse et *al.* (2002) "… modern day marketplaces have diverse requirements for alternative products and services. No one demand chain strategy can best service all these requirements". Childerhouse et *al.* (2002) state therefore that a structured approach to supply chains is required, meaning that the features of the supply chain need to be classified providing the basis for comparing features of different supply chains with each other. By using the structured and classified attributes of the supply chain we can describe and compare the impact of time, location and form on the transformation of goods in the context for a specific flow of goods. The time, place and form features may then again be used to describe how logistics activities are carried out and thereby why goods are transformed in a specific manner. As discussed in the preceding section 2.1.2, a flow of goods consists of a sequence of different logistics activities. However, there is also a need to classify the entire scope of the flow of goods in a supply chain context in order to distinguish one flow of goods from another.

The attributes of a flow of goods is not the same as the features of goods, rather it describes how goods are transformed in the entire scope of the flow of goods. Christopher and Towill (2000) propose 1) duration of life cycle, 2) time window for delivery, 3) volume, 4) variety and, 5) variability as features distinguishing the supply chain (the "DWV scheme"). Persson (1995) uses the attributes of lead-time, uncertainty, frequency, and seasonality as the distinguishing features of an order-response cycle, involving aspects of the flow of goods and flow of information as a limited part of the supply chain. These classifications of features of the flow of goods are comparable. Both classifications comprise of lead-time as a factor, thus also accounting for communication regarding goods prior to carrying

out logistics activities, such as when purchasing and ordering goods. However, while the "operational characteristics" (Persson 1995) only encompass features of the order-driven flow of goods, the DWV scheme (Christopher and Towill 2000) encompasses the entire flow in a supply chain. In addition, the DMV scheme encompasses features such as product life cycles, representing features of the goods in a wider time and customer-related perspective. For the purpose of describing the flow of goods attributes from both classification systems are used. "Time", "variation" and "frequency" are proposed and have in this study been used as the key distinguishing features to analyse the flow of goods.

Time

Lead-time is limited to the order-driven part of the flow of goods. Therefore "time" is used to describe this feature. The understanding of time as a feature of the flow of goods is in many ways overlapping in relation to the preceding discussion regarding time as a feature of utility discussed in Section 2.1. Time involves here mainly time intervals, the duration of time in the flows, and when goods are distributed if goods are seasonal.

Variation

Uncertainty and seasonality of goods are grouped into a category called variation, which describes the variation in the volume of the flow of goods per unit time. The degree of uncertainty in flow variation is regarded as an additional attribute of "variation the flow of goods". According to Thompson (1967:69) the environment of the supply chain may be described in relation to a "*stable –shifting*" continuum. In the flow of goods variation is mainly related to the volume per unit time of a specific type of goods. In stable environments the supply and demand for goods is relatively constant, while in more shifting environments variation is greater. This involves the role of the environment (including both variations in supply and in demand) on the flow of goods, and how the location and form features of goods may vary in relation to time. Variation is, therefore, regarded as a basic attribute influenced by environmental contingencies and involves variations in time, location, and form (including volume) features of goods.

Frequency

Frequency is used to describe how often an identifiable collection of goods (e.g. a shipment or a batch) is transported, stored, produced, or handled. It is also used to describe how often goods are identified prior to a logistics activity. Frequency is used within Persson's (1995) framework for the order-response cycle since the timing of logistics activities is not dependent on

whether orders or forecasts represent the basis for this aspect of the transformation of goods.

A model of the features flow of goods

Together the time, variation and frequency features of the flow of goods are used to explain how and why logistics activities are carried out in a certain manner. Features of the flow of goods, according to Jimenez et *al.* (1998), influence how logistics activities are carried out. These features also enable comparison of different flows of goods to each other. Persson (1995) proposes that operational characteristics are influenced by the structural context and managerial principles of a supply chain. Lambert et *al.* (1998b) propose that supply chain business processes (including logistics activities), supply chain network structure and supply chain management components be regarded on equal terms. Persson (1995), on the other hand, proposes a hierarchical model to relate operations to the managerial level in the supply chain.

In this thesis a flow of goods is viewed in line with Persson's (1995) framework, as influenced by a combination of managerial principles and the supply chain structure. In addition, a flow of goods is according to Persson (1995) also prone to uncertainty, which causes as previously discussed, variation in the flow of goods. Further, uncertainty may involve other supply chain capacities such as variations in workforce features, changes in government regulations, and unexpected facility breakdowns. This feature is accounted for in figure 2.3 as "environmental contingencies". The factors influencing the features of the flow of goods are shown in fig. 2.3 below:

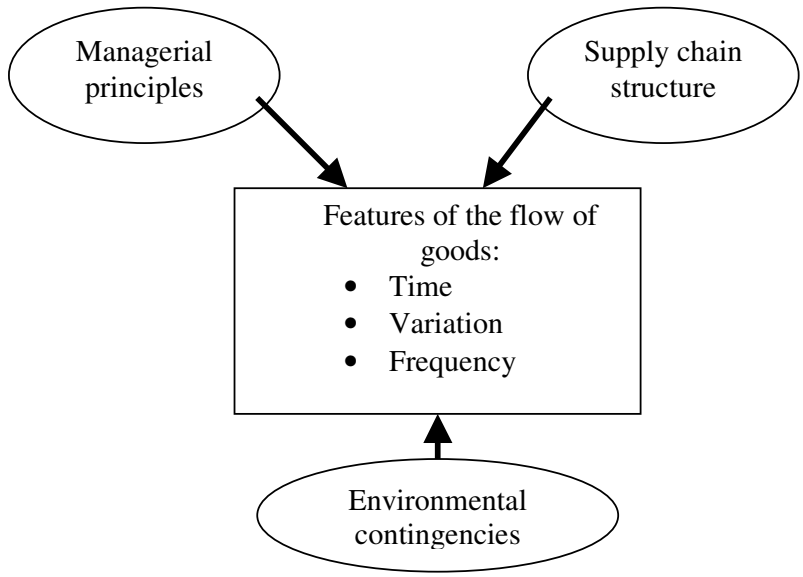

Fig. 2.3 The features of the flow of goods and contextual influences consisting of managerial principles, supply chain structure and environmental contingencies. Arrows represent direction of influence.

The role of supply chain structure

The supply chain may fundamentally be described as a structure consisting of 1) the location, number, capacity and capabilities of facilities, and 2) the volume and form features of the goods (based on Heskett et *al.* 1973:275-276, Ballou 1976, Lumsden 1998:566-573). An alternative approach to describing the supply chain structure as proposed by Lambert et *al.* (1998b) is to account for supply chain actors and how these actors are interrelated. In this thesis both features of facilities and actors related to the transformation of goods are used to describe the supply chain structure. In this study both these views are used to describe supply chain structure. Interrelated and different actors are viewed as using different facilities to carry out sequentially organised logistics activities. According to Croxton and Zinn (2005) logistics costs in a supply chain are influenced by its structure, coordination of inventories at warehouses, and adjusting the location and number of warehouses in the network.

The role of managerial principles

Managerial policies play, according to the model depicted in figure 2.3, a central role in influencing how goods are transformed through logistics activities. Speculation and postponement principles have recently been revitalised and now play a more prominent role within supply chain management literature (see Bowersox and Closs 1996, Van Hoek, 1998, Pagh and Cooper 1998). This line of approach regarding management principles within a supply chain are applied here since they account for how operating the flow of goods in its *entire scope* is influenced by different types of *information*, provided and used by intercommunicating actors in a supply chain. This aspect of the role of information in a supply chain is accounted for more thoroughly in the following Section 2.2.

When actively using inventory as a buffer to supply demand, this is according to Bucklin (1965) is termed speculation strategy. On the other hand when distribution is organised in accordance with a postponement strategy (Alderson 1950, Bucklin 1965), inventories are stored at a minimum level and goods are delivered based on actual orders. More precisely "postponement" is a principle of delaying production until order information has been received. This represents what is termed "order-based production". Alderson (1957) introduced this concept, stating that "…the most general method which can be applied in promoting the efficiency of a marketing system is the postponement of differentiation… postpone changes in form and identity to the latest point in the information flow; postpone change in inventory location to the latest." The principle of postponement is now widely used in industry practice (Van Hoek 1998). Bowersox and Closs 1996, Mattsson 2000 and Pagh and Cooper (1998) classify different forms of speculation and postponement supply chain principles showing how and why goods are transformed. These may be described as:

- Full speculation: The main part of the flow of goods is based on forecasts. Only the furthest downstream part of the flow of goods may in some cases be based on orders.
- Time postponement: Materials transport based on customer orders. A standardised product is produced as late as possible. Transformation of form features of individual products.
- Place postponement: Location of inventory moved upstream in centralised manufacturing or distribution operations to postpone the forward or downstream movement of goods. Transformation of form features of goods by the manufacturing company.
- Form postponement: Final production or component assembly based on customer orders. Transformation of form features of goods by distributors

The use of postponement or speculation principles specifies the grounds for how a particular logistics activity in a supply chain is based on an order or on a forecast. These principals show how different types of order or forecast information direct the flow of goods. In addition, postponement and speculation principles influence when certain logistics activities are carried out, and how they are sequenced with each other.

Conflicting objectives

The supply chain is not only an arena for developing harmony and actor integration. In an unruly volatile market context (Christopher and Peck 2004), environmental contingencies challenge the supply chain structure and the use of managerial policies. The supply chain may also be an arena of conflict between competing business objectives. Heskett et *al.* (1973:43-44) and Ellram et *al.* (1999) discuss how correct and timely delivery may be problematic since marketing objectives aiming to provide customer satisfaction in order to create a foundation for sales, may conflict with logistics aims of economising the use of logistics resources. For instance, Heskett et *al.* (1973:43) discuss how marketing may aim for presence of products in an abundance of retail locations in order to secure availability of goods. This may then be in conflict with logistics calculations regarding an optimal distribution of goods. Ellram et *al.* (1999) show how marketing objectives desiring high customer service and product variety may conflict with manufacturing efficiency of stable production runs of a single product. Retailed products also have differing characteristics regarding the importance of their availability. Items that show a strong relationship between retail stock availability and sales should "…be pushed forward in the distribution channel where it can be used to maintain display stock levels" (Larson and DeMarais 1999). The effectiveness of logistics activities in supplying goods is also related to marketing goals. Therefore, the balancing of the "income" or marketing perspective with the "cost" side of logistics activities will always involve a certain degree of compromise. Coordination of logistics activities, therefore, must take into consideration not only logistics aims to efficiently provide goods to an end user, but also how end user needs are satisfied which influences product sales. This is related to a marketing perspective regarding the transformation of goods.

Coordination in a supply chain

A supply chain is a complex structure involving multiple elements that must be coordinated with each to achieve an efficient flow of goods. This structure may be designed in various ways in accordance with different principles of postponement and speculation. Within this flow different types

of goods need to be combined in relation to sequentially organised logistics activities.

The issue of coordination places focus on how well different resource elements in a supply chain are interrelated in relation to the activities. The degree of supply chain integration reflects how well logistics activities are coordinated with each other in order to transform the features of goods (Lambert et *al.* 1998b). According to Holmberg (2000) coordinating activities in a supply chain is, difficult due to "…the complexity induced by a large number of related and interdependent activities in the supply chain." A fundamental challenge of logistics as a component of supply chain management is coordinating the multiplicity of actors, resources, and activities used to transform utility in the flow of goods. Supply chain actors need to coordinate the various logistics facility capacities with the goods flowing through the supply chain and transform these goods through a sequence of logistics activities often performed by different actors. These actors must be linked to each other in order to be able to coordinate the different logistics activities. Furthermore, according to Gadde (2000) the level of coordination is influenced by the use of speculation or postponement to manage the flow of goods. The use of principles of postponement increases the need to coordinate the supply chain actors since this principle increases the importance of orders in directing the flow of goods, and orders are prone to uncertainty. Therefore, an order-driven flow of goods may be regarded as demanding a higher degree of coordination of logistics capacities with variations in the flow of goods than a forecast driven flow of goods.

Accounting for different operational and managerial perspectives regarding how goods are transformed in a supply chain structure, represents the foundation of this framework. We shall now look at the role of information as a resource facilitating the coordination of logistics resources, in essence, the variations in the flow of goods and frequencies at facilities. Information is accordingly regarded as a vital tool used to secure the provision of time, place, and form utility of goods by binding supply chain actors together in achieving logistics goals.

2.2 Information and the Transformation of Goods

In a supply chain information plays an important role to support the flow of goods in accordance with logistics goals. Information is regarded as an aspect of knowledge in an organisational setting. According to Dyer and Singh (1998) knowledge sharing between actors from various firms in a supply chain may be defined as "…a regular patterns of inter-firm

interactions that permits the transfer, recombination, or creation of specialized knowledge." In business relationships knowledge sharing may encompass both information sharing and the sharing of know-how. Information may be coded in accordance with syntactical rules for encoding and deciphering. According to Kogut and Zander (1992): "Information includes facts, axiomatic propositions, and symbols." Information plays a vital role in the more immediate provision of meaning and aim, and thereby also giving direction to the technical operation of the flow of goods. It is this more immediate nature of using *information* that is focused upon in this study.

Know-how, on the other hand, encompasses the realm of "tacit knowledge" (Polanyi 1966) which is difficult to codify and thereby also difficult to communicate between actors. Know-how, due to its "sticky" features, is of importance in relation to learning how to develop logistics activities in a more long-term perspective. Learning is therefore an important feature applied when describing "know-how" since the features of know-how itself are more difficult to accurately conceive. However, know-how and information are viewed as closely interrelated resources, since using information is dependent on knowing how to use codified types of data. Know-how is therefore regarded as contingent regarding the use of the package as an information resource.

This section places focus on the various features of the flow of information and how this flow is related to the flow of goods. According to Håkansson and Snehota (1995) resources have a provision side and a use side stating that: "Provision determines the features of resource elements that can, but need not be, of use. The value of resources is dependent on the use of their features…" (ibid.:132). This part is structured in accordance with the view that in order to understand the nature of information as a resource, the interrelationship between its provision and use must be addressed. First in Section 2.2.1 features of the provision of information is discussed. This is followed in Section 2.2.2 with how information about transformed goods is exchanged, and in Section 2.2.3 the role of information systems including ICT (Information and communication technology) as the setting for information exchange is discussed. Finally Section 2.2.4 concludes this discussion by placing focus on how information about goods is adapted to different user needs before being used.

2.2.1 Provision of Information

Logistics information is communicable data used within firms and in business relationships for "…planning, operating and controlling the overall logistics system" (Heskett et *al.* 1973:500), and is, therefore, a key to being able to organise and carry out logistics activities in the supply chain. Information about goods should mirror the basic properties of goods. Transport, storage, production, and materials handling are activities with different purposes and are dependent on information in order to plan, operate, and control these activities (Heskett et *al.* 1973). In addition, activities that transform goods, the logistics activities, are carried out *sequentially* in relation to each other (Alderson 1965, Thompson 1967). Therefore, not only do different resources need to be organised to carry out operations within the scope of an individual activity. In addition, the different logistics activities need also to be organised in relation to each other in order to carry out logistics activities in an efficient manner (Lambert et. al 1998, Gadde et *al.* 2002). While the transformation of good is sequential, this feature is not equally evident regarding the flow of information. In this first part we discuss how the information about goods is used for planning and controlling the transformation of goods. This is followed by a discussion on how information is used to coordinate logistics activities. Finally, the role of documents in facilitating the identification of goods and thus the provision of updated information about goods is discussed.

Planning and controlling
Information regarding logistics capacity and inventory plays an important role in transforming goods since they control slack in capacities in relation to variation (Christopher and Peck 2004). Information is used to plan frequencies for when logistics activities should be carried out, and also plan the volume of goods and the time frame of the transformation of goods within individual logistics activities. Employing slack in capacity of transport, storage, production, and materials handling influences how goods are transformed and the efficiency of this transformation. Information about goods is used in order to provide direction to the flow of goods. "Direction" in relation to goods is information that supports the provision of time, place, and form utility to the next actor in the supply chain. The direction to specific logistics activities determines how goods are transformed based on either forecasts or orders. Forecasts and orders are founded on actual sales or anticipation of sales, and these types of information represent the planning aspect of informing about goods.

Postponement and speculation are terms used to describe and understand the premise for the information provided to the supply chain actors and as such provides logistics planning information. While speculation in a supply chain setting involves using forecast-based information to control production and use of inventories as buffers in a flow of goods, a postponement strategy relies on order information to direct the flow of goods, usually on a short notice. In practice the scope of the flow of goods is usually managed based on a combination of speculation and postponement principles (Christopher and Towill 2001). Usually an upstream part of the flow of goods is operated in accordance with principles of speculation, while a downstream part is operated in accordance with a postponement principle. The transformation of goods is, therefore, according to Mason-Jones and Towill (1999) partly driven by orders, and partly by sales forecasts. The point in the flow of goods where the principle of transformation of goods is changed from being forecast-driven to being order-driven, is termed "the materials decoupling point" (Mason-Jones and Towill 1999) or the "push-pull boundary" (Simchi-Levi et *al.* 2000).

While the order-driven part is based on actual sales, the forecast-driven part has a greater degree of uncertainty. This part of the flow is driven by logistics plans where variations in supply are coordinated with an anticipated demand. In the order-driven part the intended time, location, and form features of the goods are usually known when orders are received, and this information is then combined with information concerning resource features and capacities and/or slack in production capacity to assign these ordered goods to the next supply chain actor. Uncertainty in the upstream part of the flow of goods is, therefore, related to the accuracy of forecasts in predicting supply and demand, while in the downstream part of the supply chain uncertainty is related to features of actual orders.

Information about goods may either be based on forecasts or orders, and how this information is provided influences how logistics activities are carried out individually and in relation to each other. Leanness and agility are features describing how goods are transformed through logistics activities, and the roles of leanness and agility vary depending on whether the supply chain is managed in accordance with speculation or postponement principles. Agility is used in the sense of the actor's "…ability to match supply with demand" (Christopher 2005:117), while leanness is "…developing a value stream to eliminate all waste including time, and to enable a level schedule" (Naylor et *al.* 1999). According to Christopher and Towill (2001), the part of the supply chain that is operated in accordance with principles of speculation, should be analysed in relation to its degree of leanness since plan-based operations involve seeking to optimise the cost-

efficient use of logistics resources (Christopher and Towill 2001), while the downstream part of the supply chain operated in accordance with principles of postponement, needs to be agile since orders are uncertain and therefore represent variation in the flow of goods. Therefore, different types of information are needed to plan and efficiently operate the flow of goods. In cases where leanness is sought, accurate data is combined with planning tools to forecast and optimise the flow of goods. When agility is sought, information must be in the restricted time frame as defined by an order to be adapted in order to control the flow of goods and to coordinate and perform logistics activities.

Coordinating logistics activities

Different types of information about goods must be combined in order to coordinate operations using different facilities within logistics activities and to sequentially organise these activities (Heskett et *al.* 1973:502). To coordinate logistics activities in relation to each other, slack in production facilities in the flow of goods must be communicated. This involves providing information about the facility and human resource capacities and capabilities. This also is concerned with coordinating plans with respect to other goods handled by the same human resources and facilities. Information concerning production slack needs then to be combined with information derived from a combination of logistics plans and actual orders. The postponement and speculation principles influence the role of orders and plans that are used to give direction to the flow of goods. After a sales order has been lodged, a specific product order needs to be coordinated with plans for using different logistics resources in logistics activities.

Providing the information about goods necessary to enable the planning, control, and operations of the flow of goods involves combining different types of information. Information that provides direction to the transformation of goods is provided through orders and forecasts and is combined with plans organising the capacity of these resources. As such, information used to assign goods to logistics activities requires that the goods first have been identified, registered, and then combined with orders and logistics plans. According to Gadde and Håkansson (2001: 71); "Efficient coordination relies on the exchange of information. Performing an activity in an efficient way calls for information concerning activities undertaken before, as well as the ones coming after." This provision of information to carry out logistics activities is based on communication between supply chain actors. This provision and use of information related to the flow of goods is shown in fig. 2.4 below:

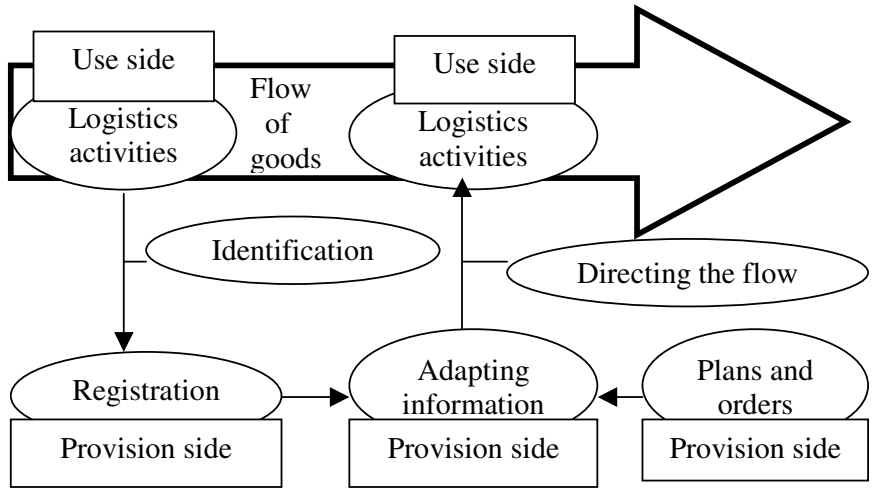

Fig. 2.4 The provision, adaptation and use of information related to the transformation of goods. (arrows show the direction of information provision)

First goods are identified and then registered after upstream logistics activities have been performed. Identification is a control activity where plans are compared with the goods in relation to a logistics activity. Registration is an activity that creates information using an information system concerning the time, location and form features of the goods. This provides updated information describing the present state of goods. Secondly, this information describing the goods is used to direct the flow of goods such as assignment of goods to the following logistics activity. This assignment is dependent on a combination of other types of information such as logistics resource capacities, orders and logistics plans. This combining of information is used to adapt the information content about goods to be able to accurately perform the following logistics activity in accordance with logistics plans.

Identification and control using documents

Identification is an activity that involves the interplay between features of goods on one hand and features of information on the other hand. Documents play an important role in facilitating the identification of goods coupling information with goods. Documents are as such an information containment facility that is structured in accordance with conventions or agreements between supply chain actors. In the same manner as goods have expected form features, information, through documents, also have form features established through conventions making the information content comprehensible to users.

The transformation of goods is based on the identification and control against documents at various stages of the flow of goods. Identification is needed to verify the time, location, and form variables of the goods. Labels or tags are attached to the goods providing an information content that may be verified with information about goods provided through an information system, thus facilitating accurate identification of goods. This information is registered in the information system. If the identification of goods is automated, the registration and identification of goods is a simultaneous action. There is otherwise a manual process linking identification with registration involving a decision whether to register this identification of the goods or not. When goods have been registered, this information is then stored and processed in the information system.

Documents are provided to personnel handling goods in an electronic or paper form in order to carry out logistics activities. A logistics document is adapted by combining different types of information and includes previous identifications of time, location, and form properties of the goods. Other types of information may also be included with this information such as forecast or order information about the goods, which provide direction to transform the goods. Also information regarding various human resource and facility capacities and capabilities may be combined to provide information content in a document.

Logistics activities are performed based on documents containing information about goods together with information of supply chain capacity and capabilities. Documents provide personnel instructions on how to act. This may e.g. be described in relation to picking orders. In a warehouse an order represents the basis for picking goods for subsequent distribution. An order consists of a number of order lines representing a product name and/or product code (De Koster et *al.* 1999). Order lines are represented in documents, picking lists, used to move goods to a location in the warehouse to facilitate loading of a transport vehicle. Each order line in the document also informs about the specific product quantity that is to be picked. De Koster et *al.* (1999) have shown that the information content in a document is a variable, and that by batching orders, picking efficiency can be significantly improved. Malmborg and Altassan (1998) analysed the use of storage assignment policies of less than unit load in warehousing systems. This form of assignment of goods involves breaking up incoming bulk goods and assign these goods to new and non-standard units of goods, such as placing them together on pallets. As an increased number of different goods need to be handled, this increasing complexity must also be contained in the information concerning goods, how they are identified, registered,

controlled, and adapted to use. How information about goods is adapted to user needs and then communicated to different supply chain actors, influences the transformation of time, location, and form utility of goods. This is, therefore, an important issue in relation to economising the flow of goods.

The borderline between the document and the information system may be fuzzy, such as when documents are provided on a computer screen, and may be altered on-line. In the case of a paper document it is clearly physically detached from the information system. Variations in product supply and demand are pieces of information describing form and volume features of goods at each end of the supply chain. Orders of goods and forecasts representing anticipated orders denote the basis for assigning goods to logistics activities. Orders and forecasts are used to provide direction to the flow of goods and together with information regarding capacities and capabilities to coordinate logistics activities. To be able to coordinate logistics activities, updated information regarding the present state of goods needs to be known. Goods are, therefore, identified and registered. This combining of information regarding the future and present state of goods, shows how time is a core feature of goods and is regarded as a core information content concerning goods discerning different types of information about goods from one another. The role of the temporal states of goods in relation to the provision of information to carry out logistics activities is illustrated in fig. 2.5 below:

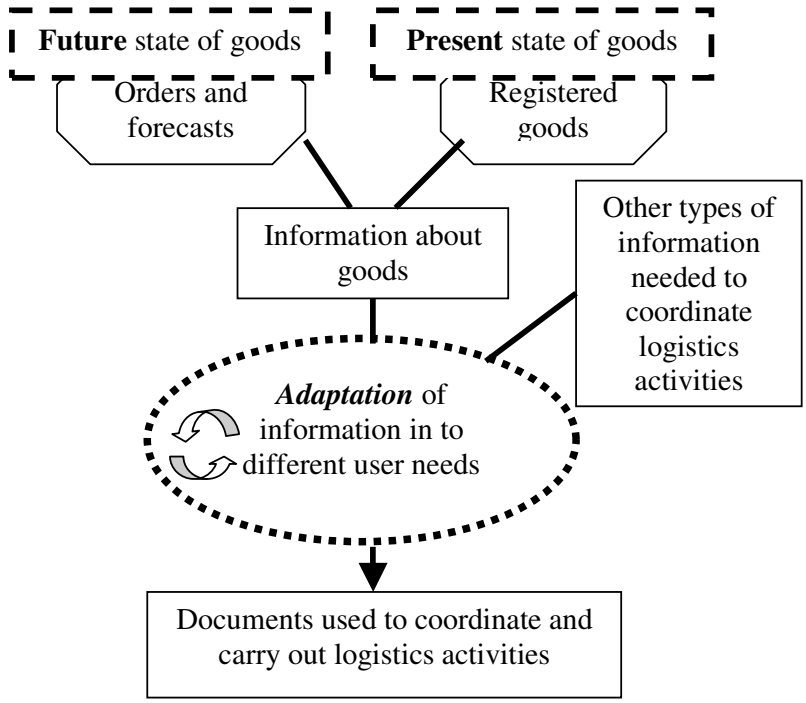

Fig. 2.5 Adaptation of information about goods to coordinate and carry out logistics activities

In a supply chain, as goods are transformed through logistics activities, information concerning the present state of goods needs to be updated at intervals in the sequential transformation of goods or in a continuous manner in order to carry out logistics activities. Information exchange plays a vital role in facilitating this provision of information, and the next section addresses in detail issues regarding the exchange of information in a supply chain in relation to the transformation of goods.

2.2.2 Information Exchange

Information sharing in a supply chain is a fundamental aspect of its operation and development (Zsidisin and Ellram 2001). The adaptation of information about goods may be organised differently depending on the structure of the supply chain and the management principles that are used. This section focuses on how information concerning goods is communicated between supply chain actors.

Information standards
Information exchange involves communication between different actors in a supply chain. Standards are conventions for carriers of information content about goods. These conventions regarding how to communicate about goods play a fundamental role in increasing the comprehensibility of information exchanged between actors. How information content and information carriers are used through documents influences the efficiency of communication in a supply chain.

Gadde and Håkansson (2001:72) discuss how information standardisation, from the perspective of a purchaser, leads to all suppliers being handled in a uniform manner, increasing the similarity of activities in relation to different suppliers. This influences the efficiency of information exchange, which again is influential in relation to how logistics activities are performed. Whiteoak (1999) presents a suppliers view of what he terms as "quick response" in the supply chain, and discusses the importance of information content concerning goods to facilitate rapid replenishment of retailer inventory. Whiteoak (1999) states that "…in retail, detail is all." Information exchange in order to replenish inventories managed by the vendor requires "… all the cooperating parties to use similar protocols and common product numbering" (Kaipa and Tanskanen 2003).

An obstacle in communications about goods, are the many isolated and incompatible units of measurement. The reason for this is that "…the measurement activities in supply chains are not managed as a single system, but as several independent systems" (Holmberg 2000). A unifying measurement system is proposed as the solution to this type of communication interference, and such a system will stimulate the integration process for which the supply chain management aims. The linkage between planning and actions related to the flow of goods is based upon, according to Holmberg (2000), "…a heavy reliance on financial measures causing reactive behaviour, and a confusing multitude of isolated measures." This means that the use of different standards to control logistics activities may confuse actors, so influencing how logistics activities are planned and later operated.

According to Holmberg (2000), an important aspect of information exchange, in order to efficiently achieve a coordination of logistics resources, is that supply chain actors also efficiently communicate with each other. In the same manner as any society needs a unifying language to communicate, supply chain actors also need to agree on conventions regarding communication. This involves the use of a common professional terminology. In addition, according to Holmberg (2000) the measurement

system used in the supply chain, involving also how goods are measured and thereby may be classified, influences how information about goods is communicated between actors, and thereby also influences the performance of the overall supply chain when viewed as a whole. A common measurement system of goods influences accordingly quality features of information exchange regarding how rapidly and accurately information may be communicated.

Within the supply chain the use of numerical codes is widespread in documents, including labels and tags attached to packages. In logistics the GS1 (www.GS1.org) standard for coding goods and facilities used in conjunction with goods is prevalent. A code is a numerical standard, and coding information represents the use of a specific form of information carrier. Codes facilitate the translation of information into a form that may be automatically communicated. These numerical codes are better adapted to electronic information systems than text. Thus information exchange in a supply chain may become automated to a higher degree, reducing the problem of information distortion caused by human interference. Codes also help make information exchange more manageable especially when communication is automated (Heskett et. al 1973:503-506).

The GS1 standards may be used as a bar-code form together with the numerical code on a label, requiring an optical scanner to communicate information. This code is basically a numerical code that may be printed in numbers or bar codes and stored electronically. The core of the GS1 system, known as the GS1 128 article code, is used to identify products. This code system provides a precise coding of a product form including consumer level packaging when used. The GS1 128 system standard is represented by a 13 to18 digit code that comprises a set of identifying codes and unique codes making each marked package a unique entity. GS1 also denotes the GS1 128 article code as a GTIN (global trade item number) may include the batch number of the item, the best-before date, and the net weight of the goods. This is done to accommodate relating this core aspect of the GS1 code with other coding features included in the GS1 standard. The GS1 system consists of the following three code attributes that are used together:

- GTIN (global trade item number): GS1 128-based article number used to identify a specific product. (in addition, a GTIN+ code may be used, here extra digits are applied to give each labelled article a unique identity)
- GLN (global location number): to identify a specific location or facility and the firm administering this facility

- SSCC (serial shipping container code): used identify a unique logistics unit.

Together these coding sub-systems may be used to provide accurate numerical identification of goods.

Information sharing

Information sharing involves collaboration between various supply chain actors as a way to improve how information is exchanged in a supply chain. This is an important aspect of increasing integration, which is a prime objective of supply chain management philosophy (e.g. Lambert et *al.* 1998b). Different management and operational principles exist for how information about goods is exchanged, including economic order-based methods (EOQ), just-in-time methods such as materials requirement planning (MRP), and types of push (forecast-driven) and pull (order-driven) distribution principles (Ballou 1999b). These represent the basic framework for information systems-based procedures as part of inventory replenishment procedures carried out by a supplier for a customer in a supply chain. Skjoett-Larsen et *al.* (2003) propose a framework of supply chain information sharing using CPFR (collaborative planning, forecasting and replenishment) as a general approach. CPFR is defined as: "Collaboration where two or more parties in the supply chain jointly plan a number of promotional activities and work out synchronised forecasts, on the basis of which the production and replenishment processes are determined" (Skjoett-Larsen et *al.* 2003). The framework of CPFR shows how a wide variety of information types are communicated in order to replenish stocks in the supply chain. This way of replenishing goods through attempting to achieve some form of supply chain collaboration, is a challenge since "…individual functional managers may be viewed as barons of their own territories and the organisation as a union of kingdoms or silos" (Skjoett-Larsen et *al.* 2003 interpreting Christopher 1998).

Småros et *al.* (2003) studied the various situations where information sharing practices among supply chain members including vendor managed inventory (VMI), are most valuable to manufacturers. This study shows that for products with "…a stable demand a partial improvement of demand visibility can improve production and inventory control efficiency, but that the value of visibility depends on the target products' replenishment frequencies and the production planning cycle employed by the manufacturer" (Småros et *al.* 2003). Småros (2003) discusses approaches to and the use of collaborative forecasting in a supply chain. In this article focus is placed on using the product life cycle model to identify variations in the essential information that needs to be shared among supply chain actors.

The product life cycle, the supplier's capabilities, the relationships between supply chain actors, and the degree of criticality and the value of the products are mentioned as factors having impact upon how supply chain actors may collaborate with each other regarding information exchange. Daugherty et *al.* (1999) have studied automatic replenishment programs (ARP) through a survey among retailers, and found a great awareness among retailers of this mode of information exchange in order to replenish stock, and also found that the effectiveness of ARP was influenced by how this program was implemented and the capabilities of the information system used.

Communicating about goods between different supply chain actors is dependent on the provision of accurate information about transformed goods based on the quality of identifications and registrations of goods. The next step is to address the issue of information accuracy in relation to directing the flow of goods.

Information accuracy

Information content may become changed in an unintentional manner in the scope of the supply chain. As early as in 1961 Forrester showed how a "bullwhip effect" distorts information in the context of a supply chain structure involving several intermediaries. The order patterns, as shown by Forrester (1961), increase in variance as one proceeds upstream in the flow of goods. The bullwhip effect is caused by insufficient coordination in the supply chain (Shore and Venkatachalam 2003). Towill (1991) shows how the interaction between actors in a supply chain influences the bullwhip effect, and that by integrating decision-making mechanisms this effect may be reduced. Variation in the supply chain is shown by Lehtonen et *al.* (2005) to be mainly induced by distributors, whereas retailers induce delay in demand synchronisation regarding inventory replenishment. Lee et *al.* (1997), based on the existence of a bullwhip effect, argue that order information should be used with great caution. Demand distortion arises according to Lee et *al.* (1997) as a result of uncoordinated optimising behaviour among the individual actors in a supply chain. Information distortion is influenced by how information is exchanged in order to replenish stocks, and shortening lead-time from order to delivery is identified as a route to reduce the time-frame within which order information may become distorted. Demand information is often withheld due to a "rationing game" among the supply chain actors that influences how forecast information, risk, and flexibility are shared. In addition the batch quantities of goods are often changed to reduce order costs and acquire price discounts. Thus, the information content about goods may not always accurately describe the actual characteristics of the goods.

Information distortion is accordingly a fundamental problem regarding information sharing in the supply chain since multiple actors receive, process, and communicate information, and each supply chain actor has needs and aims that are not necessarily aligned with the interests of other supply chain actors. Accordingly, we can expect information distortion to pose the greatest problems in the less integrated supply chains. The main strategy proposed to counter information distortion in a supply chain is through "…information-sharing of sell-through and inventory status data, coordination of orders across retailers and simplification of pricing/promotional activities to the manufacturer" (Lee et *al.* 1997). Lehtonen et *al.* (2005) advocate the provision of accurate downstream demand data to actors upstream, often manufacturers, in order to align production with market demand. Thus communication of POS (point of sales) data plays, an important role in reducing the information distortion problem in the supply chain allowing a more efficient coordination of supplies with demand.

The challenge to the manufacturer, according to Lee et *al.* (1997), is to motivate the retailer to provide the information that the manufacturer needs in order to adjust production in line with market demand, since the retailer has no obvious benefit of this form of information exchange. Based on Lee et *al.* (1997), Disney and Towill (2003) discuss the use of vendor-managed inventory within supply chains, identifying which actor, in the case of VMI the retailer, should control the overall supply of goods in a flow of goods. This question was originally brought up by Magee (1958), and Disney and Towill (2003) discuss how to allow the retailers to control their own supply involving a "condensing of the pipeline" and thus leaving less room for information distortion. Chen (1998) shows the value of centralised demand of inventory information in communications between supply chain members in coordinating supply with demand. The communication of information about goods may be organised in a manner reducing the threat of misinterpretation in relation to decision-making within the supply chain (Fiala 2005), and supply chain management aims of integration (e.g. Lambert et *al.* 1998b), representing a potential that may influence the accuracy of the information content by developing information exchange between actors. Holmberg (2000) explains how, through the standardising of the measurement of goods, information content that is exchanged also becomes standardised. When the flow of goods is standardised, this impacts on how information is exchange in the flow of information influencing also the degree of distortion in communication.

Information accuracy influences the transformation of goods both in relation to how goods and slack in the supply chain are identified and registered and how the flow of goods is directed, based on a combination of orders and logistics plans. In relation to planning, information accuracy also involves how well these plans are adapted to different supply chain user needs. The next step is to take into consideration the role of information systems in the exchange and adaptation of information to operate logistics activities.

Information systems

Information systems are tools used to support information exchange in order to plan, operate, and control the flow of goods. Information systems "…include both communication facilities and data processing facilities" (Heskett et *al.* 1973). The form of information content may, therefore, be changed and shared with other actors through using an information system. How information systems are designed, is founded on ICT (information and communication technology) representing the realm of opportunities for creating a structure for information exchange in a supply chain. According to Gadde and Håkansson (2001), taking the perspective of a supply chain actor having "…a multitude of customers with substantial differentiation with respect to the sophistication of information systems", how information is exchanged varies dependent on the impact of applied ICT.

Information systems may be classified in relation to degree of automation of information processing within individual information systems and communication between information systems. Information processing facilities transform information received from various actors in the supply chain and adapt information about goods for different uses. Golicic et *al.* (2002) discuss that information systems may provide increasing information visibility, and that this increase of provided information also increases uncertainty. Therefore, information must be provided in a context where information content is understood, and this depends according to Golicic et *al.* (2002) on information exchange and the integration of actors in the supply chain. Van Hoek (2002) found that information helps logistics service providers try to expand their service operations by "…expanding their grip on the supply chain and moving into operational areas…" (Van Hoek 2002), and how this activity also influences the configuration of the supply chain. Moberg et al. (2002) argue that since managers invest significant resources into acquiring and implementing logistics information systems, that "…it is extremely important to consider the quality of the information and the ability of the recipients to utilize the information based on differences in technologies being used" (Moberg et *al.* 2002). Information exchange must, therefore, take into consideration the capabilities of all supply chain actors to secure that information content is "accurate" also in relation to user needs.

Information system design is an important aspect of information systems. Information systems may be regarded in relation to speed, user friendliness, and accessibility (Gadde and Håkansson 2001:72). The use of ICT influences these features of information systems. One such information system design or structure is the ERP (enterprise resource planning system). An ERP system denotes different types of electronic-based information systems that may have a wide range of business applications. Each application in an ERP system is often organised into modules designed to accommodate more specific business functions. A supply chain management module within an ERP system may according Simchi-Levi et *al.* (2000: 240-241) have various logistics applications regarding 1) logistics network design, 2) inventory deployment, 3) sales and marketing region assignments, 4) distribution management, 5) inventory management, 6) fleet planning, 7) production location assignment/facility deployment, 8) lead time quotation, 9) production scheduling, 10) workforce scheduling, 11) demand planning, 12) capacity or supply planning, and 13) procurement/purchasing. An ERP system is then adapted by combining these different modules and providing a rich data-base that is used to inform supply chain actors involved in carrying out the logistics activities.

ERP systems usually are used for control purposes and represent an information infrastructure that may be used to facilitate the flow of information between all supply chain processes in an organisation (Martin 1998). However, Al-Mashariand and Zairi (2000) show in a case study regarding implementing and use of a specific form of ERP system (SAP R/3) that this is a challenging task involving a range of obstacles. In the past years many firms have reconfigured their supply chains involving the use of information, and this has implications for how transport is organised (Lemoine and Skjoett-Larsen 2004). The development of ICT creates according to Giannopoulis (2004) possibilities for the operation and management of transport networks. Recent developments in ICT may help improve terminal and port communication system, freight and vehicle tracking, and logistics systems in general.

EDI (electronic data interchange) represents, compared with an ERP system, a more restricted application of ICT to facilitate data exchange within and between information systems. EDI is understood as “computer-to-computer transfer of information” (Ellram et *al.* 1999) in a standardised form. EDI represents a potential for automating communications between supply chain actors, which also limits human error in information exchange. One application of EDI is the automatic transfer of POS data from retailers to distribution centres in for instance a VMI system (Ellram et *al.* 1999). Information, therefore, may play an important role in achieving supply chain

management goals for customer service through laying the foundations for a more timely and correct supply of goods. EDI systems may also be integrated into or linked with more overall ERP systems.

A more recent development related to EDI is the XML (extensible mark-up language) standard (www.w3.org). This represents a "mark-up language for documents containing structured information", and "…provides a facility to define tags and the structural relationships between them." (www.xml.com), thus improving the efficiency of electronic information exchange using documents. XML may, for instance, be used to communicate GS1 codes through a document facilitating scanning of goods without intervening manual information processing activities at a goods-receiving location.

Using information systems

As previously discussed, information content must be provided in a manner that is adapted to user needs. Information systems facilitate this adaptation of information content. For instance, a document containing information about goods may be also used for other purposes, such as marketing, other business purposes, or a wide array of societal purposes. A societal reason to inform about goods may be concerning documenting detailed product characteristics to secure product safety. Information about goods contains detailed information about goods combined with other types of information in a form adapted to different supply chain actor needs. According to Simchi-Levi (2003) the objectives of ICT (information and communication technology) and SCM (supply chain management) are: "1) providing information availability and visibility, 2) enabling a single point of contact for data, 3) allowing decisions based on total supply chain information, and 4) enabling collaboration with supply chain partners". These represent positive aspects of using ICT to support electronic data interchange. Accordingly, Williams et *al.* (2002) discuss how the use of electronic media represents an extremely dynamic structure, allowing actors to more easily be exposed to each other.

In the supply chain there is often a discrepancy between the needs of actors regarding how information is exchanged and adapted and their needs when using an information system. Supply chain information systems, however, tend to be implemented by technical experts in an environment perceived as "foreign" to the ICT professionals and used by logisticians not understanding the nature and potentials of ICT. Ellram et *al.* (1999) discuss that "…much of information technology in use today has been implemented in a piecemeal fashion, and is not directly connected to other internal or external systems". Further that "IC&T's supporting the various activities of supply network process are diverse and disconnected…", and that ICT needs

to a greater degree to "… shift from 'local optimisation' to 'supply network optimisation'" (Romano 2003).

Walton and Miller (1995) found that logistics actors were motivated to implement EDI due to expectations of faster and easier communication especially in relation to the use of supply chain management (SCM) principles of inter-organisational integration. In a study of implementing ICT solutions for SCM Auramo et *al.* (2005) found that "...benefits are overlapping and interlinked." When using "state-of-the-art" ICT, this type of media also provides an abundance of information in an economical manner. Sometimes logistics decision makers have to deal with the problem of navigating through too many documents provided by an information system (Gadde and Håkansson 2001).

Decision-makers in supply chains often feel as one logistics manager stated, "...swamped in information but starved of data…" (Popp 2000) and would like to be provided a focused form of comprehensible information adapted to their needs. There is, therefore, no uninterrupted cause and effect relationship between using ICT to design information systems to increase the accuracy of information exchange in a supply chain. Information system design must include both the information provided, and in addition, information about how this data needs to be adapted to user requirements. Also, the rapid development within ICT increases the challenge of using ICT in designing information systems that in an efficient manner contribute to the transformation of goods. ICT represents a resource that demands careful adaptation to supply chain actor needs in the scope of the chain regarding information exchange and the adaptation of information.

Information system design

Developments within ICT increasingly facilitate the design of information systems as networks or webs (Van der Vorst et *al.* 2002) rather than as a linear flow. A supply chain is in most cases managed and operated by using several interrelated information systems operated by different supply chain actors. These different systems further need to communicate with each other. In this manner, information subsystems together are used to manage and operate the flow of goods. Arntzen and Schumway (2002) present a practical ICT application using a model they term as "The Hub and Portal Architecture". In this model a focal actor, called "NMS", is placed at the centre of an information system representing a hub in a supply chain. Communication links are drawn between the focal firm and all actors involved in the supply chain as shown in fig. 2.6 below:

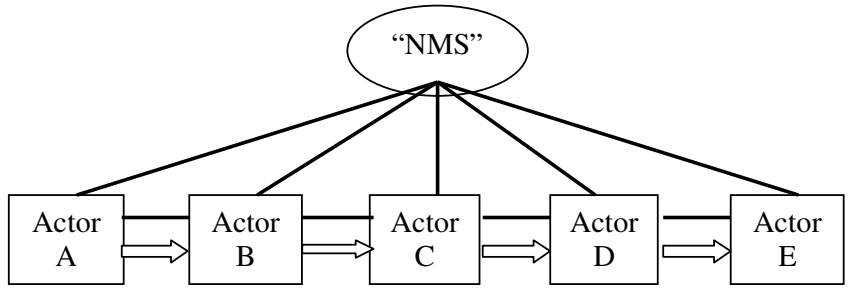

Fig. 2.6 The hub and portal information system used for physical distribution (based on Arntzen and Schumaway 2002). Each actor represents a different information system that need s to be linked with other information systems. (Lines indicate information flows, and arrows flows of goods.)

According to this model, information exchange is basically sequential between the different actors in the same manner as the flow of goods is sequential. However, in addition, information about goods may either be available in real-time through a central database to all supply chain actors or be communicated between pairs of supply chain actors sequentially "reflecting" the flow of goods. The hub and portal ICT system architecture enables the different supply chain actors using existing ICT solutions to communicate with each other using e-mail, e-mail spreadsheets on forecasts, schedule building, and more. The lines linking the various supply chain actors together indicate this. The centralised "NMS" system also facilitates on-line order entry and enquiry through the Internet. Customers can log in and receive order status information. This study shows the use of recent developments in ICT influencing the configuration of the information system that also provides the basis for moving the materials decoupling point upstream in the flow of goods. This design of an information system facilitates easier access to information from the entire supply chain, providing increased accuracy through greater speed in providing updated information to users. This centralised information system improves the control of the flow of goods. It also provides a more accurate and easier access to updated information that is of importance to the planning of logistics activities. However, this information system structure also binds supply chain actors together through investing in a common information system resource.

Information content that is exchanged about goods is influenced by the structure of the information system. The structure of the information system is again a result of a design process where ICT represents a realm of opportunities for solving the information needs of the supply chain actors.

The next important step is to consider how information about goods exchanged and provided may be adapted to user needs.

2.2.3 Adapting Information about Goods to User Needs

Information exchange has in addition to its provision side also a user side involving supply chain actor needs, and the combined needs within the scope of the complete supply chain network of actors. Information provided through the identification and registration of goods needs to be combined with information concerning the future state of goods and information regarding capacities and capabilities in the supply chain. Information systems have a supportive function in facilitating information exchange and adaptation in order to transform goods. In a supply chain, adapted information concerning goods is exchanged between different actors or used internally by a supply chain member.

Information and different activities
An information system is the main facilitator used to adapt information content to different supply chain user needs. While the transformation of goods involves registering the present state of goods and combining this information with the future state of goods, features of the past and present state of goods are related to two specific activities, tracking goods concerned with locating goods, and tracing products through investigating the history of goods. The provision of information to be able to inform about goods for carrying out logistics activities, tracking goods or tracing products is illustrated in fig. 2.7 below:

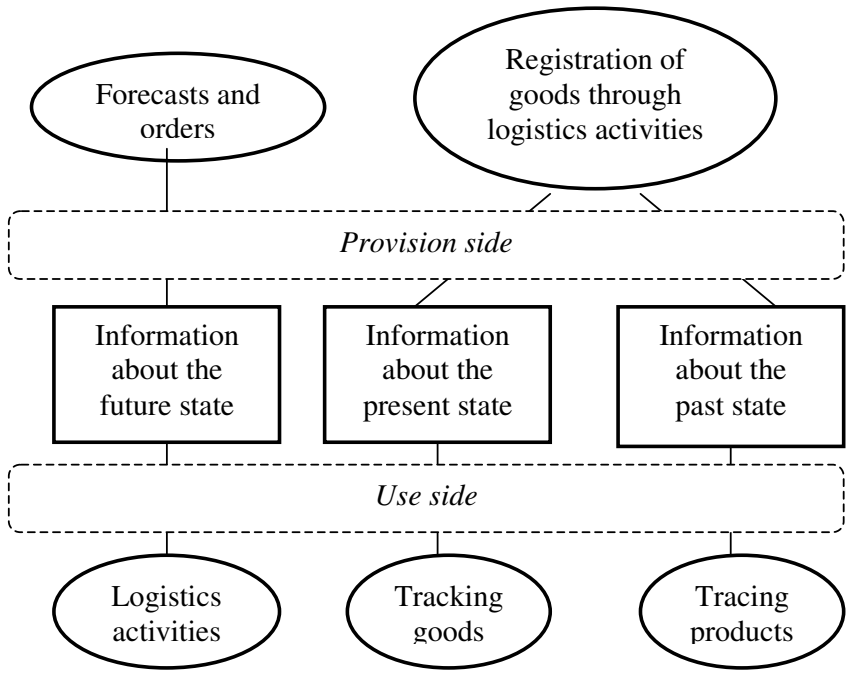

Fig. 2.7 The use of information concerning the different temporal states of goods

Information to track goods

Tracking goods is an activity that is carried out in order to provide information about the present state of goods. This activity, therefore, uses information provided through the most updated identifications and registration of goods. Any supply chain actor including those not directly involved in physically transforming the goods, may use information provided through tracking goods. Tracking goods may also be closely intertwined with logistics activities, since actors intending to handle goods also may need to carry out a form of tracking activity, possibly only to locate the goods within a warehouse, or when a delivery is delayed.

Tracking should be applied according to Johnson et *al.* (1999:235-236) as a problem-solving activity, when a shipment is lost or delayed. According to Williams (1997) tracking may be used to 1) manage the asset by identifying its present location, 2) avoid losses by identifying the point of loss 3) to accelerate the circulation process, and 4) minimizing stocks of non-circulating containers (or other reusable packaging). Information provided by tracking goods may be used in relation to inquiries regarding whether the goods are being moved according to plan including product form characteristics in a combination of specific times and locations. Tracking

goods also supports changing the direction of movement of the goods. This may be based on changes concerning order information, such as a request by the customer to change the destination address, the goods may be requested returned due to payment difficulties for sold products, or products which may have been resold to another customer requiring delivery to another address. Tracking goods may also hinder theft of goods since the time and location for such a disappearance may be more easily pinpointed with a tracking system. Also, a tracking system may more quickly detect that a package is missing if the goods do not arrive at a specific location at an expected time.

Tracking goods is an activity that secures the transformation of goods according to plan. However, in a wider perspective, the securing of delivery quality also has marketing implications, for example when customers need to coordinate their activities according to an estimated arrival time of a product. This information is of value to the customer in relation to e.g. inventory management, production scheduling, and informing its own customers regarding onward deliveries. The customer may be able to provide real-time information of a product's location to estimate a precise delivery time. This information may further be given to the firm's own customers further downstream in the flow of goods.

Huivio et *al.* (2001) describe regarding tracking goods the use of "…a lightweight distributed system that allows for the automatic notification of a parcel's movement directly to a server of the 'owner' of the parcel…" Williams and Rao (2001) have studied the use of RFID (radio frequency identification) as a tool to help track goods and identify organisational challenges related to the implementation of new ICT used to track goods. Giaglis et *al.* (2004) propose a tracking information system to increase the efficiency of vehicle routing based on real-time information regarding vehicle location. Kärkkäinen et *al.* (2004) discuss how tracking systems are rather uniform and that this might be based on that "…tracking was long perceived as simple in theory, but, surprisingly difficult to implement in practise". Tracking accordingly is an activity that takes place using an information system, and, therefore, shares the problems of using information systems in transforming goods as discussed in Section 2.2.1.

Key factors involved in tracking goods are: 1) the intended destination and route, 2) the actual destination and route representing the route the package or goods is currently following, 3) the item and, 4) the container (Williams 1997). This shows how tracking involves the flow of goods, logistics facilities, and information content concerning actual and planned destinations. To be able to track goods, a logistics information system needs

to be used containing information about goods having been transformed, but not yet delivered to the end-user. Important features involved in tracking goods are: 1) the operational scope of the system, 2) the goods identification technology used, 3) the coding of the tracked items, 4) the content of the exchanged tracked information, 5) the information architecture used in tracking application and, 6) the ways of accessing the tracking information (Kärkkäinen et *al.* 2004).

Tracking involves a combination of manual and automated routines. GS1 codes may be used to facilitate electronic and automated identification of goods. In order to locate goods, manual tracking involving the use of telephone queries, is still commonplace. Manual tracking routines may also coexist with an automatic tracking system. It is especially in relation to this mode manual tracking may take place since upon making an initial query, the holder of the desired location information may be unknown. In such a case, an intuitively based search process may be called for. Alternatively, globally unique identities may be assigned to the goods facilitating the registration of this information in an information system where all actors in the supply chain potentially may have equal access. RFID or GPS (global positioning system) technology may be used and automatically interface a supply chain information system.

Information to trace products

Tracing products is based on using information provided through registration of the previous transformation of goods. This involves uncovering the history of a product in the supply chain. In addition, products may be traced within a firm. In a supply chain, chain traceability represents interlinking the internal traceability of products. The need to trace food products has recently become highlighted due to recent EU directives. Since Jan 1st. 2005 in accordance with EU regulation 178/2002, full traceability of food-products is required within the EU. Product traceability is being able to trace a product's origin, use, and locations based on systematic registration (ISO standard 8402). The aforementioned EU directive is rather lenient in its formulation in relation to the individual actors that are part of the logistics network supplying a specific type of goods. Each actor in a supply chain must also be able to individually provide product traceability for one step in each "direction" of the chain, being able to account for their suppliers, customers, and logistics service providers. However, even though product traceability involves a limited explicit responsibility concerning the provision of product information on each individual firm involved in the supply chain, complete product information is required. Individual actors in the supply chain, therefore, need to cooperate in order to provide the required information if they do not themselves possess the necessary

information records about the product transformation. Product traceability includes therefore, as pointed out by Dreyer et *al.* (2004), combining internal traceability of a single actor, with chain traceability, linking these actors together.

According to Stock and Lambert (2001: 101) product tracing and tracking goods are activities that are combined and in order to "…avoid litigation, firms must be able to recall potentially dangerous products from the marketplace as soon as problems are identified". In this manner product traceability hinders a logistics or production facility in repeating discrepant activities , and similarly faulty products may be tracked and returned, repaired, or destroyed. Florence and Queree (1993) describe the inter-organisational character of this type of information placing focus on the importance of the complete point-of-origin to point-of-consumption nature of this information. Product traceability provides transparency in a supply chain through information exchange. The authors also discuss the opportunity of using this information to obtain accurate cost information and to register the value created by different firms participating in the total supply of the product. Dreyer et *al.* (2004) discuss how the implementation of a product traceability standard, using the GS1 system, in Norwegian fisheries industry is an enabler of information exchange securing the quality and efficiency of chain traceability. These authors also point to the need for cooperation between supply chain actors in order to coordinate information resources to secure electronic traceability through automated information exchange.

Information provided through tracing a product also may have impact on other business process. Kees (2002) is concerned with the business scope of using product traceability, that organisations "…do not operate solo, they are part of a larger network of interrelated organisations which are linked by markets of supply and demand." Bourlakis and Allison (2003) discuss the importance of an information-transparent supply chain in relation to issues related to food product safety concerning the recent foot and mouth crises in British agriculture. Töyrylä (1999) shows how information provided through tracing a product is used to manage the flow of goods, for legal verifications, to identify products with specific attributes, and to identify connections and causal relationships between the attributes of individual items and lots. Product traceability may be used to manage and operate the flow of goods in accordance with government regulations. According to Töyrylä (1999) it is the speed and ease of information availability combined with its accuracy that is shown as being vital to fully realise the use of product traceability. These factors are considered dependent on the nature of the information system which again is dependent on the organisational

setting. The study shows that product information regarding its past states is provided and used in an inter-organisational context, and that the provision and use of this information entails different functions within and between firms.

Kees (2002), in a study about tracing food products, states that: "Tracking and tracing of food products, however, is more difficult to define, as the literature reveals no common understanding on this subject." This view is founded on the still somewhat underdeveloped conceptual base used to study these activities. Van der Vorst et *al.* (2002) show in a study of 16 prevailing electronic business-to-business initiatives in food supply chains regarding how tracking and tracing are a part of supply chain planning, that tracking and tracing are an integral functional of this process together with co-forecasting and co-planning among different supply chain actors. The authors emphasize the importance of tracking goods and tracing products in relation to food safety and environmental issues and also the presence of quality certification programmes. The authors aim to show that by using electronic information exchange, a greater degree of visibility is provided, and this is important in relation to consolidating an increasingly more complex flow of goods to end users. Tracing products and tracking goods are in this study viewed as two distinguishable and separate activities. These activities may be carried out at the same time or sequentially and are often viewed as closely related activities as described by Van der Vorst et *al.* (2002).

Adapting information to variations in use

Product traceability and tracking goods is achieved through linking different information systems, and how these types of informational activities are carried out is influenced on how information is exchanged between different information systems. Tracking goods and tracing products is an example of adapting information content in the information flow to a specific purpose. In addition, information needs to be adapted to a wide range of other uses. Information used to distribute goods must, according to Heskett et al. (1973:502-503), be aggregated involving "…to combine as many pieces of information as possible to reduce costs of analysis without obscuring the basic differences in characteristics for segments of a firm's logistics system." An information system facilitates this aggregation of information components to support this need. The efficient aggregation of data types within an information system also depends on the registered information being accurately classified. The use of product coding systems, such as the GS1 standard, plays a key role in relation to this issue.

Different types of information about goods are used for communicative purposes in relation to various user needs. In a supply chain different actors manage and operate separate parts of the flow of goods. Therefore, the use of information may vary greatly within the supply chain since different capacity features of the supply chain need to be combined with different form features of the goods. In addition, information about goods may be used for other business and societal purposes than planning, operating, and controlling the flow of goods. In order to more precisely approach the nature of the variation in needs of different actors regarding information about goods, a classification taking into consideration the purposes of the activities is needed.

Gadde and Håkansson (2001:49) describe how different types of information in a supply chain may be linked with different uses or "roles of communication" using a matrix form. The type of information is a more static form of the information content being either 1) technical information concerned with product characteristics and use, 2) commercial information that is information needed prior to entering into a business transaction, or 3) administrative information needed to carry out a business agreement. These may be described as features of provided information. In relation to the use side, the roles of communication represent a more dynamic aspect of information since communication is an activity. The roles of communicating a specific information content may in a supply chain be either aimed at 1) coordination of supply chain actors using different logistics resources and being responsible for carrying out different logistics activities, 2) influencing supply chain actors including end-users and, 3) learning to develop the structure and processes of the supply chain. The different 1) types of information and 2) roles of communication may be classified using a matrix as shown in fig. 2.8 below:

Roles of communication:

Type of information:	*Co-ordination*	*Influencing*	*Learning*
Technical info.			
Commercial info.			
Administrative info.			

Fig. 2.8 The types of information and roles of communication matrix (Gadde and Håkansson 2001:49)

Information content concerning goods is intertwined with the flow of goods involving informing about the different time, place and form states of goods. The information content about goods that has been identified and registered into an information system is mainly technical in nature. This is information concerning the time, place and form features of goods. In an information system this type of previously registered information may then become adapted to user needs, and thereby becoming administrative or commercial. Information content about goods may through the use of documents exhibit a combination of various types of information, and thus documents may be used to provide information adapted to user needs. This information concerning goods may, depending on the contents of the document, be technical, commercial, or administrative and used to carry out logistics activities, goods tracking, and tracing of products; in this way satisfying the needs of different actors regarding coordination, influencing, and learning concerning the transformation of goods. Adaptation of information for a supply chain is accordingly regarded as a highly complex many-faceted process.

Information about goods is adapted through the use of documents. Goods, however, rely being contained in a facility. The next phase is to return to the flow of goods and focus upon the role of the package in facilitating the transformation of goods and then regard how the physical role of packages also has an information side that is vital to identifying and informing about goods.

2.3 The Package as an Information Resource

The role of the package as an information resource is closely related to the fact that packages facilitate the containment of goods. Previously, goods have been described as identified and registered into an information system, not considering that in many cases these goods are packed. Therefore, the package as an element in the identification of goods needs also to be taken into account. When goods are contained in packages, this influences how logistics activities are carried out and, therefore, also the information needed to carry out these activities. In addition, when goods are packed, this influences, the information provided and used concerning goods.

As mentioned in the introduction, in a supply chain, it is the package and not the product that may be regarded as the most important physical resource in a supply chain (Ballou1987). This chapter discusses how the package facilitates the provision, exchange, and use of information in a supply chain. This chapter starts in Section 2.3.1 with a basic discussion concerning how packages contribute to the transformation of goods. This is followed in

Section 2.3.2 by a discussion of packaging including packaging technology, the purpose or functions of packages, package design and form, and the classification of packages. This section aims to show how packages are developed based on a logic that is independent of how information systems and logistics activities are carried out and developed. Packages have features that need to be combined with other resources in a supply chain in order to secure logistics and other purposes of a supply chain. Finally Section 2.3.3 discusses the role of the package in the identification of goods, and how this identification facilitates the provision and use of information about goods.

2.3.1 Packages and the Transformation of Goods

Pain's (1981:1) first words in his handbook on packaging state that: "Efficient packaging is a vital necessity for virtually every product." Features of a package should ensure a safe delivery of the product in an economical manner to the end user. Fundamentally, the package has a logistics objective and its most obvious function is to carry goods. When Ballou (1987) states that it is mainly the package and not the product that must be handled in a supply chain, this statement may be interpreted as packages representing a key resource in achieving efficiency regarding logistics activities. Packages may therefore also be regarded as a resource that plays a role in the coordination of variations in supply and demand with supply chain capacities. Packages are, however, primarily facilities for carrying goods, and also used to handle and inform about goods. How packages are used, depends on how well adapted the different functions of packaging are and in relation to different logistics and other purposes of the package in a supply chain.

The importance of packaging varies between industries. Some products such as petroleum for cars and raw materials are not contained in packaging. When goods are distributed through retailers, packaging gains importance. An obvious aspect of this importance is to facilitate product sales in the predominant self-service type of retail environment.

According to Paine (1981:215), "…packaging is an economic activity which plays an important part in the production and distribution chain of the majority of goods." Also, "…the functions of any packaging will be dependent on the item to be contained and the method by which it is to be transported from the manufacturer to the consumer" Paine (1981:20). The two vital physical interfaces of the package are the goods contained in the package and the facilities that contain or handle the package. Facilities where the package is used to store and handle goods include storage rooms,

material handling equipment, and information system equipment such as computers, printers and scanners.

Packaging standards help increase the degree of match between combinations of packages, goods, and facilities. How packages, goods, and information are combined and used in relation to human resources varies and also influences the efficiency of logistics activities. This interplay aimed at providing goods to an end-user is shown in the figure 2.9 below:

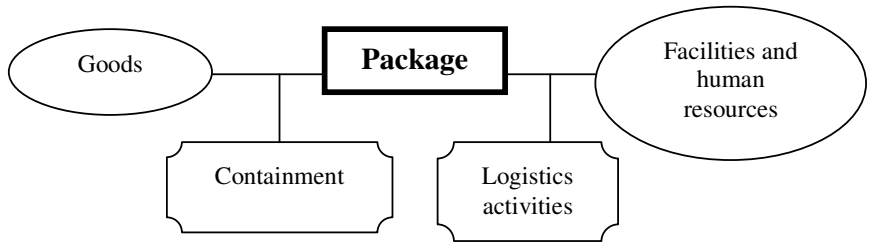

Fig. 2.9 The use of the package in the supply chain

In addition to the logistics use described in fig. 2.10, packages must be adapted to intermediary professional supply chain actor and end-user requirements. According to Lambert et *al.* (1998) packages mainly have a marketing purpose and a logistics purpose. An aspect of the marketing purpose of packages is according to Paine (1981:215) that a "good" package promotes the product thereby increasing its sales, while poor packages provide the end-user with damaged products. The physical features of packages vary. Thus there is, an economic activity involving the design, selection and use of packages which influences the efficiency of firms involved in transforming goods for both logistics and marketing goals. Packages both facilitate the transformation of goods in accordance with customer needs and also promote a product through their form and information on the package.

Packages are, since they facilitate physical distribution and marketing products, an important part of the core entity in the flow of goods (see Arlbjørn and Halldorsson 2002). Packages also have an important marketing aspect since they are vital in providing a delivery of goods in accordance with customer expectations and also that packages themselves may be used in the marketing of products. The package may accordingly be viewed as a central feature regarding how marketing and logistics are interrelated.

2.3.2 Features of Packages

The main focus in this study is placed on the role of the package as an information resource. It is, however, a fundamental view that this role is dependent on features of packages including the technology used to develop packages. Packages are used in combination with other logistics resources (Jahre and Hatteland 2004, Jahre and Fabbes-Costes 2005) and package design has an impact on supply chain efficiency (Johnsson 1998, Klevås 2005). Features of packages involve its technology influencing the physical features of packaging involving different levels of packages that are used together, and that the package also has different functions related to variations in actor needs.

Physical features of packages and goods containment
The form of a package is based on packaging technology (Paine 1981, Twede and Parsons 1997). In this study focus is directed mainly to the logistics use of given package forms and not issues regarding the development of different package forms. Package design must take into consideration 1) physical properties (form of the package), 2) dynamic limitations (e.g. acceleration, vibration etc.), 3) environmental limitations (e.g. temperature, pressure, humidity etc.), and 4) hazardous effects (e.g. radiation, explosives, personnel safety etc.) (Dowlatshahi 1996, see also Lumsden 1998:419-448 on technical features of packaging). The materials used, weight, size, and shape of the package are adapted to carry the goods contained in packages. Thus the characteristics of goods influence how a package is designed, since packages contain products in a supply chain setting. A package must be designed to be able to contain the material features of the goods. Either the goods must be adapted to the package or the package adapted to the goods. Important product characteristics that are regarded as influential in relation to packages are (based on Stock and Lambert's (2001:83-84) classification of product characteristics influential in a supply chain):

- **Technicality:** degree of technological complexity influencing package form and the technicality of the package influencing the product.
- **Bulk:** product size in relation to value influencing the importance of the goods related to the cost in handling the goods.
- **Perishability:** the durability of goods influencing the time-frame within which goods may be transformed in the flow of goods.
- **Combination with other goods:** the number of different products offered in combination with product variations such as colours,

flavours, and sizes influencing the need to pack different products in discernable packages.

Packages have many different forms e.g. cardboard boxes and crates that are loaded onto pallets and plastic-wrapped containing a variety of different package forms. Packages can be classified according to different levels based on Johansson et *al.* (1997:12) and GS1 standards as:

- **Consumer packages:** Individually wrapped products, includes also multi-pack solutions.
- **Distribution packages:** Secondary or multi-unit packages. Crates, cartons that may be displayed in stores, containing either unpackaged or consumer packaged products. This form of packaging may be handled manually. Usually contains consumer-level packages.
- **Transport packages:** Tertiary packages such as containers, large crates, pallets (including goods on pallets), storage tanks for liquids. Contains distribution- level packages or unpacked materials.

The use of these levels of packaging varies. Consumer packages are designed primarily to expose a product at a retailer facility, while the other levels are used mainly in relation to logistics activities. The borderline between these packaging levels is also in some cases "fuzzy" as consumer packaging may also serve the role of a distribution package, for example video television sets in stores displayed in their cartons. In other cases consumer-level packages may be placed directly into a transport-level container.

Features of using packages

The next step is to consider some key aspects of using packages as a logistics resource. Packages are used in combination with both goods and other packages. Caixeta-Filho (1999) describes in a case study how features of packages are of importance in relation to securing product quality when transporting perishable fresh foods. The physical features of packages influence accordingly the time frame within which goods may be transformed. According to Jahre and Hatteland (2004) the form features of packed goods are influenced by standards that again influences how well packages are combined with other goods and packages, and with logistics facilities such as containers and handling equipment. In a case study, (Jahre and Fabbes-Costes (2005), show how the standardisation of the size and shape features of packages influences how different levels of packaging are combined, thereby reducing waste in the use of space. In addition, the standardization of packages also influences the use of packages containing

goods by various actors in different "sub-systems" in the same supply chain. Standard-sized packages reduces uncertainty regarding the physical features of transformed goods supplied though logistics activities. The main contribution from the Jahre and Fabbes-Costes (2005) study is related to features of this suitability between package levels. When a transport level package is developed to directly accommodate a specific and important type of consumer packaged product without the use of distribution packaging, this reduces the suitability of combining these types of specifically adapted transport package to contain other types of goods packed in other forms of packaging. Therefore, the development of physical package standards involves a degree of compromise since each supply chain actor usually needs to handle a multitude of different types of goods with differing physical features. When cross-docking goods at a terminal, standardised packaging influences how quickly goods may be moved from one transport vehicle to another (Bartholdi and Gue 2004).

Packaging functions

There are different more or less overlapping classifications of the purpose or functions of packaging. Twede and Parsons (1997) describe the functions of packaging as providing 1) protection, 2) utility and, 3) communication. Together the nature of these packaging functions may be used to analyse the value created by packaging. Stock and Lambert (2001:460-462) provide a more detailed classification of the logistical functions of packaging:

- Containment: enclosing the product
- Protection: against the physical environment
- Apportionment: translating the product into a manageable size
- Unitisation: represents groupings of products and/or secondary packaging
- Convenience: reduces waste through easier handling
- Communication: carries readable logistics and product information

Twede and Parsons (1997) view containment and protection as aspects of the same basic function of packaging and apportionment, while unitisation and convenience are understood to represent the function of utility. Twede and Parsons (1997) describe also how the utility of packaging is related to how packages are palletised and loaded into storage and transport facilities. Apportionment is related to the consumer packages displayed in retail environments. This provides consumers with product sizes adapted to their needs. The manner in which a product is apportioned may also influence consumers in a purchasing situation. Unitisation is related to identifying packed goods in the supply chain. Volume is registered, processed, and communicated by registering packages and goods contained in packages.

Apportionment and unitisation represent the use of different packaging levels to influence consumers. While apportionment mainly is related to consumer-level packaging and marketing aims, unitisation involves primarily distribution-level packaging, potentially used in combination with transport-level packaging.

A package is a logistics resource, and the way packages are designed, used, and combined with other logistics resources (e.g. other packages, facilities, and information) influences their degree of utility. In relation to production, how packing and unpacking goods are carried out influences the overall efficiency of a logistics system (Lee and Lye 2002). Packages contribute to providing varying degrees of utility, thereby influencing how goods are transformed through logistics activities.

2.3.3 Packages and Information about Goods

The final step is now to investigate how goods and information interplay through packages. Goods, information, and packages are resources that gain value through being combined in relation to managing and operating the flow of goods. The information system plays a key role in this process. Goods are identified based on documents provided through an information system. An information system connects, as discussed in section 2.2, a number of actors and provides these actors with an information content that is adapted to these actors' specific needs.

The communicative functions of a package
The functions of packaging are all concerned with how packages are mainly used for logistics and marketing objectives. The protection and utility functions are concerned with the physical handling of the package. The communicative function is associated with supporting the transformation of goods and providing information about goods that are used for other purposes, such as for promoting products. The two main logistical and communicative functions of a package may be described as (see Johansson et *al*. 1997):

- **An information carrier:** information attached to the package itself, label, tag or other document forms that are attached to the package.
- **As an information source:** information concerning the package registered in other media forms than the package, through documents either in an electronic or paper form.

The function of the package as an information carrier is based on the physical presence of information on the package and this information is

physically present when transforming goods. The function of the package as an information source is based on identifying the package or goods and is registered in an information system. This is information about goods that includes time, location, and product form. The communicative function thus shows how the package is a link between the transformation of goods and an information system in the supply chain.

The logistics unit

As goods are transformed on their downstream journey, the use of packages to contain goods increases. Packages contain goods and possibly also a number of other smaller packages. At facilities where logistics activities are carried out, it is the packages which are primarily observable. In the case of packed goods, the goods themselves are a more "obscure" logistics resource since the goods are hidden from visibility. The term "logistics unit" has been developed by GS1 in order to communicate how to use GS1 codes. When bar codes or RFID tags are read, it is only the outer packaging layer that is used as an information carrier. The "logistics unit" represents a precise description of the outer package level that is identified in relation to logistics activities. A logistics unit is fundamentally a combination of goods and one or more packages as shown in fig. 2.10 below:

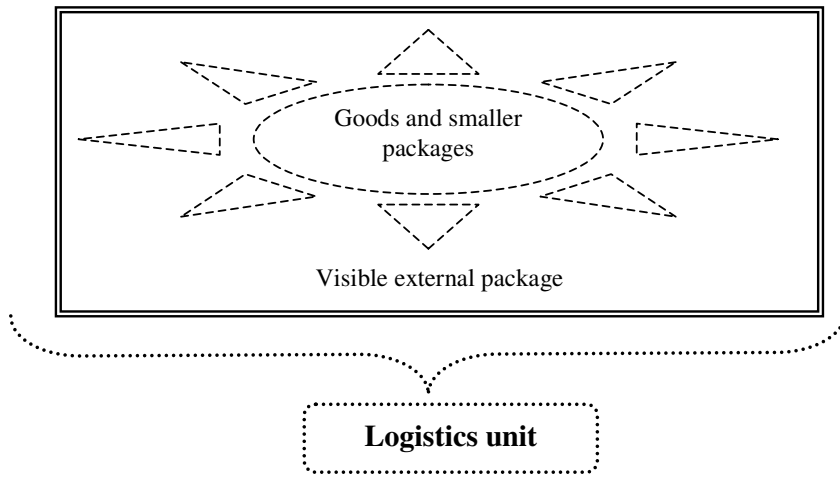

Fig. 2.10 The logistics unit

The logistics unit is the visible aspect of the transformed goods. It is the GS1 (GTIN and SSCC) code attached to the logistics unit that is registered and informs about the present state of goods.

Goods identification and adapting information for use through packages
When a logistics unit is identified, the information about the goods stored in the information system in relation to their form and location is updated. Identification of goods through a logistics unit is only the starting point of a wide range of activities where information provided through identifying goods is processed and communicated in a manner that is adapted to different actor needs. This is shown in fig. 2.11 below:

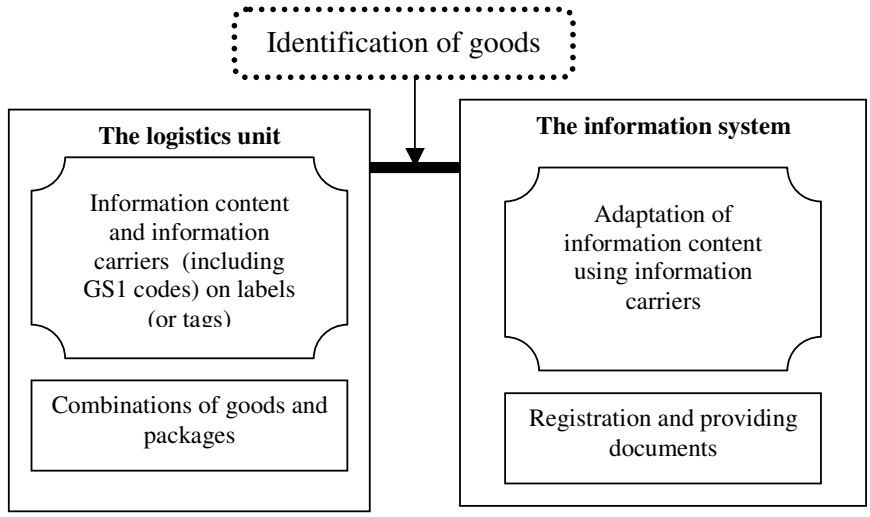

Fig. 2.11 The logistics unit used to identify and register goods

This identification of goods represents an activity where the roles of the package as an information carrier and as an information source transcend each other. In order for an identification of goods to function properly, the information content in labels or tags on packages and in documents must correspond through information carriers. The use of GS1 codes represents a tool to increase the accuracy and efficiency of identification through automating these procedures. When goods are identified, they may be registered into the information system creating new information content. As packages and goods may be classified into different levels, information about packed goods is also classified into different levels involving:

- **Information content:** the description of the time, location, and form features of goods and packages.

- **Information carriers:** the facilitators of the transformation of information about goods, text, numbers, and symbols including GS1 codes.
- **Labels and documents (including RFID tags):** facilitates the provision of information in a form adapted to usage.
- **The information system:** the overall facility within which information about goods is received, stored, adapted, and communicated to meet actor needs.

Packed goods are transformed in a manner that is different from that of unpacked goods, and, therefore, information must be adapted to that of the packed goods. When goods are packed, the borderline between goods and packages may become fuzzy, especially when it is the logistics unit and not the product that needs to be handled. Packed goods are identified using logistics units and informed about through a description of the packaging used. Packages thus influence how goods are transformed and how information is provided, adapted, and used in a supply chain. The role of the package as an information resource is also influenced by the fact that the transformation of goods involves coordinating different logistics activities taking place in a sequential manner. Logistics units are, therefore, identified at different stages in the flow of goods. The next step is consequently to consider how packed goods are identified and transformed in a supply chain context consisting of multiple actors exchanging information about goods.

2.4 Research Model and Research Issues

The use of the package as an information resource is based on its function as a goods containment facility and provides the information to carry out logistics activities. Information is provided "through" packages and used "through" packages. The information system plays a key role in facilitating the transformation of goods by providing the information needed to carry out logistics activities. The question still remains regarding how information is adapted to the transformation of goods carried out through sequentially organised logistics activities. Section 2.4.1 describes the transvection model (Alderson 1965) used to explain how goods are transformed in a sequential manner and how information is used to facilitate this sequential transformation. Finally section 2.4.2 presents more detailed research based on this frame of reference.

2.4.1 A Transvection View of how Goods are Transformed

Goods are physical resources that have past, present, and future states. These aspects regarding the utility of goods are of importance when considering how to inform about goods in order to facilitate the transformation of goods and potentially use this information for additional purposes. This involves coordination, influencing, and learning both within the supply chain and outside of the chain. As previously discussed, the past and present states of goods are registered based on identifying goods through logistics activities, while the futures state is derived also through plans or orders. A model is needed that takes into account how goods may be viewed in relation to its different temporal states and relate these states of goods to how information about goods is provided and used to sequentially transform goods and for other purposes.

Within marketing channel literature Alderson (1965) created the term "transvection" to describe more precisely the sequential nature of the flow of goods. The marketing channel focuses primarily on the transfer of title to the product (Rosenbloom 1995), while a transvection focuses on combining sequentially organised logistics activities to contribute to the provision of the product to an end user. The transvection logistics model was created at a time when research topics, still were commonly regarded as a part of the field of marketing channels (Bowersox 1969, Gripsrud 2004). Alderson's contribution within marketing channels is from a supply chain management perspective regarded by Lambert et *al.* (1998) as that of "…drawing actual marketing channels". The transvection term is based on two words from latin, *trans* meaning movement and *vehere* meaning passing through. The transvection may be regarded a logistics term, since it may be used to describe how goods reach placement of goods in the hands of an end user in what may be referred to as a supply chain context.

The transvection is a model used to describe a type of supply chain where various physical inputs are transformed into finished products. According to Alderson (1965:92) "…the transvection comprises all prior action necessary to produce this final result, going all the way back to the conglomerate resources." The transvection describes the flow of goods as a step-by-step process of different logistics activities, thus allowing for a "…piecemeal analysis" (Alderson 1965:94) of the material movement and storage in the supply chain.

The transvection is used here as a foundation to carry out a more detailed study of the flow of goods, including the idle periods of storage and how information is provided and used by actors responsible for controlling goods

and assigning goods to logistics activities. The transvection describes a flow of goods as sequentially organised transformations of goods that are controlled and assigned through a decision-making event Alderson (1965) terms as "sorts".

A transvection gives therefore a detailed understanding of the features of the flow of goods as an activity structure. In a transvection goods may be followed in a supply chain from the state of conglomerate resources, through logistics transforming the goods and placing a product in the hands of an end-user as shown in fig. 2.12 below:

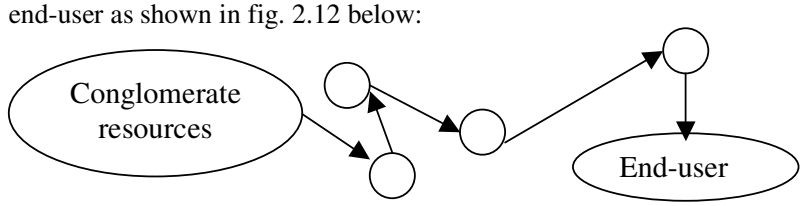

Fig. 2.12 The basic transvection model (circles indicate sorts while arrows show transformation of goods)

"Transformation" and "sorting" represent the key concepts of a transvection. Focusing on the transformations of goods, these are according to Alderson (1965:93) "…a change in the physical form of a product or in its location in time and space." Alderson (1965:88) also states that "…transformations affecting the conditions under which the goods eventually will be brought to the market" therefore, influence the nature of the sorts carried out at a later time in the supply chain. Sorts therefore impact on the time, place and form features of products eventually provided to consumers. Material handling, transport, and storage activities are the logistics activities that transform goods. In addition production is also regarded as the logistics activity that transforms goods mainly in relation to form features (see section 2.1).

Each sort in a supply chain provides direction to the flow of goods, and this is important in order to be able to control and efficiently transform goods according to plan. According to Alderson (1965:94); "Different facilities are required for fabrication, shipment, storage and credit. Thus, there has to be an intervening assignment to the appropriate facilities". The sort represents in this assignment of goods between two sequentially related logistics activities. "Sort" may be seen as a function where the physical outputs of the preceding logistics activity, creates the basis for the assignment of goods to a next activity. Alderson (1965) uses the term sort to create this link in the transvection model and expresses that "…two transformations cannot appear successively without an intervening sort". Sorting is a decision-making

action that according to Alderson (1965:93) assigns goods to logistics activities that transform the goods in time, form, and location. The sort is an information-related activity that uses the information system to produce documents and labels used by personnel operating the flow of goods. At a sort operational plans are created that include detailed instructions regarding how to handle the goods, including a specification of actual facilities, personnel, and potentially a description of other goods and the destination of the goods. A picking list is one example of a document used to assign goods to picking activities in a distribution centre.

The sort is thus an operational activity where the information system is used to control and direct the flow of goods. At the sort information about goods is combined with other types of information in the information system and used to operate the flow of goods. What types of information and how it is used, may vary depending on the structure of the supply chain and how principles of speculation and postponement are used to manage the flow of goods. The sort may, therefore, be viewed as a supply chain event where the information system provides information adapted to usage. Sorts also lay the basis for creating new information since sorts represent an assignment to logistics activities, and to be able to carry out these activities new documents need to be created. The registration of updated information regarding goods may also be related to sorts since this information content is needed in combination with other information to control the present location of goods, for subsequent logistics activities. The sort is accordingly an operational-level mechanism used to coordinate variations in the flow of goods with facility capacities. At sorts, actors use information to mediate between logistics aims and features of the flow of goods.

The flow of goods may, therefore based on a transvection view, be viewed as a sequence of sorts that are dependent on each other. At sequentially organised sorts, interplay between logistics units and information may be described. The logistics unit represents *packages containing goods* transformed through logistics activities and *information* that needs to be adapted to user requirements using an information system. At a given sort of the flow of goods, this interplay between information and logistics units varies from the preceding and following sort. The sequential nature of the flow of goods in accordance with the transvection is shown in figure 2.13:

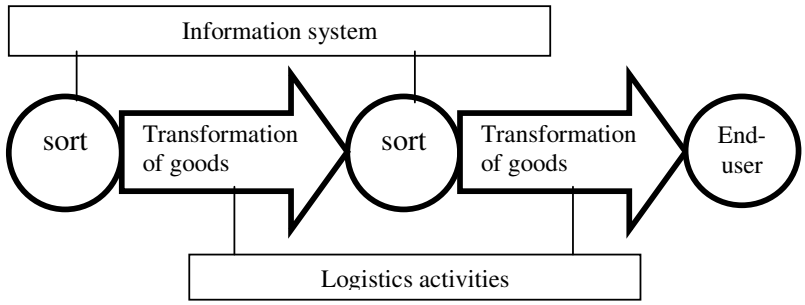

Fig. 2.13 An adapted transvection model

The role of the package in relation to the model depicted in fig. 2.13 is as an logistics resource embedded in the transformation of goods including labels and tags (carried on the package). In addition information about packages is prevalent as an information source embedded in the information system.

2.4.2 Research Issues

The overall research issue of this study concerns the role of the package as an information resource. The preceding framework has shown that this research issue involves three basic elements. The first element looks at how goods are transformed, based on an understanding of the nature of the flow of goods. The next element is in regard to how information is provided, using the package to identify and describe goods in relation to logistics activities. This represents the role of the package in relation to the provision of information concerning goods in relation to sorts. The third and last element, regards the use of information about goods.

Information needs to be adapted to different user needs. Adaptation of information about goods involves describing the form features of the package and the goods it contains that have past, present, and future states. This information is registered, processed, and communicated using an information system. It is within the information system information about goods becomes adapted to different user needs. In addition, adapted information is exchanged between different supply chain actors. Based on the overall research issue, the development of the preceding frame of reference has lead to the formulation of the following research issues. These issues place focus on aspects of the interplay between the transformation of goods, information, and packages in a supply chain being investigated. The three following research issues are, therefore, formulated.

The transformation of goods
A description of the transformation of goods is required as the foundation for understanding how information and packages are used to reach the logistics aim of placing a finished product in the hands of an end-user. This issue involves studying the following in more detail:

- *Transformation of time, location, and form utility of goods*
- *Logistics activities involved in the transformation of goods*
- *The role of sorts in the provision of time, location, and form utility regarding the features of goods*

Information and the transformation of goods
The focus of this research issue is on the interplay between the transformation of goods and information. This issue involves studying the following in more detail:

- *Exchange of information and the transformation of goods*
- *The role of goods identification and registration in the provision of information*
- *The interconnectivity of logistics activities and the information system at sorts*
- *The adaptation and use of information for logistics activities, tracking goods, and tracing products*

The package facilitating the provision and use of information about goods
This research issue places focus on the package and how the package as an information resource facilitates information about goods. This issue involves studying the following in more detail:

- *Packages as an information carrier and the identification and registration of goods into an information system*
- *The physical characteristics of packages in combination with features of products as an information source in the provision of information content about goods*
- *The role of the package in the adaptation and use of information*

3 Research Design and Method

As presented in the introduction, this research consists of four fresh food cases concerning distributing strawberries, bananas, low-fat milk and consumer-packed fresh white fish filets. The frame of reference has discussed the foundation for designing and analysing these cases. In this chapter the grounds for conducting this study is accounted for. In Section 3.1 the case study strategy chosen and the fundamental consequences of choosing this type of research strategy are discussed. In Section 3.2 the research process is described, followed in Section 3.3 by methodological considerations made during the research process.

3.1 Case Study Research Strategy

The first section regarding research design and method is concerned with discussing the reasons for selecting case studies as a research strategy. This also involves discussing the fundamental emergent and iterative design of this study.

3.1.1 Choosing the Research Strategy

During the research process it became evident that studying the role of the package as an information resource, would also involve studying the package as being part of the total supply chain. As the frame of reference gradually developed, it became apparent that the package as a physical as well as an information resource, needed to be investigated in relation to different actions carried out by the various actors in the supply chain. This study accordingly involves approaching a phenomenon with a high degree of complexity that involves the role of packages at a sequence of different sorts. Each individual action is carried out by various actors where different physical and information resources interplay and are related to different activities. An appropriate research strategy that could handle this complex phenomenon with unclear borders was, therefore, sought.

The borderlines of this research theme in relation to its supply chain context were at the beginning of the research process relatively unclear. According to Yin (2003), case studies are well adapted to studying phenomena with this type of unclear borderlines between the phenomenon and its context. The case study research strategy was as a result of these research demands chosen initially. A case study is defined as "…a research strategy which focuses on the dynamics present within single settings" (Eisenhardt 1989). Case studies represent a holistic approach that allows capturing what is

unique in the scope of a supply chain, but "...attempting to keep together, as a unit, those characteristics which are relevant to the scientific problem being investigated" (Goode and Hatt, 1952: 333).

The interplay of packages, information, and the transformation of goods is an entity that may be made operational for research purposes through the use of the frame of reference (this is described in Section 3.2). However, the features of this resource interplay vary in relation to the various sorts in a supply chain. Therefore, a case will need to describe how different types of packages, types of information, and the variable features of goods interplay in relation to different sequentially organised sorts. The case study was chosen as the most appropriate research strategy to study the focal interplay between packages, information, and the transformation of goods, and how this interplay varies between different sorts in a supply chain. In addition, the case provides an approach that shows how sorts, involving using the package to identify and provide information about goods, are interrelated with previous and subsequent sorts.

3.1.2 Contribution through a Case Study

Case studies are used to gain insight into a specific phenomenon or limited conceptual realm instead of contributing to an overall “grand theory” (Dyer and Wilkins 1991). In this study, the four individual cases have been used to gain what may be viewed as numerous different local insights that have been used in a sequential manner (each new insight developed based on the preceding one) to direct the further development of the case in an iterative manner. A case study may be designed to use iteration between theory and empirical findings in order to generate a new theory (Eisenhardt 1989). When comparing theory with empirical findings, conflicting understandings may emerge, and this “…forces researchers into a more creative, framebreaking mode of thinking than they may otherwise be able to achieve” (Eisenhardt 1989). In this manner, the frame of reference has been used as a tool to help the researcher structure the cases and thereafter analyse structured data.

Within logistics the use of case studies as a qualitative methodology has during the 1990ies become an accepted and common method (Ellram 1996, Vafdis 2002:83, Gubi et *al.* 2003). Gammelgaard (2003) discusses how different schools of research within logistics are based on varying degrees of positivist assumptions that often are contradictory to using case studies as a dominant research strategy.

Case studies are often criticised for lack of rigor from a positivist viewpoint (e.g. Miles 1979). This lack of rigor may stem from perceptions of the reliability of the study, the validity or "truth" value of the study, and "anecdotalism", meaning that the research has a limited relevance in relation to other settings (Silverman 2001). Case studies are, however, a qualitative form of research strategy that may be used independent of research stance (Eisenhardt 1989). According to Morgan and Smircich (1980), different epistemological stances may be placed on a subjectivist-objectivist continuum as shown in fig 3.1 below:

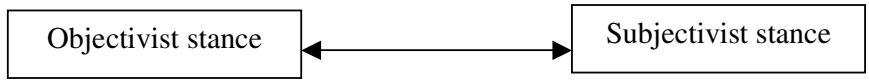

Fig. 3.1 Epistemological stances placed within the subjectivist – objectivist continuum (Based on Morgan and Smircich 1980)

The figure illustrates how an exact research stance may be difficult to pinpoint. However, a research stance may, based on figure 3.1, be described as leaning to varying degrees towards one of the extreme positions, either completely objectivist, or completely subjectivist. According to Morgan and Smircich (1980) qualitative researchers usually take a "subjectivist-leaning" stance. "Subjectivist-leaning" denotes here an understanding that the researcher's epistemological stance may be placed on the subjectivist-objectivist continuum depicted in fig. 3.1 at a location closer to the subjectivist side.

An epistemological stance of a researcher is founded on ontology pertaining to a the fundamental view of reality; "what really exists?" (Wallén 1996). Subjectivist epistemology entails according to Burrel and Morgan (1979:5) that reality "…can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied." While more objectivist approaches seek causalities and regularities and aim to be able to predict reality, empirical findings derived through a more subjectivist stance are viewed as more time and space specific, thus limiting both the ability and need to generalise empirical findings. This research is basically "subjectivist-leaning" with the purpose of gaining understanding based on interplay between empirical evidence and theory.

Qualitative approaches including case studies represent a natural choice of research strategy when conducting a subjectivist-leaning study. In addition, this research stance influences, other, more specific, decisions regarding the method of this case study. How entities found in a supply chain, e.g. logistics

activities, packages, goods, actors, facilities, and strategies, are studied, is influenced by the chosen subjectivist-leaning epistemological stance. These entities in the supply chain are accounted for in this study involving interaction between the 1) "world out there", 2) observations regarding activities and logistics resources leading to researcher perceptions of these entities, and 3) information given the researcher by users of the studied logistics resources through interviews.

Informants may in interviews attempt to describe their tacit knowledge (Fleetwood 2004:29-30). This is knowledge regarding how activities are carried out. This type of knowledge is not found in instruction manuals, but conjured up in the mind of the interviewee (Polanyi 1966). The researcher may in such cases of conveying tacit knowledge attempt to more precisely articulate what an informant finds difficult to formulate. This represents interpreting interview data, and these interpretations may more or less accurately influence the course of the study. Therefore, the research path described in this chapter accounts for how the researcher, the world "out there", and the informants interact.

In this study, the setting of the interviews and observations, which is the basis for deriving empirical findings, is not viewed as a "virgin" entity. On the other hand, the researcher is also, in this study, not viewed as "enslaved" by the research setting. This is why the term "leaning" is used to describe the basic stance of the researcher. A research stance is taken between the objectivist and subjectivist extremes. The research setting is viewed as influencing the interaction between the researcher and informants, seeking to derive fruitful empirical findings in relation to research objectives. This basic subjectivist-leaning research stance views reality as in part socially constructed and in part existing independently of the perceptions of informants and researchers.

3.1.3 An Emergent and Iterative Research Design

Research may be inductive or deductive regarding the relationship between theory and empirical findings. In an inductive study theory is derived from empirical findings, while in a deductive study theory is tested regarding empirical findings (Wallén 1996, Abnor and Bjerke 1997, Chalmers 1999). It is the direction of interconnectivity between the realms of theory and empirical findings that separates these two basic approaches (Chalmers 1999).

In this study the frame of reference and the empirical findings have gradually emerged hand-in-hand. The overall research theme and more

specific issues (see Section 2.4) have during the course of the research process changed in an iterative manner. An iterative research process is a basic feature of conducting a case study where "…the accumulation of knowledge involves a continual cycling between theory and data" (Eisenhardt 1989). An iterative research process involves "…a successive refining of concepts" (Dubois and Gadde 2002) or a "learning loop" (Taylor et *al.* 2002).

An abductive research process is a specific form of emergent and iterative research design. Dubois and Gadde (2002) express the basis for an abductive understanding being that "… theory cannot be understood without empirical observation and the other way around." An abductive approach represents an iterative form of sequencing the interrelationship between theory and empirical findings. The "real world" or realm of substance is approached using a developing analytical framework that may be both confirmed or changed by empirical evidence. An abductive approach is regarded as applicable within operations research (Lewis 1998), industrial networks studies (Dubois and Gadde 2002), and within logistics (Kováks and Spens 2005) to achieve new insight into different phenomena.

The research design of this study is abductive with both inductive and deductive properties. This design has strived to be systematic by continuously developing the frame of reference in an iterative manner, and using this frame of reference in its "unfinished" form also to guide the data collection. Formulations emerged during research that may resemble a "hypothesis" or simply explicit "hunches" based on empirical data that may guide the ongoing research process (Eisenhardt 1989). This represents a deductive aspect of this research. Inductive questions were on the other hand explorative, aiming at reaching an understanding of a more or less unknown phenomenon.

Abductive reasoning is initiated by encountering events where empirical findings are not corresponding to an existing theory (Kováks and Spens 2005). The research process as such is, therefore, only partly a result of a planned process. The final results could not be planned due to the explorative nature of this study, and new insights provided through gradually developing the frame of reference in interaction with empirical findings has influenced the data collection and analysis. In addition, literature studies and academic lectures have also influenced the frame of reference. The important role of the transvection in the frame of reference was, for instance, not a result of a planned process. Research conducted by Hulthén (2002) opened the door to the transvection through a lecture by this researcher. The transvection was initially perceived as only a viable theoretical approach to

describing how products are traced, thereby including this type of information exchange between supply chain actors into the frame of reference. Eventually the use of the transvection was developed in the frame of reference to encompass the existing focus on packages in relation to logistics activities and also to include information exchange to track goods.

Through the research process terms such as “the flow of goods”, “information content”, “product tracing”, “goods”, and “tracking goods” were gradually developed and refined in an iterative manner. The tools of research have been developed and refined during the course of the study, and this development process has been gradual and “bumpy” rather than smooth. Through this emergent research process the understanding of the interplay between packages, information, and the transformation of goods gradually developed and also how this interplay is influenced by the supply chain context. The frame of reference, as it is now described in Chapter 2, could accordingly only in a vague manner have been envisioned at the start of the research process.

3.2 The Research Process

The research process involved a number of choices when selecting cases, including operational research issues, data collection, and finally deciding when the empirical findings were judged adequate for closure.

3.2.1 Selecting Cases

The main criteria for selecting the cases was based on the emergent frame of reference involving detecting of products from a transvection (end-state of product) perspective regarding variations in 1) the transformation of goods, 2) the role of information in the transformation of goods, and 3) the role of packages in relation to information both as an information source and as an information carrier. Each case was chosen to be a “product case”. This choice was influenced by the transvection view of how goods are transformed. In accordance with the transvection view the features of a finished product are placed into focus and then this view of the product as the core entity of the supply chain, is used to account for how the time, place, and form features of the goods have become transformed upstream in the supply chain.

An understanding of how goods are transformed plays a fundamental role in the frame of reference. The transvection is, therefore, used as a research tool by relating the product to the transformation of goods featuring packages,

information, and other logistics resources in interplay with each other. This represented accordingly a means to be able to describe the use of packages and information in relation to the transformation of goods in a supply chain context.

When deciding which product cases to conduct, specific criteria were chosen. Time, variation, and frequency features of the flow of goods represent factors used to distinguish potential product cases from one another. Also, product cases were sought where the distribution of goods was carried out using different information systems and involving various types of actors in different industries. Finally, regarding packaging, product cases were chosen where different forms and combinations of levels of packaging were used.

This study was conducted as a part of the NETLOG project at BI Norwegian School of Management (Gadde et *al.* 2002, Jahre et *al.* 2006). Within this project involvement was initiated with a case study concerning bananas and followed by a strawberry case study. These explorative case studies focused upon how a focal product resource is used in combination with other logistics resources in a network setting. These two "NETLOG cases" were influential in limiting this study to encompass fresh foods. By focusing on foods products, commonalities regarding the transformation of these goods could be accounted for, and thereby direct focus not on features of these products, but rather on how goods are transformed in a supply chain by combining different logistics resources.

As the frame of reference was developed, the criteria for selecting cases also became refined. While the first case was chosen based on relatively few criteria, the choice of the fourth and last case was based on a more refined understanding. The Dole banana was the first chosen product to be studied. At the time of choosing this case the frame of reference was relatively undeveloped. Some knowledge regarding features of the banana and how this product is being distributed had been acquired through NETLOG-related research.

It had through this research become evident that bananas are an important product for the wholesaler, and that the product also is subject to a complex distribution process. Distributing bananas involves a number of different international actors and a unique transformation of goods that depends on specifically adapted facilities. Since this was the initial case, the selection of the following product cases needed to take into consideration variations between the products and features of distribution, information system, and the role of information and packaging. The following cases aimed to be both

different and complimentary in achieving the research aims. The initial Dole banana case consisted of a limited number of interviews. After the other case studies were completed, the empirical basis of this case was judged insufficient, and additional interviews were conducted both with interviewees from the original NETLOG case in addition to several new informants.

Corona strawberries was the second case selected. It was the key contact person of the Norwegian fruit and vegetable wholesaler BAMA involved in the NETLOG project that pointed to the challenges of distributing this product. While the distribution of bananas involves relatively small variations in volume over a period of a year, Corona strawberries is a seasonal product with variations also in the daily harvested volume. Corona strawberries have a much shorter durability than bananas. In addition, while Dole bananas lack consumer level packaging, Corona strawberries are contained in small, unmarked consumer level baskets. Dole bananas are in addition distributed in especially adapted cartons, while Corona strawberries are distributed in plastic reusable IFCO crates that are also used to distribute a variety of different agricultural products. In addition the distribution of Dole bananas depend on the interlinking of different information systems, while the distribution of Corona strawberries relies on one relatively manual in-house information system within BAMA. In addition, since a NETLOG study had been conducted regarding Corona strawberries, as was also the case was for Dole bananas, it felt natural to use this study as a basis for the second fresh food product case.

TINE was the other of the two distributors of fresh food products involved in the NETLOG project. Within TINE other doctoral students in the NETLOG project had, at the time of selecting a third case for this study, conducted studies regarding the roll-rack type of packaging, and the "LFD" distribution agreement (see Chapter 7) between TINE and other Norwegian fresh food distributors. Since TINE also distributed fresh foods to Norwegian retailers, the next two products were chosen from within the TINE network. This involved studying fresh foods in a supply chain context using different information systems to distribute the goods from regional distribution centres to retailers. TINE Lettmelk was the first TINE product chosen. This is a dairy product that undergoes an industrial production process, involving transforming goods from raw materials to final products. The timing of production is used to buffer variation and regulate frequencies within the flow of goods of this product. TINE Lettmelk was also the first product chosen that had detailed product information on the consumer packaging.

The final product chosen was Marian fresh fish filet. This product is packed in an innovative form of consumer packaging that slows the rate of product decay. In addition, Fjordland, an independently organised subsidiary of TINE with an information system independent of TINE's information system, distributes this product. Another independent actor, Aker Seafoods, is the producer of this product. Therefore, this case involves multiple actors in various types of industries with different information systems that need to be linked with each other. While the other cases concerned agricultural products, this case encompasses fishing at sea. The catch of wild fish species at sea varies in season and daily quantities. Marian fish filet is in addition newly developed product that had been recently introduced on the market. This producer is therefore distributed frequently in a low volume meaning that transport and handling efficiency is dependent on combining this product with already existing flows of goods and forms of distribution packaging. While TINE lettmelk and Corona strawberries usually are only transported within limited distances, Marian fish filets and Dole bananas are distributed over longer distances involving a larger time frame of the flow of goods and, therefore, a greater risk of deterioration during transport.

Four case studies were step-by-step chosen concerning 1) Corona strawberries, 2) Dole bananas, 3) TINE Lettmelk and 4) Marian fish filet. These four cases are all fresh food cases and have product-related similarities, however, their distribution varies. These cases are based on their differences but are also complimentary to each other. Therefore, these four different product cases together provide a better understanding of the overall research theme regarding how packages are used as an information resource in the supply chain.

3.2.2 Casing the Study

Casing the study is a part of the initial phase of a case study and represents according to Ragin (1992) bringing "operational closure to some problematic relationship between ideas and evidence, between theory and data" and is carried out to structure the research process, to "…simplify and bracket problematic relationships between theory and data…" (Ragin 1992). Casing the study involves a "...way of organising social data so as to preserve the unitary character of the social object being studied" (Goode and Hatt, 1952:331). Casing this study may be described as making operational the unit of analysis represented by the interplay between the transformation of goods, information, and packages in different supply chain settings.

According to Miles and Huberman (1994:25), initiating case studies is a challenging part of case studies since how well the study is cased influences

how the research issues are answered later in the research process. Casing the study involves how the interplay between packages, information, and the transformation of goods is translated into a terminology used in interviews. These main features shown in fig. 1.1 involve how 1) the transformation of goods, 2) information and 3) packages interplay with each other:

- Transformation of goods:
    - Characteristics of goods
    - Identification of goods through documents
    - Features of logistics activities
    - Time, variation, and frequency in the flow of goods in relation to logistics activities

- Information:
    - Information content
    - Information carriers
    - Labels and documents
    - The information system
    - Identification and registration of goods through logistics activities

- Package:
    - Package form
    - Packaging levels
    - Logistics units, combining packages with goods through logistics activities
    - Packages as an information carrier and the identification of goods
    - Packages as an information source and information exchange

In addition features of the supply chain context regarded as influential to the interplay between the transformation of goods, information, and packages were accounted for

- Actor structure of the supply chain
- The use of orders or forecasts to carry out logistics activities
- Features of information exchange between supply chain actors

These factors are used to guide the composition of the interview guides and were also influential in determining case selection criteria. An introduction

to how the interview guides are structured and used, including a few examples of interview guides, are provided in Appendix 2.

3.2.3 Data Collection

Data collection was directed by the emergent frame of reference. This frame of reference was written down and successively refined in an "abductive" manner as new theoretical approaches were formulated, based on previous empirical studies and empirical findings. This functioned as the core part of a "research protocol" that included, as advised by Ellram (1996), the key research issues as they were gradually formulated through the research process. In addition an overview of the iterative design of the study, features of the applied case study methodology adapted to the frame of reference, and a basic structure of the interview guide were included in another document which eventually became the basis for this chapter on research method and design. This protocol, in its changing form, has been used to guide the research process. This also involved the search for informants. Eventually this research protocol in practice evolved into the current frame of reference and the description of research design and method provided in this chapter.

Data was collected mainly using a semi-structured interview (Ellram 1996), listing the topics for each interview sequentially as shown in Appendix 2. In addition, interviews were supplemented by observations. Both interviews and observations were open, meaning that the true intention of the case study was communicated to the informants and persons observed. This openness was also used as a tool to ensure credibility of the research as discussed later in this chapter. Based on the research protocol a unique interview guide was adapted for each informant. Interviews were dependent on each other in what may be called a "snowballing" interview strategy. This involved designing the research process leading to "…observations generated new questions on which further interviews could be based" and eventually "added new dimensions to the subject, which eventually resulted in a new view of the phenomenon itself" (Dubois and Gadde 2002).

The quest of the applied research strategy was accordingly following the research protocol aimed at gaining new insights. This quest thus involved also searching for new informants and adapting the interview guide to each interview in order to use understanding derived from previous interviews to gain new understanding from the following informant. For instance, the strawberry case involved first interviewing the product manager at BAMA providing an overview of the case. This informant then also suggested a number of other informants covering various stages of the flow of goods. In addition to actors directly responsible for logistics activities, other types of

informants were used including informants from e.g. suppliers of packages, information systems, and standardisation institutes.

Each interview guide consisted of a number of different topics that were not formulated as precise questions; instead a plan for each interview was formulated. For example: “overview of the supply chain of Marian fish filets”, “the information system of BAMA”, or “the distribution of Corona strawberries from BARE Oslo distribution centre to REMA 1000 retailers”. These relatively general topics of each interview were used to formulate more specific questions during the interview. In the case of distributing Corona strawberries, the interview also consisted of observing the delivery of goods by accompanying a delivery truck. This interview consisted of issues involving the driver and features of the transport firm hired to make the delivery, the business relationship including features of information exchange between the transport firm and BaRe (distribution centres supplying REMA 1000 stores), picking routines including the use of documents and labels, physical features of the delivery truck, and finally how goods were delivered to retailers.

The choice of interview topics was based on judgement founded on previous interviews under the guidance of the frame of reference. These issues were accordingly adapted during the interview process such that the precise question formulations were made during the interview. This was important in order to maintain openness for new insights. In practice, each interview also included topics not listed in the interview guide. These were usually issues that were brought up by the informant during the course of the interview, or based on new insights from the interview process or through observations of activities, goods and facilities. Occasionally the informant was allowed to guide the interview when new and unexpected information was provided.

All the interviews were taped, and a written transcription was produced based on this tape. Each interview lasted on average 1 hour, with the longest interview lasting almost 4 hours and the shortest 15 minutes. Interviews were followed up by telephone interviews to clarify data and update information. Clarification of data also involved discussing potentially different interpretations of interview transcripts. In appendix 1 a complete and chronological list of all the 63 interviews conducted for this study is provided. Below in table 3.1 an overview of interviews conducted according to types of firms and topics is shown:

	Goods distribution	Product and packaging	Information
BAMA	11	5	5
TINE	7	3	2
Logistics firms	8		2
Producers or suppliers	6		
Retailers	3		
Other actors		3	8

Table 3.1 Information sources

All four cases were supplemented by observations of the packing and the unpacking of goods, of different types of packages used to contain goods, and of how goods were transformed through logistics activities. In addition informants provided labels and documents for closer inspection. This included also viewing the use of electronic documents while in use. With the informant acting as a guide, observations of logistics facilities and in some cases watching logistics activities performed were often made after an interview. This provided the opportunity to ask further questions and to make comments. These were noted down if they provided additional relevant information to the topic of the interview. Usually observations resulted in gaining a visual experience of how packages, information, and the transformation are used in the interplay providing the basis for the completeness of the description of the case narratives presented in Chapters 6 and 7.

3.2.4 The number of Cases and Reaching Closure

Four product cases were studied involving two pairs of products distributed through a common distributor. The conducted interviews and observations together "…represent replications that allow for development of a rich, theoretical framework" (Ellram 1996). The complexity of studying in detail the interplay between packages, transformed goods, and information in a supply chain provided arguments for carrying out a limited number of cases. Corona strawberries and Dole bananas are distributed through the same Norwegian fruit and vegetable wholesaler BAMA, while TINE Lettmelk (brand of low-fat milk) and Marian fish filets are distributed by TINE, a dairy company. There was no predetermined number of cases deemed sufficient for this study. An understanding that the Marian fish case was the

final case emerged when this part of the study was conducted. However, at this final stage, new interviews were also conducted to improve the empirical findings of the Dole banana case.

Eisenhardt (1989) suggests the use of multiple cases to compare different cases with each other. This provides a basis for understanding how product and supply chain features influence the use of the package as an information resource in physical distribution. Studying more than one case also allows for comparing patterns found in the different cases with each other (Campbell, 1975). Data collection took place not at the exact same time but sufficiently close in time to ensure a degree of comparability. The main aim of carrying out different cases was, however, not to achieve comparable data in order to find differences or likenesses regarding different issues. Patterns found in the cases were based on data collected at approximately the same time and were used in a complementary manner to strengthen the understanding of the researched phenomenon.

Reaching closure occurs when finalising a case and involves determining when to "…stop adding cases and when to stop iterating between theory and data" (Eisenhardt 1989). In practice this involves setting the boundary of each case based on reasoning that a point of saturation has been reached. In relation to reaching a closure, Dubous and Araujo (2004) state that: "The task of the analyst is to progressively construct the context and boundaries of the phenomenon, as theory interacts with method and empirical observations." Dubois and Gadde (2002) also argue that "…the way boundaries are expanded (in the empirical world) is of major importance since it determines what will be found…" Each case contains a large amount of detail relating to different sorts in a flow of goods. During the research process new insights provided by the additional case were considered in relation to the resources used to collect these data.

In order to understand when research closure is approaching, empirical findings may in accordance with Dubois and Gadde (2002) be described as either "passive data" that the researcher expected to find, or "active data" representing new findings. During this study most data has, however, been perceived as active data since even the data that may be described as "passive", was always to some degree different than expected. An additional reason to carry out multiple cases was, therefore, to be able to collect more "active data", providing new insight into how packages are used as an information resource in the supply chain. Trough the course of the study, focus has gradually become more directed towards accounting for the form features of goods. This involves how goods are identified using packages protecting goods and then accordingly how information is exchanged

between supply chain actors using descriptions of packages to exchange information about goods. When the Marian fish filet case was written down, concurrently with refining the Dole banana case, it became evident that these features were more or less duplicated compared with the previous cases. Therefore, as fewer examples of relatively "active data" were encountered through the research, it became evident that the closure of the study was approaching. Four cases were eventually judged as sufficient to be able to start the analysis phase of the study.

3.3 Methodological Considerations

This section focuses on issues regarding the trustworthiness and transferability of empirical findings from this study. In addition, the role of the case narrative text provided in part two is discussed in the context of this research.

3.3.1 Trustworthiness of the Study

Data for this study was collected during a period of three years starting in the winter of 2002. In a case study the role of the researcher, including the integrity of same person, are of greater importance than in quantitative studies in establishing trustworthiness. This is because the element of choice of how data is acquired and handled is often dependent on decisions of the researcher in specific contexts. Establishing an objective truth is viewed as not being critical in this study. This view is influenced by the basic subjectivist-leaning research stance of the study. "Truth" is viewed as influenced by social conventions. Within a subjectivist-leaning stance it is possible to speak about "…practical adequacy, and of progress in terms of 'epistemic gain' rather than establishing absolute truth about some situation once and for all, whatever that might mean" (Sayer 2004:7-8). This view of truth has been influential in determining the objectives of this study. For operational purposes regarding real-life events truth may involve the following factors: 1) how 'truth' will be determined, 2) how it will be communicated, and 3) how errors will be detected and corrected (Erlandson et *al.* 1993:29). Truth is in this study accordingly viewed as mainly linked to the credibility of data and the usefulness of the findings.

Interviews complemented by observations play a central role in acquiring empirical evidence in this case study. In an interview setting the researcher interacts with the informant. An interview is described by Silverman (2001) as an event that takes place in a limited amount of time, involves communication between the interviewer and the interviewee and that these

two persons view the purpose of the interview differently. Questions were posed in a manner aimed at being understandable for the interviewee. In the interview guide the topics of the interviews were listed, and questions formulated in such a manner that through conversation it was ensured that the questions were correctly understood. However, in an interview setting, according to Silverman (2001) the responses may be biased by the interview context. An interviewee normally does not answer questions from a scientific researcher. The visit of a researcher to a firm is an example of "abnormality". Supply chain actors are primarily concerned with their logistical work task. When placed in such a unique setting, responses may be influenced by the interview context.

In addition, answers may be formulated concealing facts that are viewed as undesirable by the informant, or simply answers to "please" the interviewer. Limiting this form of interview bias was sought through the conversational form of interviewing aiming to build an atmosphere of openness during the interview. It was, therefore, especially important that the interviewer presented the aim of the research and said a few words regarding the NETLOG project (see Jahre et *al.* 2006) since this played an important contextual role in the study. In addition, research findings or more general opinions regarding logistics that might be of use to the informant, were discussed before starting the interview.

Supply chain actors may also perceive the interplay between packages, information, and the transformation of goods differently. There exists, therefore, as Silverman (2001) describes, a multiplicity of meanings in relation to a phenomenon. Interviews contributed to identifying some of these different perspectives with regard to how packages are used as an information resource in the four different cases. The aim of a specific interview accordingly was to seek features regarding the identity of the informant. An informant may have both a professional view of the role of the organisation and personal view of this role. This identity was attempted accounted for during interviews and complemented with information regarding the actor's descriptions of logistics activities or other issues. During the interview, time was taken to ensure an open environment, thus trying to account for and also reduce interview bias.

Since the entire collection of data was carried out over a period of about 3 years, this involved a prolonged engagement involving a continuous relationship with informants in the focal companies, TINE and BAMA. These repeated encounters allowed for checks regarding previous observations and discussing possible interpretations of the data by comparing different interview transcripts with each other. Interviews were

carried out at the location where the informants had their professional occupation. This involved, therefore, in many cases an opportunity to observe issues described in the interviews. In addition texts in brochures and on internet web sites concerning the firms were used. Informants also provided examples of documents and labels used on packages. A number of interviews were carried out together with other researchers, and potential divergent interpretations were discussed with informants and research peers.

Triangulation is often suggested as a mode to increase the credibility of a study. Triangulation of different methods in research design involves e.g. combining qualitative with quantitative methods is used to secure trustworthiness of empirical findings (McKercher 2000). Exclusively case study methodology has been applied in this research project. According to Dubois and Gadde (2002), in an abductive research design, where the aim is to attain an understanding of the researched phenomenon, the role of verification provided through inter-method triangulation is viewed as limited. However a form of "perceptual triangulation" may according to Meredith (1998) also be applied within a case study involving "…the accumulation of multiple entities as supporting sources of evidence to assure that the facts being collected are indeed correct." According to Erlandson et. al (1993) this form of triangulation provides "…the best way to elicit the various and divergent constructions of reality that exist within the context of a study is to collect information about different events and relationships from different points of view." Within the cases this form of perceptual triangulation plays an important role in establishing credibility of the data through interviewing different supply chain actors with overlapping views of the studied phenomenon. First, four different cases were conducted that provided information that complemented each other, since they also described at core a sequential transformation of goods in relation to the use of packages and information. In addition, in relation to each flow of goods sequentially organised actors could provide different perspectives of the same goods in a role as either sent, transported, or received goods.

Different perceptions of the same phenomenon are viewed as complementary. Selecting informants with different backgrounds or perspectives on the studied phenomenon contributes to the trustworthiness of the study by increasing the degree of objectivity in research (Eisenhardt 1989). In addition, Dubois and Gadde state that; "Rather, multiple sources may contribute to revealing aspects unknown to the researcher, i.e. to discover new dimensions of the research problem" (Dubois and Gadde 2002). Interviews were supplemented by observations of the interviewer in order to gain additional understanding of the phenomenon and to ensure the credibility of perceptions provided by informants as suggested by Eisenhardt

(1998). Observations were carried out in the settings where logistics activities transforming goods involving the use of packages and information could be observed in use, e.g. in participating in delivery transports with distribution vehicles from a distribution centre. Observations were also used to ensure that the responses of interviewees were properly understood, and to verify the description provided by informants with the researchers own observations. This may, however, have lead to a bias because of observations being influenced by the informants' perceptions. By averaging different perceptions of the same phenomenon, we can increase the credibility of the empirical findings, such as how different actors perceive the use of labels to identify and assign goods in a specific supply chain.

The main sources of data are based on interviews where informants were asked to provide information such as: on various aspects of packages containing goods; how goods were identified; which information is registered; for what purposes information was used. In this manner a "snowballing" design was used to collect data as one informant lead the process onward to other informants. Informants, therefore, mainly provided information that was complimentary to information provided by other informants. The information from multiple informants provided overlapping perceptions of the same phenomenon thus ensuring credibility of the data.

A specific logistics activity was accounted for by: 1) a retailer describing delivery to the store, 2) the researcher accompanying a truck supplying retailers with goods, 3) using the delivery truck driver as an informant by interviewing the driver prior to observing how goods were transported to the store, and 4) an informant at the distribution centre provided a description regarding how they perceived how goods were delivered to the same retailer. In this manner different perceptions of the use of the package in relation to the same transformation of goods were acquired. To further ensure credibility of the data, documents have been studied including various documents used to distribute goods, package labels, company brochures, and internet web-pages of the companies where research has been carried out.

3.3.2 Transferability of Empirical Findings

A qualitative case study research design allows an in-depth study (Eisenhardt 1989), and this form of study has consequences regarding the use of the findings in other practical settings. This study involving four detailed cases does not seek to explain issues regarding food products in general since only a small selected range of food distribution is covered. Detailed understanding is sought regarding the actual distribution of these studied food products that may be useful in other situations. This endeavour

has been directed by the overall research theme regarding the use of the package as an information resource in fresh food supply chains. As a qualitative study no attempt has been made to generalise the empirical findings of the study. Empirical findings aim here rather to provide "…specific sights, sounds, and relationships, the scene created in the reader's mind may be remarkably close to that would be gained by direct experience" (Erlandson et *al.* 1993). Detailed descriptions of empirical findings may, therefore, be compared to other settings familiar to the reader of a research report.

A goal of this study may be expressed in the terms of what Yin (2003) denotes as "analytical generalisation", what Erlandson et *al.* (1993) term as "transferability", or conceptualised as "theoretic generalizability" (Merideth 1998). Theoretic generalizability represents the ability and potential of applying theory developed based on previous case studies to other settings. "Transferability" as a concept is formulated by Lincoln and Guba (1985); resembling theoretic generalization, and further made operational for research purposes by Erlandson et *al.* (1993). Lincoln and Guba (1985: 290) define transferability as the extent to which other actors can apply the empirical findings in other settings. The empirical findings aim to stimulate an understanding of the research theme. "Understanding" represents a step further than describing and explaining (Merideth 1998) and involves developing knowledge, and this knowledge-creation is related to the overall research theme of this study.

Regarding trustworthiness of the empirical findings, the verification of data does not represent the main emphasis. According to Merideth (1998), in a case study "…replicability is attained by applying the resulting case study to theory to a somewhat different set of conditions." Case studies permit the focal product in a flow of goods to be expressed in relation to time and location-specific activities that may be described in detail. Activities are in practice time and place-specific sets of actions, and the individual nature of these sets of actions using a specific set of combined resources cannot be exactly replicated. As previously discussed, a view is proposed that empirical findings from this research may be transferable to other supply chain settings. For instance, features of using the package as an information resource may be transferred to cases regarding the distribution of other types of products. Empirical findings may also be transferred involving the use of different types of packaging, and different types of information systems.

In a qualitative research context the role of the researcher is more active than in quantitative research. A fundamental view, is also, that it is impossible to detach the researcher from the substance being attempted researched.

Interpretations and judgements made by the researcher will, therefore, to some degree be "biased". The empirical findings will never in a full and complete manner "perfectly" replicate the slice of reality that this study aims to depict. Therefore, the aim of this chapter is to create an openness regarding the applied method and to provide insight into important choices and processes in the research.

Through the course of the study it has been attempted to limit the researcher's bias and increase the credibility of the study through debriefings of preliminary empirical findings and discussions with informants regarding different ways of interpreting data. Also by constantly adapting the design of the research to the frame of reference has helped steer the direction of this study, binding it more closely to its objectives. The credibility of the study is influenced by how the emergent design of the frame of reference has been made operational. This process has further involved numerous small decisions where peer debriefing in relation to the development of the frame of reference in an iterative fashion related to new empirical findings, have directed the course of the study.

3.3.3 The Role of the Case Narrative

The cases are documented in a narrative report in Chapters 4 and 5 that is used to communicate the empirical findings in an as truthful manner as possible given the described research constraints. According to Yin (1981); "The typical case study report is a lengthy narrative that follows no predictable structure and is hard to write and hard to read". Therefore, a final focus is directed towards the text form of the case since the quality of the case narrative influences how well the reader may understand the empirical findings. Comprehensibility of the frame of reference will thus influence how the case narratives are understood. This involves how empirical findings are communicated to a wider audience, influencing perceptions regarding the transferability of the empirical findings. It is the case text that accordingly provides transferability. Accordingly, it is important to discuss aspects of how the empirical findings are communicated through the text.

In accordance with the subjectivist-leaning epistemological stance, the empirical findings in a text form are regarded in line with the ontological views of the "later" Wittgenstein (1953) as social constructions. Language involving the ability to communicate and know is learned in a cultural context. Language is, therefore, never a neutral object, and this understanding also influences the view regarding "truth" and the possibility of being objective in relation to the realm of substance. In this study theories, models, interview transcripts, and observation notes are used together to

construct the text describing the empirical findings. All these are elements constructed in the course of this study by the researcher in a research context to create the "story" about the role of the package as an information resource. Existing literature including previous case studies within logistics and supply chain management, have in accordance with Eisenhardt (1989) been used as a source to gain a deeper understanding.

A narrative is a text that is used to "…exhibit an explanation instead of demonstrating it" (Polkinghorne 1988: 21). The narrative accordingly describes rather than explains a phenomenon. The empirical findings allow multiple interpretations by readers with different needs influencing how they perceive the case "stories". A narrative is regarded here in line with Polkinghorne (1988:13) as "a story". The main elements in a story are according to Polkinhorne (1988) a plot, meaning, or some form of intention described in the text. In the following case text this plot is related to describing how packages facilitate the transformation of goods, identify goods, and exchange information about goods. "A plot is able to weave a complex set of events to make a single story" (Polkinghorne 1988:19) and thereby communicate meaning to the reader through story-telling.

The case narrative is regarded as a "thick description". Geertz (1973) views a thick description as an anthropological way of gaining in-depth insight into events mainly focusing on actor perceptions influenced by culture. In this study a form of thick description is made by describing the complexities of the transformation of goods in interplay with information and packages in the supply chain context. The supply chain is accordingly also regarded as a type of business culture. This description is interpreted here as "thick" involving the complexity of how different logistics resources are combined in a limited amount of time through sets of actions termed as specific and named logistics activities. This study is accordingly not an anthropological endeavour involving prolonged engagement with different actors in a supply chain environment. The study gives rather a "snap-shot" view of the complexity of distributing fresh foods from initial producer to retailer with a focus directed towards using the package as an information resource.

The empirical findings are presented in a text form that can be viewed as a type of narrative. This is a story that in its form is driven by the frame of reference described in chapter two. This involves describing how the chosen products are distributed involving a sequential transformation of goods, how information supports this transformation, and how packages both facilitate the transformation of goods and informing about goods. The actual narrative in this study is founded on the iterative interplay between the frame of reference and data collected through interviews, observations, and scientific

literature. The provided narratives are accordingly stories that aim to provide knowledge concerning the use of the package as an information resource in the supply chain in a specific manner. That this story may certainly be told differently is not regarded as a decisive factor when regarding the truth-value of the narratives.

The case text in the following two chapters presents, accordingly, a structured story regarding the role of the package as an information resource in the distribution of four different food products. This narrative form does not imply a particular writing style. In this study the narrative represents a descriptive text influenced by the structure of the frame of reference in an iterative interplay with empirical findings. The narrative form provides a description of interrelationships between packages and other logistics resources by postulating why these resources are combined in a specific manner and how they are used. The plot is found in the descriptions of using packages as an information resource. The following case descriptions are accordingly descriptions or the "stories" of distributing four fresh food products. The aim of these narratives is to exhibit the "how and why" of using the package as an information resource in a supply chain. The narrative is a text construct that is the result of interplay between the frame of reference, what was observed combined with the transcripts of the interviews, and the aim to meaningfully describe the empirical findings in relation to the theme of this research.

Part Two: Empirical Findings

This part consists of four cases that describe how the transformation of goods, packages, and information interplay in the distribution of four different fresh food products to Norwegian retailers. First, Chapter 4 covers how the Norwegian fresh fruits and vegetables distributor BAMA distributes Corona strawberries and Dole bananas. Then, in Chapter 5, the distribution of TINE Lettmelk and Marian fish filets is covered as regards to the Norwegian dairy product producer and distributor TINE. The four products are used as a point of reference to describe the transformation of goods and use of the package as an information resource. Each set of two either TINE or BAMA product cases are initiated by an overall description of the organisational setting of the products either within the supply chain of BAMA or TINE.

The chapters containing a set of two product-related cases start as a single description of either TINE or BAMA. Each chapter is then split into two parts, one part for each product. The description of the flow of goods follows the transvection understanding of distribution as discussed in section 2.4. This understanding uses the state of a product in the hands of the end user as a point of reference. The case narratives presented in this part, however, follow the flow of goods according to its usual downstream direction of flow. The transvection has therefore, as accounted for in Chapter 3, mainly been used as a research tool enabling the descriptions of the flows of goods. The product plays accordingly in the case narrative in this part a relatively sublime role in relation to goods and packages.

The four cases follow a same fundamental narrative structure to provide a basis for comparison. In the case text, an overview is first given regarding the product, its packaging and distribution. This is followed by how goods are transformed through activities in the flow of goods. After this, the provision and use of information directing the delivery of goods with regards to sorts is covered. Finally, the information-related activities of tracking goods and tracing products complete each narrative.

4. The BAMA Cases

BAMA is the organisational context of the two studied products, Corona strawberries and DOLE bananas. First, in 4.1 the BAMA system, consisting of its industrial network and the information system BAMA, uses to distribute its products, is described. This is followed by 4.2 with a narrative related to Corona strawberry product and this is followed by Section 4.3 concerning Dole bananas.

4.1. BAMA

4.1.1 The BAMA Network

BAMA is a major actor in the Norwegian fresh fruit and vegetable market with 4950 million NOK in turnover in 2004 and a market share of slightly above 50%. BAMA is also a minor actor in the Norwegian flower market, distributing flowers mainly through grocery retailers. BAMA's roots may be traced to an agent named Matthiessen who started importing mainly lumber in 1886. In 1905 the first bananas were imported and gradually became the main source of this agent's revenues. BAMA's main role is as an intermediary between domestic and foreign production of fresh fruits, vegetables and flowers and the Norwegian consumption of these products is illustrated in the following figure 4.1:

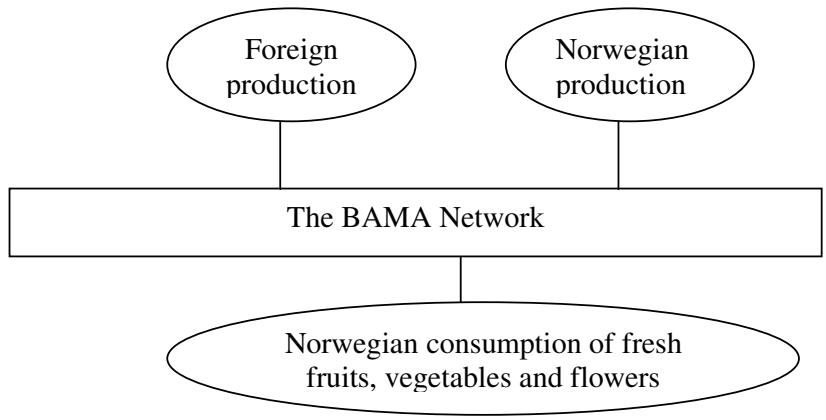

Fig. 4.1 The interconnecting function of BAMA

BAMA is an intermediary actor between suppliers and retailers and distributes its products through a nation-wide network of regional

distribution centres. The customers can be grouped into four categories: 1) the food processing industry, 2) hotels, restaurants and catering (HORECA) service providers, 3) food and other household product retailers, and 4) kiosks, petrol filling stations and other forms of convenience stores. The network of BAMA's types of suppliers and customers is shown in figure 4.2 below:

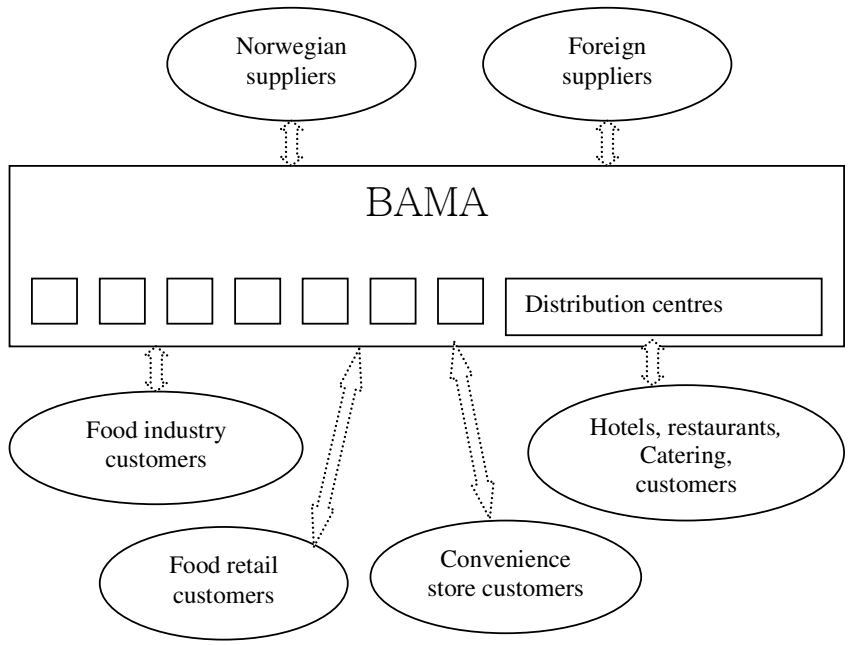

Fig. 4.2 BAMA's customers and suppliers (Double-headed and dotted arrows indicate business relationships)

On the customer side, the food processing industry uses fresh fruits and vegetables as raw material in the production of food products. HORECA service providers use fresh fruits and vegetables as ingredients in meals served to its guests. Convenience stores and food retailers distribute fresh fruits and vegetables to consumers, selling these products with specific service attributes such in combination with petrol filling or other activities at convenient locations for customers or at stores with extended opening hours. Food retailers are basically different forms of household item retailers commonly termed as supermarkets. It is the distribution to food retailers that is the focus of this study.

An important distinguishing quality feature regarding fresh fruits and vegetable products are requirements regarding their degree of freshness. BAMA seeks to coordinate product supply of its relatively perishable products within a limited time frame. Fresh produce from a multitude of suppliers varies according to season. Also, the different customers represent a relatively stable, year-round demand for most products. On the supply side the variations are greater. Some products such as potatoes, carrots and apples may be stored for a longer period of time.

All four BAMA and TINE product cases (covered in Chapter 5) focus on the distribution to food retailers in Norway. In Norway, household item retail, including foods, is characterised by four integrated supply chains. In addition a network of small independent fruit and vegetable retailers, mainly run by immigrants and mostly present in the larger cities in Norway, have approximately a 5% national market share of these products. They also carry a selection of other household products and specialise in imports. These retailers receive their goods from smaller wholesalers and the market at Økern Torg ("Torg" is Norwegian for marketplace). The main groups of food retailers in Norway are HAKON, Reitan, Norgesgruppen and COOP. Altogether, these retail groups account for more than 95% of food retail in Norway. The various supply chains of fresh fruits and vegetable products from wholesalers to retailers in Norway are shown in figure 4.3:

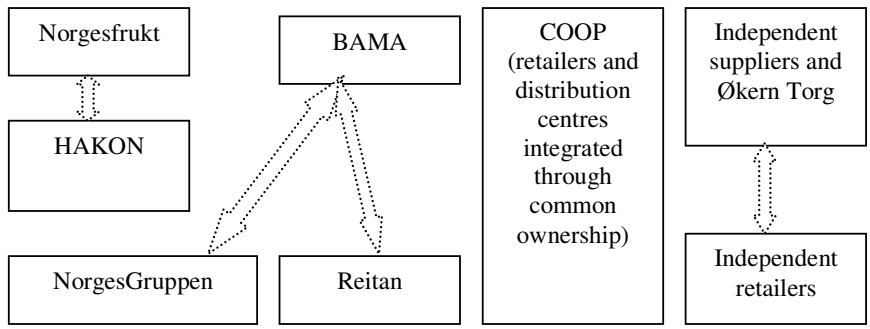

Fig.4.3 Supply chains of fresh fruit and vegetable products in Norway

BAMA is a supplier of fresh fruit and vegetable to both Reitan and NorgesGruppen, which together account for in 2004 a 52,3% market share of this type of retail products in Norway.

On the supplier side, the main bulk of the Norwegian suppliers are small actors who harvest their products during the summer and autumn. Many of these perishable products, such as strawberries and lettuce, demand rapid

delivery after harvesting. Other products, such as potatoes or cabbage, may be stored for some months. A few others, like tomatoes and a limited amount of Corona strawberries, are cultivated in greenhouses, securing a year-round supply of these products. Imports provide the supply of products not grown in Norway and are also a supplement to seasonal Norwegian-grown products when this supply runs out, usually during the winter and spring seasons.

Within its industrial network BAMA Gruppen is the strategic-level actor in BAMA. It is the corporate organisation that handles relationships with government and other non-government organisations, including competitors. It also carries out long-term planning, including more overall decisions concerning the development of its internal organisation, as well as the development of business relationships with its suppliers and customers. BAMA Gruppen, is in other words, not directly involved in the operations of its supply chains. Within BAMA Gruppen, BAMA Trading represents the central actor in managing and operating the flow of its goods as illustrated in figure 4.4.below:

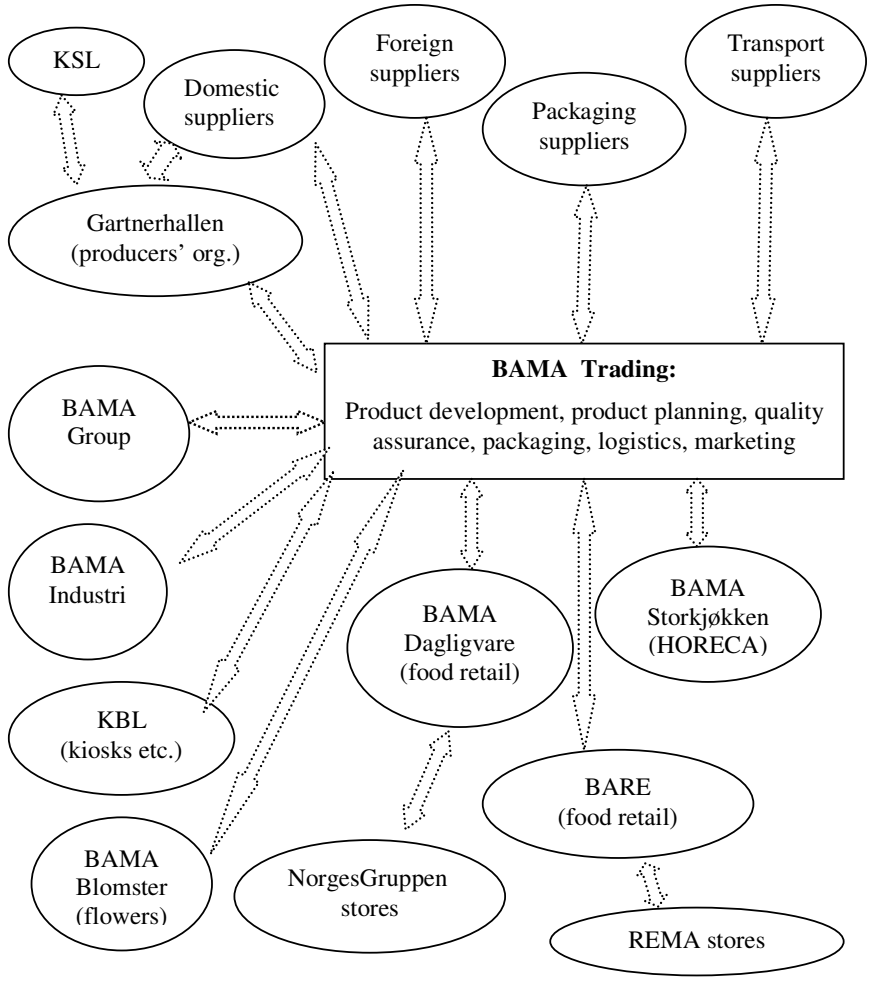

Fig. 4.4 The business relationships of BAMA Trading

The main function of BAMA Trading is as an intermediary that maintains business relationships with BAMA's suppliers and its customers. BAMA Trading is, as its name implies, a trading organisation. BAMA Trading employs a range of product managers who handle the purchasing and sales of its products. Product managers lead a small group of people who are responsible for the distribution of a group of specified products. BAMA

Trading also has a marketing department that promotes its products mainly towards customer actors, such as supermarket chain managers, in the case of promoting sales through retailing. Additionally; BAMA Trading is responsible for the transport of goods from its suppliers to the distribution centres. BAMA Trading coordinates the purchasing and distribution of BAMA's products and is responsible for carrying out the annual planning of production volume from domestic producers and more long-term agreements regarding supply from foreign suppliers.

The main groups of customers are the distribution centres represented by KBL (kiosks, convenience stores, gas stations etc.) BAMA Dagligvare (distribution to NorgesGruppen food retailers), BARE (distribution to REMA food retailers) and BAMA Storkjøkken (distribution to hotels and catering) represent an intermediary organisation. Furthermore, BAMA Industri is a major customer of BAMA's products used in production of industrial food items like frozen mixed vegetables and frozen french fried potatoes.

Different types of packaging are used to contain the domestic products distributed by BAMA. These are mainly cardboard boxes and IFCO reusable plastic crates. IFCO Norge supplies all the reusable crates used in Norway for agricultural purposes, and within BAMA, different sizes of IFCO crates are used to carry about 30-40% of its domestic production of fruits and vegetables. Moreover, 2% of its imports arrive in these crates. A range of suppliers provides carton-type distribution crates and different types of consumer packaging for carrying different products. Containers and pallets are normally provided through transport firms.

BAMA uses Gartnerhallen to maintain a more long-term business relationship with its producers. The annual domestic production planning at BAMA is carried out through Gartnerhallen which also coordinates the provision of information to assist the producers in production operations and management of their production. Gartnerhallen has close ties with BAMA Trading and its administration is located in the same building as BAMA Trading. BAMA Trading has a limited degree of direct contact with its domestic producers as well, for instance by holding two annual meetings with the producers. Production of domestic fresh fruits and vegetables is done in accordance with standards developed through KSL (Kvalitetssikring i Landbruket), an organisation that develops quality standards for the Norwegian agricultural industry. KSL is owned by BAMA together with other producer, distribution, and retail actors. It is mainly the individual producers through Gartnerhallen who have relationships with KSL regarding the use and development of these production standards.

BAMA Trading maintains and develops business relationships with a range of regional transport firms. Nor-Cargo Thermo, one of Norway's leading thermal transport firms, handles much of the long-distance transport of BAMA's products. Nor-Cargo Thermo has a network of terminals with temperature-adjusted facilities throughout the country. BAMA Trading also has business relationships with several different regional transport firms, such as Waagan Transport in Ålesund on the North-Western Coast of Norway. The logistics network of BAMA Trading involves the business units that take part in managing and operating the supply of BAMA's products to end-users.

BAMA distributes to food retailers through two separate networks of distribution centres, BaRe and BAMA Dagligvare. BaRe distributes products to REMA 1000 stores within Reitan Gruppen, and BAMA Dagligvare distributes products to stores organised within different supermarket chains belonging to NorgesGruppen. NorgesGruppen has a 44% ownership share in BAMA Gruppen, while REMA 1000 International has a 10% share in the same company. BaRe, a wording that stands for the cooperation between BAMA and REMA, accouned for 1150 million NOK in revenues in 2003, which is 24% of the turnover in BAMA. Reitan Gruppen is the owner of the REMA 1000 supermarket chain. BaRe is owned by both BAMA and Reitan. BaRe distributes a limited range of products with a relatively large volume, compared to BAMA Dagligvare, of each product type through its nine distribution centres. These products are distributed to consumers through REMA 1000 supermarkets. REMA 1000 is a "soft-discount" supermarket chain with large stores and a limited range of product items. A regional transport service provider handles transport with trucks to supermarkets for the distribution centre terminals. Normally a BaRe distribution centre has only a single provider transport service. The closest business units and their most important facilities in the logistics network surrounding BARE are shown in figure 4.5 below:

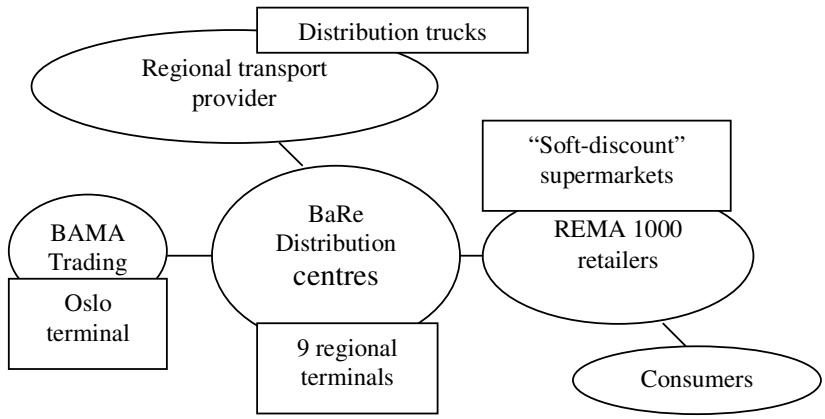

Fig. 4.5 The main business units and their most important facilities in the logistics network of BaRe

BAMA Dagligvare is the central actor in the other mode of distribution to Norwegian retailers. In 2003, it had a turnover of 2300 million NOK, which represented 48% of BAMA's total revenues. This network consists of eighteen distribution centres that distribute to stores within NorgesGruppen; a retailer group that is a conglomerate of various supermarket chains, some regional and some national. In the Oslo district, the following chains within NorgesGruppen are supplied by the BAMA Dagligvare Oslo business unit: ULTRA (full-assortment mega supermarket), MENY (full assortment), MENY Champion (full assortment, run in cooperation with Champion, a French retailer), KIWI (limited assortment soft-discount), Bunnpris (limited assortment soft discount, smaller stores that may in some cases be open on Sundays, no or limited car-parking), Spar (medium assortment with delicatessen and fresh meats counter), and Nærkjøp (medium assortment, "the shop around the corner" concept). Since BAMA Dagligvare has a large number of full assortment supermarkets as customers, its distribution centres need to supply a wide range of products. BAMA Dagligvare also maintains a "high-quality" market position of its products. Besides, its soft-discount customers, such as KIWI, offer better quality products and a wider assortment than the competing REMA 1000 stores supply through BaRe. The main business units and their most important facilities in the logistics network surrounding BAMA Dagligvare are shown in figure 4.6:

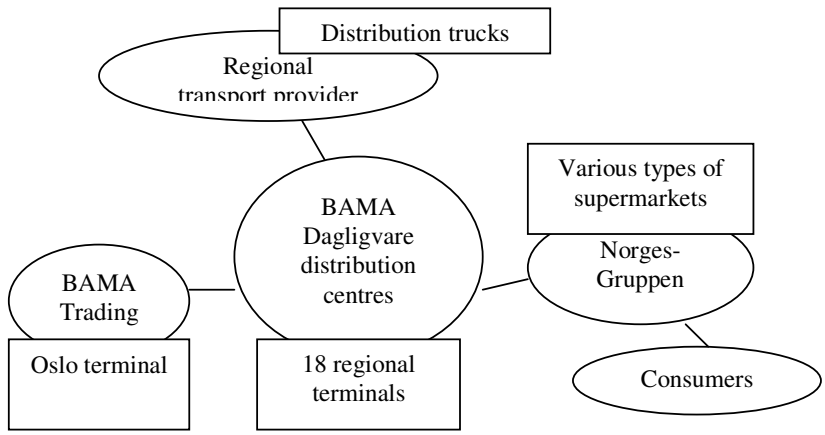

Fig. 4.6 The main business units and their most important facilities in the network of BAMA Dagligvare

4.1.2 Information System

BAMA uses several different forms of technology to collect, process and communicate information. BAMA's information system consists of two core EDI systems used to distribute various BAMA products and these are loosely interlinked. Around these systems a variety of manual forms of information exchange take place, mainly by telephone, fax, Internet, and SMS mobile phone texts. Goods are delivered to customers based on orders and forecasts. Weekly forecasts of demand measured in volume are estimated for each product at BAMA Trading. These estimates are done manually and are registered on an EXCEL spreadsheet. The demand for fresh fruits and vegetables is relatively stable, and a forecasting system makes a prognosis for the demand of each article based on last year's demand that is related to a manually calculated, potential trend in demand, and how holidays rotate between dates from year to year. Forecast information is provided to product managers and the distribution centres and is the basis for long-term, domestic production planning and ordering of import items. Forecasts are conveyed to the distribution centres and used by their actors to order goods on a weekly basis from BAMA Trading.

The two EDI systems used by BAMA, LORRY and OLFI, employ a set of standard screen formats that may also produce standardised documents. Within these systems, each product type is assigned an article number, a

GS1-based numerical code for each product. A domestic product is represented on the LORRY system screen formats with a 6-digit numerical code; the first 4 digits representing a product type, and the last two representing the variety type of the product. The complete GS1 product code contains 13 digits and this contains information about exact place and country of origin, the product number, product type designation, and more specific product features (e.g. colour, texture etc.) used to identify import products. The logistics department uses a goods location code it terms a *position number* and consists of the article number combined with the volume of the product. The product variety mainly specifies what form of packaging is used. Red onions are, for instance, packed directly in 5kg. paper sacks or delivered in distribution-level packages containing 4-pack consumer packaging. Accordingly, the different forms of delivery of the same product have accordingly their own unique article number. On the screen the article number is followed by a text describing the product. Other information also coded is names of actors, including producers, transport firms, different actors within the BAMA group, and its customers.

From BAMA's perspective, customers are found at two tiers in the supply chain of its various products. BAMA Trading regards the 50 distribution centres as its customers, representing their first tier. Each distribution centre, in turn, has its own customers, such as retailers, kiosks or HORECA business units, representing a second tier of customers. In both LORRY and OLFI, the main unit of information is volume related to the article number. The LORRY EDI system is used mainly to operate the flow of goods to the distribution centres. Information regarding product orders, deliveries from producers, and customer orders are registered in LORRY. Since LORRI and OLFI are interconnected, the customer orders registered in LORRY are automatically transferred to LORRI based information previously registered through the OLFI system. LORRY is used to coordinate transport and storage and give distribution centres precise supply information about when specific products will arrive at the distribution centres. This information is used to coordinate supply volume with actual orders from the retailers. LORRY also produces transport documents and packaging labels through different label and document printers at its distribution terminals. The main actors and types of information communicated within LORRY are shown in figure 4.7:

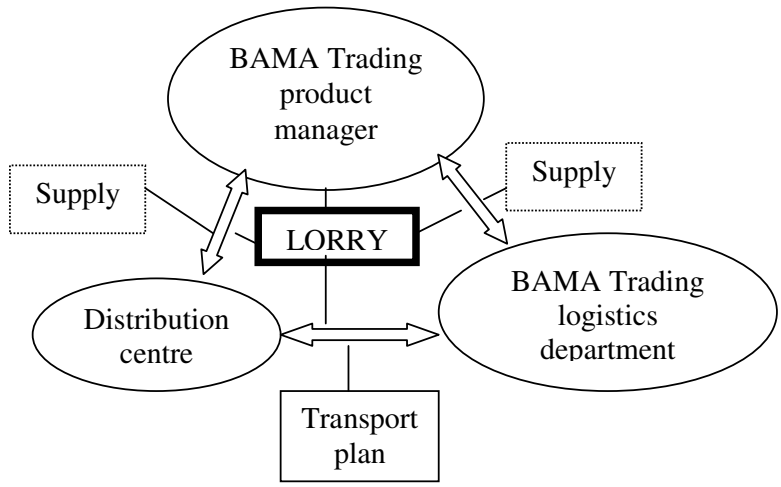

Fig. 4.7 LORRY information system (information exchange shown by double-headed arrows), and the type of information that is communicated using this system

OLFI is used to register orders from the retail customers of the distribution centres and to coordinate the delivery of goods to these customers. Based on retailer orders and forecasts the various BAMA distribution centres place orders communicating through OLFI to BAMA Trading. OLFI also produces picking lists used by terminal workers at the distribution centres, transport documents, and distribution and transport package labels to support the delivery of the goods. The marketing department at BAMA Trading uses OLFI to control orders, both from the distribution centres that are forecast-based, and the actual retailer orders. An original plan was also to use OLFI also to communicate order information between the distribution centres and its retail customers. This is not yet been attempted. The main actors and types of information exchanged within the OLFI EDI system are shown in the figure 4.8 below:

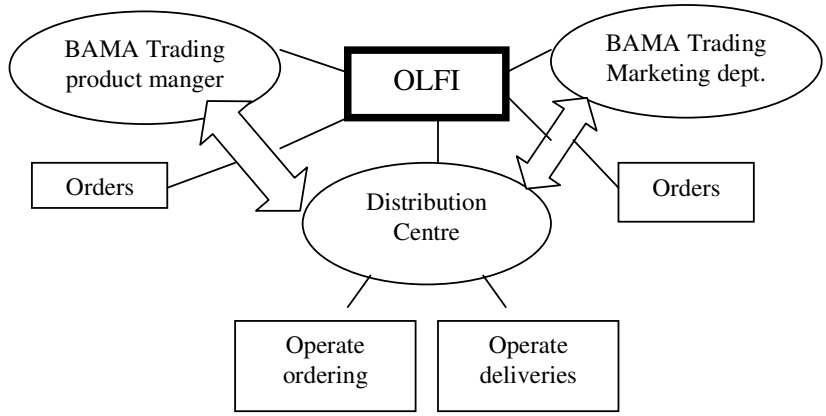

Fig. 4.8 OLFI information system and the type of information that is communicated (Information exchange shown by double-headed arrows and also indicating operations using information at the distribution centre)

4.2 Corona Strawberries

Corona strawberries is the first of four product cases described. 4.2.1 describes important features regarding the Corona strawberry product. This is followed by a description, in 4.2.2, of the various forms of packaging used for this product. Section 4.2.3 gives an overview of how the product is distributed, including the most important actors and facilities within the flow of goods. 4.2.4 describes the transformation of Corona and its packaging: 4.2.5 concerns the role of information in relation to this transformation of goods; and finally, in section 4.2.6, tracking and tracing Corona are accounted for.

4.2.1 Product

The Corona type strawberry is harvested during a relatively short early-summer season normally providing strawberries to the major cities in Southern Norway for a period lasting from 8 to 12 weeks. The start of the season varies from late May to mid-June depending on weather conditions. Strawberries are first harvested in the southern regions of Norway, then gradually harvested further north in a region-following-region manner. The CORONA strawberries are grown and harvested outdoors. This form of

production is in Norway called “friland” (meaning “open-air”). Friland strawberries represent the major volume of the annual Norwegian strawberry consumption. A very limited volume of Corona-type strawberries is cultivated in greenhouses near the Oslo region. Corona is a tasty, fairly large, bright red strawberry species perfect for eating as is. It is used only for consumption in its original form or combined with other food products, for instance in desserts or cakes. Corona is distinguishable from imported strawberries, e.g. of the Santa type, which have a good visual appearance and smell, longer durability, but have a more “watery” flavour and harder texture. These strawberries are, however, suitable as ingredients in desserts and cakes. The taste quality of imported strawberries with longer durability is improving.

Corona strawberries grow on a plant and may be annually harvested 3 to 4 times. The plant carries many berries that ripen at different times over a period of a few summer weeks. The specific Corona species has been cultivated and adapted to the peculiar Norwegian growing conditions; it is harvested in its ripe condition and picked manually. This type of strawberry is vulnerable to transportation damage caused by vibration or shock. During transport and storage, Corona requires an environment kept at 4 degrees C, which is colder than most other fruit and vegetable products. Corona has an approximate life span of maximum 48 hours from time-of-harvest to consumption. BAMA representatives themselves express this as a “24-hour limit”. This means that from the strawberries are picked up at the farm it should take less than 24 hours to have them delivered to the retailer. About 95% of the open-air grown eating strawberries distributed by BAMA are of the Corona type. New species with superior product characteristics are also in the process of being developed.

4.2.2 Packaging

Corona are contained in 500 gram unmarked green or blue plastic baskets. These are open at the top and placed into distribution cartons or plastic IFCO distribution crates. The IFCO crates and cardboard boxes used measure 60cm. x 40cm. BAMA tries to pack as much of its production of Corona into IFCO crates due to this packaging form’s superior handling qualities compared with cardboard distribution crates. Four IFCO crates or cartons containing baskets of Corona strawberries fit perfectly on EURO pallets measuring 120cm. x 80cm. These pallets fit into a truck compartment that is measured according to how many pallets they may load. Trailer-type trucks used to transport Corona from the farms to the distribution centres carry a maximum capacity of 34 EURO pallets in its two compartments; one on the truck itself, the second on the trailer.

The distribution package form, whether an IFCO crate or cardboard-material crate, is used to carry the product from harvest in the field to the display area of the store. These crates have the same capacity and contain the same amount of 500-gram unit baskets. The IFCO crate is made of green-coloured, hard plastic. Its sides are fashioned in a grid-like manner permitting ventilation of the products. In temperature adjusted compartments, this allows for more direct temperature control of the products. The IFCO crate is sturdier than the cardboard boxes and may therefore be stacked up to the roof within the truck compartment, or about 220 cm. in height. Stacking equally high is not possible with a cardboard box.

Pic.1: IFCO crate and baskets containing Corona strawberries

There have been told stories about truckloads of Corona strawberries carried in cardboard boxes arriving at the BAMA Trading terminal at Økern in which a majority of the load was damaged due to shock and vibration during transport. The logistics manger at BAMA Trading complained then that, "…we received only strawberry jam", commenting on one occasion when a truck driver had encountered traffic causing severe shock damage during transport of Corona strawberries and was forced to return to the BAMA

Trading terminal with the load that was to be exported to Sweden. Corona strawberries are lightweight products. Stacking them high may be carried out using the IFCO crate and involves manually lifting of crates one on top of the other. A stepladder is available for use at the distribution centre terminal to stack crates up to 220 cm. in height on pallets.

Harvesting Corona strawberries often takes place in rainy weather, and the plastic IFCO crate is not vulnerable to damage in an open-air environment. Cardboard boxes damage the products they carry more easily if soaked during harvest. When previously soaked boxes are stacked, and then dry gradually, the lowest layers often are crushed, damaging the products. The IFCO crate has gained popularity within BAMA, especially among the producers and the logistics department at BAMA Trading, thanks to their superior goods protection and handling characteristics.

A cardboard box carrying a printed text that contains the company logo, brand name, and product information, may easily be stamped with additional information, and a label may be easily glued onto it. The IFCO crate is a reusable crate that must go through a cleaning process after use and before reuse. Labels may not be glued onto this crate. If glue were used to stick labels on IFCO crates it would interfere with the cleaning process since glue and paper waste from stickers would clog the cleaning machinery. The IFCO crate is instead designed with a slot into which a paper label may be slid without using glue. The problem with this slot is that the label may slide out during handling and transport. This does not pose a major problem, however, since stacks of IFCO crates are grouped together, and thus it is possible to read the information from crates stacked around the crate that may be missing its label. The use of the IFCO crate is also carried out using a return-deposit system: BAMA rents the crate from IFCO Norge paying a 1,50 EUR deposit at regular intervals. This sum is rounded off into an equivalent amount in NOK and at regular intervals adjusted fluctuations in the exchange rate.

4.2.3 Distribution

Corona strawberries is the most important product within BAMA during its short season, measured both in value and volume. In the exceptionally good summer season of 2004, during the weeks no. 22-33, 49 million NOK of Corona were harvested and sold, out of a total domestic BAMA production of 258 million NOK representing 19% of the turnover. During the short and hectic season, Corona strawberries is accordingly, the most important product distributed by BAMA, measured both in value and volume. The production and sales of Corona increased greatly from 2003 to 2004 due

mainly to a prolonged summer season, but was reduced again in 2005 because of poorer weather conditions. The actors, facilities and the flow of goods involved in the distribution of Corona are shown in fig. 4.9:

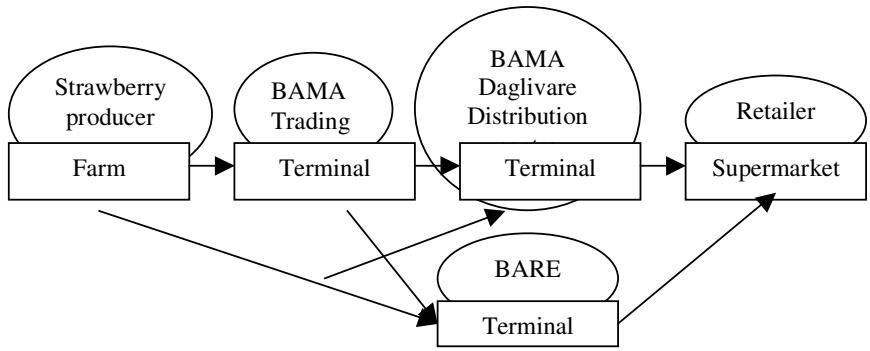

Fig. 4.9 The Corona strawberry flow (Arrows indicate the flow of strawberries)

About 25-35% of Corona strawberries are moved through the BAMA Trading terminal while the rest are moved directly to distribution centres. Goods are moved through the BAMA terminal in order to combine goods from different regions for distribution to specific distribution centres. NorgesGruppen stores and HORECA facilities receive almost all of their strawberries through BAMA. Within REMA 1000, however, 40% of strawberries are delivered directly from a producer to the store.

During the summer season BAMA Trading organises a "strawberry team" that consists of 4 persons to manage the Corona flow. This team's function is to coordinate the supply from strawberry producers daily with demands from the distribution centre customers and provide information regarding the harvest locations and volumes of Corona strawberries needed to be loaded and transported from the producers on a specific day. Two of these persons are taken from other parts of BAMA Trading and are assisted by two seasonally hired people. These two are students at the Norwegian University of Life Sciences where agricultural-related technology represents the core competence.

Prices are adjusted in accordance with the daily supply as perceived by the community of different Norwegian fruit and vegetable wholesalers. Price is the main mechanism used by BAMA to coordinate variations in supply with variations in demand. Prices are set depending on daily supply and demand information and an informal, daily communication routine by telephone with representatives of the competing fruit and vegetable wholesalers. Setting the

"market" price is done in what is expressed as a "deceptive", thus also in a lawful, manner. Prices to the producer average at about 16 to 17 NOK per kilo in 2003. The strawberry farmers, however, claim that they require 20 NOK per kilo if this production is to be profitable. If the weather has been poor, quantities may be low, and the team needs to inform customers that volumes will be reduced that day. This process represents the basis for the price to supplier. Price mark-ups to producer are calculated to estimate the retail price. Retailers may be given discounts or "promotions", as BAMA terms them, if they accept large quantities of Corona. This is especially common on days with higher than average harvested volumes, such as if the weather has been good and several harvesting regions provide Corona simultaneously.

4.2.4 Transformation of Corona Strawberries and its Packaging

The transformation of Corona strawberries in its flow and the various forms of packaging used to contain this product are shown in figure 4.10 as a transvection:

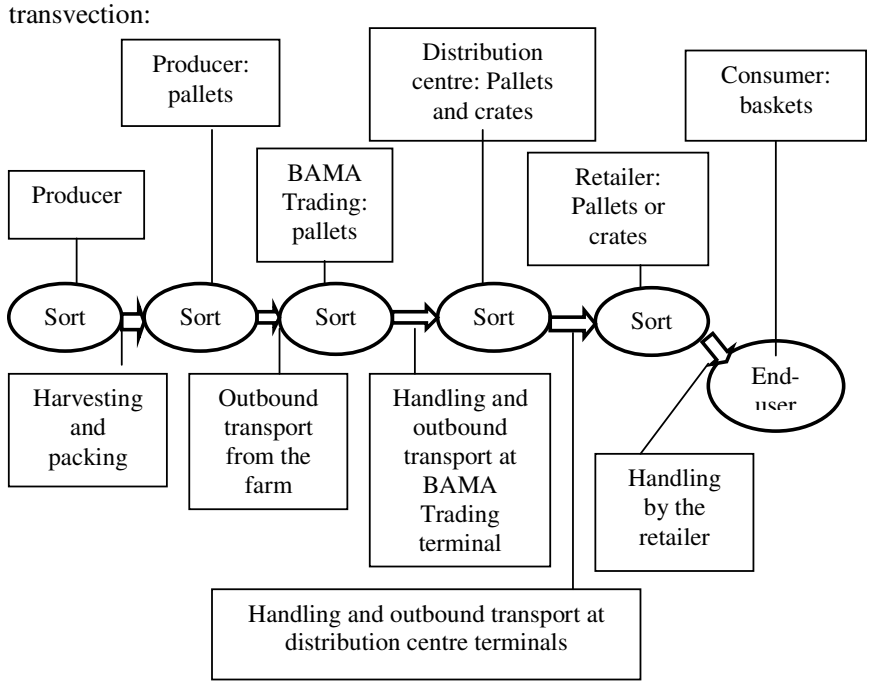

Fig. 4.10 The transforming activities and types of packages used in the flow Corona strawberry goods (Arrows show the transformation of goods between sorts)

Figure 4.10 describes how Corona strawberries are distributed in a manner that aims to reduce this product's character qualities. After harvest of the product, it is primarily decay and damage due to transport and handling that alter the physical features of Corona strawberries. The activities that transform the Corona strawberries are either material handling or transport. The consumer package and distribution package types used at harvest remain unchanged until the goods reach the retailer. The total time used from harvest to delivery at the retailer is normally less than 24 hours. The following parts consider the individual transforming activities depicted in fig 4.11.

Harvesting and packing

Production volume varies depending on the time of harvest during the season and weather conditions the day before harvest. Cold and rain hamper the ripening process. Insects, birds, and the occurrence of plant diseases may also reduce the volume harvested. Harvesting Corona was studied at a particular farm in Nes in Hedmark county, a two hours drive north of Oslo. Harvesting is labour-intensive, and at this specific farm, a migrant work force of about 60 mostly Eastern European youths was housed during the 2003 season. Corona strawberries must be harvested as soon as possible as they ripen to avoid rot damage to the plant in the field. Each morning during the season and until about 14:00 in the afternoon the pickers manually harvest the ripe strawberries. Specialised strawberry harvesting equipment exists but is considered too crude to harvest and handle the products.

The farm labourers pick and then place strawberries into plastic baskets that will hold approximately 500 grams of Corona strawberries. These baskets are then placed into their IFCO crates. A label has the name of the type of product partly printed and partly filled in with a marker pen by the picker. The names of the picker and producer, and date of harvest are also registered on this label that is slid into a slot on the short end of the IFCO crate. This is the only form of labelling on this type of crate. When an IFCO crate is filled up with baskets of strawberries, it is loaded onto a specialised trailer waiting close to the field. When this trailer is fully loaded, a tractor pulls it to a refrigerated storage facility consisting of about 100 square meters located in the barn on the farm. At the storage facility, IFCO crates are unloaded off the trailer and placed on EURO pallets. 48 IFCO crates containing Corona strawberries are usually stacked onto a EURO pallet. The pallets of strawberries are not labelled at the farm.

Outbound transport from the farm

In season, the strawberry team at BAMA Trading expects deliveries of Corona from each producer without giving the producer a product order.

BAMA Trading coordinates the transport of Corona strawberries from the farm to the BAMA Trading terminal located at Økern in Oslo, or to any specified regional distribution centre within either BARE, BAMA Storkjøkken or BAMA Dagligvare. A large trailer truck that will hold up to 34 pallets of strawberries arrives at the farm daily in the afternoon at approximately 15:00. The pallets of Corona strawberries are loaded onto the truck using a forklift. The truck usually has two compartments, one on the truck itself, and the other in the trailer. These compartments are refrigerated. The truck does not have a positioning device using RFID or GPS technology; the truck driver carries instead a mobile phone. Each compartment carries only strawberries since these products demand a lower temperature than other fruit and vegetable products, and large volumes of Corona are collected at each production facility.

Handling and outbound transport at the BAMA Trading terminal
Corona strawberries arriving on pallets are unloaded using forklift trucks. The temperature of the products is controlled and the arrival of Corona is registered in numbers of pallets. Then the products are placed in the refrigerated terminal for a few hours of storage. The pallets are placed against the wall in an area with only Corona type strawberries. Pallets of Corona are reloaded onto trucks bound for distribution centres. The most recently arrived pallets are taken first.

Handling and outbound transport at distribution centres
Corona strawberries on pallets are unloaded off the incoming trucks during the late evening to late night. Upon arrival, some of the strawberries are controlled for temperature and visual appearance. The goods must not have signs of decay or plant diseases. In addition, they must not be too small in size. Goods that are controlled and measured to be of insufficient quality are not accepted, and the producer receives no payment for these. At the BAMA Dagligvare Oslo warehouse facility Corona is stored in an inner holding room using the aisle during the peak of the season. The products are stored overnight for delivery the next day, hence, there is no problem with access to other products at the terminal. At the BAMA Dagligvare Oslo facility, usually 20-22 pallets of Corona are stored during weekdays, and up to 40 pallets on weekends since there is no outbound transport to customers on Sundays.

The terminal facility where Corona is stored is temperature adjusted. Here the goods are either refrigerated or heated depending on the season of the year. Norwegian weather conditions shift from freezing winters to warmer summers. The terminal facilities consist of truck docking ramps, goods storage, and goods handling facilities. They also have facilities for

administrative functions. Quantities of Corona are picked up at the terminal and placed in the truck loading area to be made ready for delivery to retailers. Corona is placed together with other goods, with one or more pallets going to each retailer. If only a limited number of crates of Corona are being sent to a retailer, these crates are stacked together with packages containing other products on a EURO pallet. When reaching approximately "chest-height" (about maximum 150 cm.), the pallet is wrapped in plastic film, and a label is attached containing information about the retailer destination. Entire pallets of Corona may also be sent to a retailer, and are handled in a similar manner as if the pallets were containing various product types. During the season, a few trucks make deliveries containing only pallets of Corona strawberries. These trucks make deliveries to the largest supermarkets. The outbound transport is administered by the distribution centre and follows a route that is planned on a weekly basis. Stores receive goods from BAMA between daily to twice a week. The number of deliveries to each store depends on the size of the store and its location.

Handling by the retailer

Regional distribution-sized trucks deliver Corona strawberries during the morning. The strawberries arrive on pallets containing an assortment of goods with IFCO crates containing Corona strawberries or on pallets of IFCO crates only containing Corona strawberries. Normally the person responsible for the produce department at the retailer's receives the goods and controls the quality of these. In practice, there is little time to carry out any control. The fruit and vegetable goods, including Corona strawberries, are taken into the store's back storage room and prepared for display. Then, stored products are moved into the store. Corona strawberries are, when ordered in smaller amounts, displayed in their IFCO crates on a display shelf in the produce department of the supermarket. If larger quantities of Corona have been delivered, a stack of IFCO crates may be put on view alongside a display counter. If very large quantities have been delivered IFCO crates may be used to display the products while the remaining are stacked on the pallets. In some cases half of the delivered quantity is placed in a refrigerated storage facility and the rest are then displayed in the store. Corona strawberries should be sold out the same day they arrived.

4.2.5 Information Directing the Delivery of Corona Strawberries

This part shows how information is provided and used at sorts to transform the Corona strawberries as described in the previous part.

Long-term production planning
The basis for how Corona strawberries are distributed through sorts is that a more basic long-term planning is carried out. This is described in fig. 4.11 below:

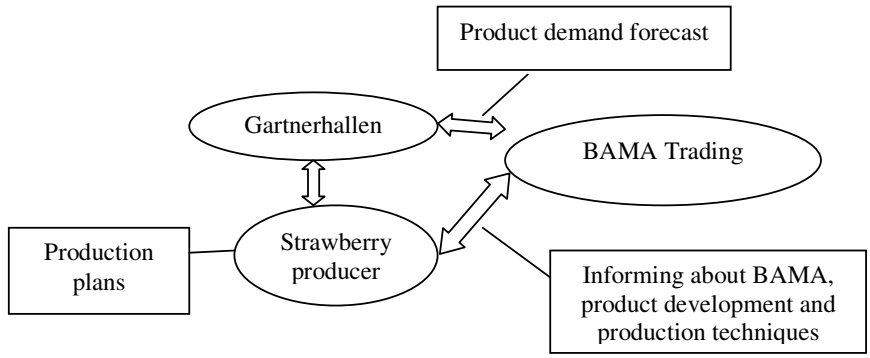

Fig.4.11 Long-term production planning of Corona strawberries (The double-headed arrows show information exchange representing the context for communicating information -this same basic type of figures is used to describe information exchange in all the four cases)

BAMA Trading annually negotiates with Gartnerhallen, the fruit and vegetable producers' organisation about yearly production volumes. Based on the last years' sales and annual trends a forecast covering the next year's production is created. Gartnerhallen uses this information to coordinate the amount of fields used to produce Corona. Since a strawberry plant has a life span of about 3-4 years, production volume is mainly influenced through regulating the planting of new plants when old plants need to be replaced. The fields may be used to produce alternative products. In the case of strawberry producers, the alternative is most commonly to produce some form of grain product. At the farm, types of products produced in the fields must rotate to preserve the quality of the soil. Most types of vegetable or fruit production demand specialised equipment and often a special climate, coupled with a specific geographical location. BAMA Trading holds two annual meetings with the producers of Corona strawberries to inform and motivate them. The main function of these meetings is to develop bonds

between BAMA Trading and the approximately 60-70 producers of Corona with whom BAMA Trading has business relationships.

Ordering by the retailer
Orders represent the basis for transporting goods from the distribution centre to the retailer. The actors and information involved in ordering at the supermarket are shown in fig. 4.12 below:

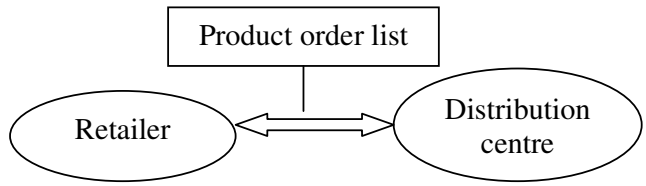

Fig. 4.12 Ordering Corona strawberries

Each week, the distribution centres within BAMA send out an updated product list usually by fax. This list contains the complete product offering of the BAMA distribution centre for a week including prices of the various products offered. Due to fluctuations in volume and price of BAMA's various product supplies, this list changes in content from week to week. Corona strawberries are represented with one line including the article number in this list. Each day before 15:00 in the afternoon, the fruit and vegetable responsible person at the supermarket anticipates, based on intuition and experience, the following day's requirement of Corona strawberries. This person then fills in the order-list and sends it using fax to the distribution centre. Strawberry consumption is lowest on Mondays and increases towards the weekend. Also, on rainy days consumer demand for Corona strawberries is considerably lower. In season, strawberries are ordered daily except Sundays in a specific number of distribution-level packages; larger orders may be registered in pallet-loads. At the distribution centres, the orders from various supermarkets are accumulated and registered into the OLFI system.

Informing to transport from the farm
The next sort considered is about deciding how to transport strawberry goods from the farm. The actors and information involved in this sort are shown in fig. 4.13 below:

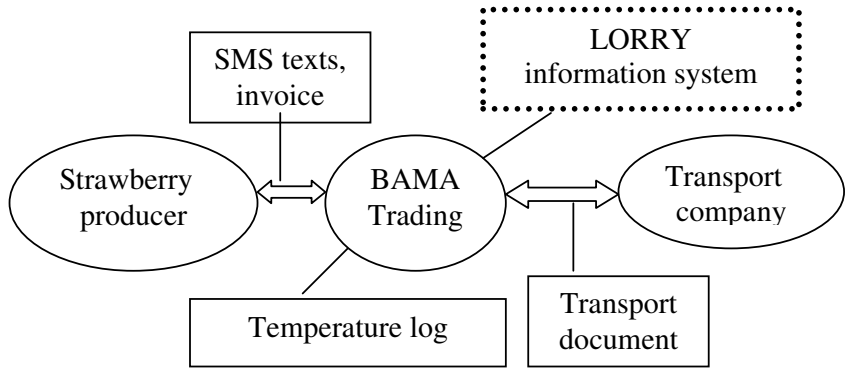

Fig. 4.13 Informing about transport from the strawberry farm (information types exchanged between actors and provided by an actor. Dotted box indicates media form used to provide information)

The strawberry farmer does not receive an order document that initiates daily harvesting. The harvest is carried out each day during the season and the producer must report to the strawberry team at BAMA Trading concerning the production volume of that day. Twice a day, first early in the morning, then around noon, the producer sends a message containing information to the strawberry team about the anticipated volume of strawberries to be harvested during that day. This is done by SMS text messages using a mobile phone. The production volume information in its SMS form is recorded using rough estimates measured in pallets of strawberries. The strawberry team has an electronic device that registers all incoming SMS messages. The precise delivery is registered by number of crates containing twelve 500 grams baskets each. When the truck arrives, a document is created that confirms the actual production volume of the day. This document, which is an invoice, is faxed to the strawberry team at BAMA Trading and used as a basis for payment to the producer and to secure onward delivery. This information is then used by the strawberry team at BAMA to coordinate the production volume of strawberries with received orders and direct the trucks picking up the harvest at farms in the same region.

Each day during the Corona harvest, the strawberry team registers SMS-based production estimates from farmers, and later that day, the exact production is also registered into the LORRY part of BAMA's information system. The logistics department at BAMA Trading uses this information to adjust, if needed, the transport routing plan to collect the Corona strawberries harvested at different farms that day. If volume is larger than expected, an extra truck must be hired. If volume is less than anticipated

based on the SMS-messages, the truck may be rerouted during transport to pick up strawberries at more farms if this is convenient. The logistics department has a long-term business relationship with a range of different regionally based truck operators and knows the size and loading capacity of their trucks. The truck operator is faxed a transport document indicating which products to collect at what locations.

Upon arrival at a terminal, the transport documents are controlled against the actual goods received. The arrival of goods is registered in LORRY. A temperature control is taken of the goods and registered together with noted product damage. Temperature control is registered in a temperature control log, and product damage is registered in a separate document that is sent to the strawberry team.

Coordinating deliveries

In the distribution of Corona strawberries the focal sort that coordinates supplies with deliveries has been identified. The strawberry team at BAMA Trading is responsible for carrying out this sort. The actors and information involved in this sort are shown in fig. 4.14 below:

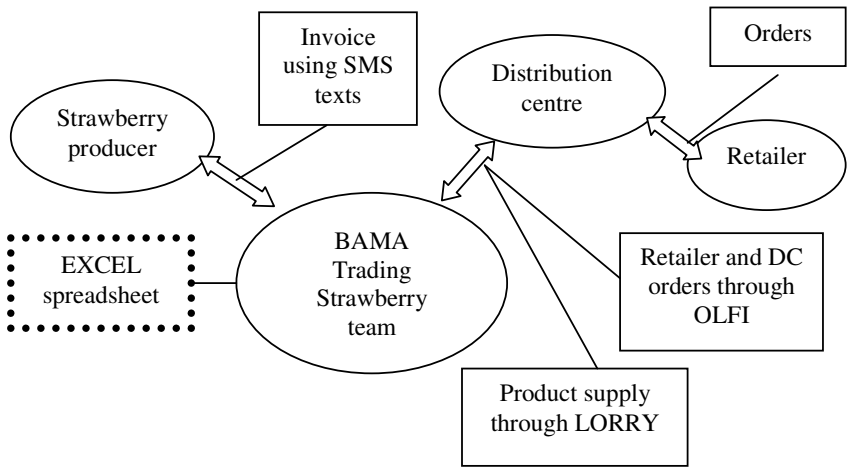

Fig.4.14 Coordinating deliveries (OFLI: part of BAMA's information system. DC: distribution centres)

In the morning, a market price for strawberries is set based on the first production estimate of the day; this price is also adjusted in relation to the anticipated demand from the distribution centre customers. At BAMA Trading, the strawberry team handles incoming production volume

information. This information is registered both in LORRY and on an EXCEL spreadsheet. The other two persons in the strawberry team compare production volume information now registered in LORRY with orders of Corona strawberries from distribution centres registered in OLFI. Orders and production are both measured in crates or pallets that may be translated into crates of strawberries. The strawberry team attempts to match the order volume with production volume using the EXCEL spreadsheet.

Orders that are accumulated from different retailers at a distribution centre (either within BAMA Dagligvare or BARE) never exactly match the volume produced. Usually, orders from the distribution centres are less than production. Therefore, the two persons working towards the distribution centre customers must promote the products, offering lower prices. If a large volume needs to be promoted, the strawberry team may take direct contact with a supermarket chain representative to coordinate deliveries to a number of different supermarkets in that chain the next day. Normally, the strawberry team offers a lower price to the distribution centre if they purchase a larger volume of strawberries. The distribution centre is responsible for phoning its retail customers to promote its increased supply or inform them of an insufficient supply of Corona strawberries.

Informing the retailer about delivery

This section concerns the delivery of Corona strawberries together with other goods to retailers. The actors and information involved in informing about this delivery of goods are shown in fig. 4.15 below:

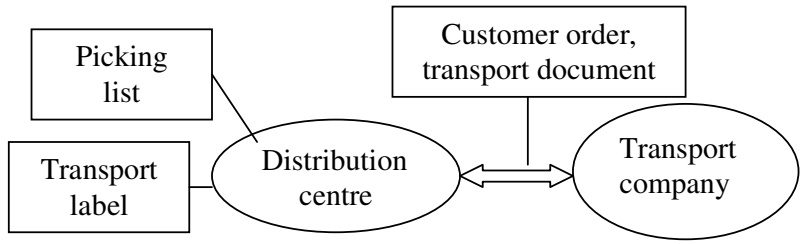

Fig. 4.15 Informing the retailer and transport providers about delivery of Corona strawberries together with other goods

After the final orders are confirmed for Corona strawberries and the other BAMA products, the volume of ordered products measured in units of various types of packaging has become registered in OLFI. The OLFI information system is then used to create a picking list including orders of

numbers of crates of Corona strawberries. This list is used to combine a variety of goods for delivery to each retailer customer. The assorted goods are collected and placed at a pre-defined location in the warehouse and are in most cases placed on a pallet. A GS1-based transport label is also created, together with the picking list gives the name and location of the retailer. This label is attached to a pallet containing a variety of goods or only Corona strawberries. Goods to each retailer destination are packed together on pallets and wrapped in plastic stretch foil. A label is attached to this foil and used to inform the driver by helping to identify the goods through a control of these against the transport document. This document contains the names of each destination and the number of pallets to be delivered there and is used mainly by the delivery-truck driver. This information is also written in a short text on the pallet label. Furthermore, a customer order list is created which includes the goods registered on the picking list for that retailer, as well as dairy products from Q-Meieriet that BAMA distributes. This is because BAMA also distributes dairy products for Q-Meieriet in accordance with a general agreement on the distribution of these products. One list is made for each destination and are handed over to the truck driver who gives them to the retailer upon arrival.

Informing about the Corona product by the retailer

This part focuses on how Corona is being informed about in the retail setting. Actors and information involved in the sort at a supermarket are shown in fig. 4.16 below:

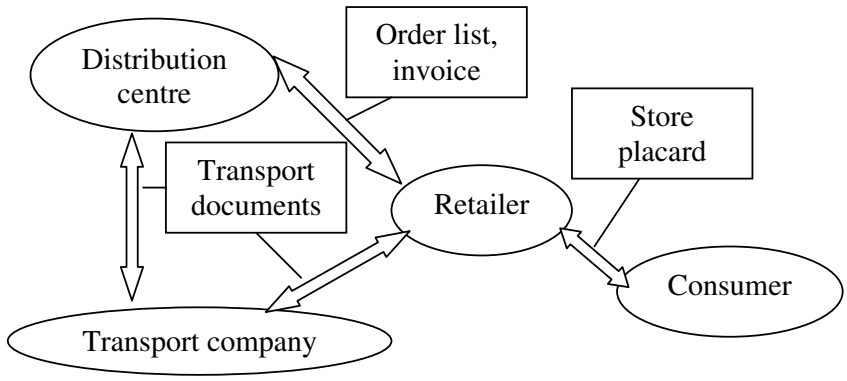

Fig. 4.16 Informing about Corona strawberries at the supermarket

BAMA products are received in the same manner at the retailer's. The order list is copied and also serves as a transport document that is signed by the

retailer upon receiving and controlling the goods. The retailer keeps a copy of this. In practice the retailer only controls delivery when placing products in the store for display. This is done to save time. The retailer has an in-store information system that is connected to the cash register. This system is not used to register volumes of BAMA products since most of these products are not packed into standardised consumer packaging. Corona strawberries are sold in standard volumes of packaging. Units of 500-gram baskets are manually registered at the cash register by the store information system when they are sold. Sales data are not used as a basis for ordering this product. Inventory control must be carried out manually using a visually based estimate carried out by the person responsible for fruits and vegetables in the store. Here, the consumer is informed about the Corona strawberry offer with a hand-made placard or smaller label reading "Corona" and the price per basket.

4.2.6 Tracking and Tracing Corona Strawberries

This part starts with a description, in 4.5.1, concerning the tracking of Corona strawberries and this is followed by a description in section 4.5.2 of tracing Corona strawberries.
\
Tracking goods
Tracking Corona involves the following actors and types of information shown in fig. 4.17 below:

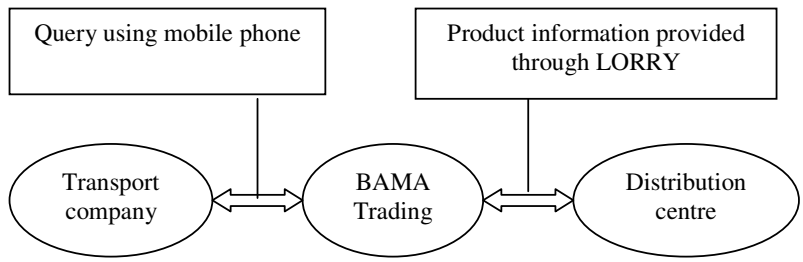

Fig. 4.17 Tracking Corona strawberries (Double headed arrows show information exchange and type of communication involved)

Corona strawberries are very seldom tracked. Tracking mainly constitutes finding information about identified quantities of Corona strawberries at various logistics facilities within the BAMA supply chain. This includes identifying the production volume. Since this registered information is found

in LORRY, this system may be used to track the goods. In LORRY, transport and storage plans indicate where goods currently are or have been recently located. The system does not, however, identify specific packages from an individual producer. Therefore, it is the volume of goods that a customer has ordered that may be tracked. Packages containing Corona strawberries may be tracked during transport from the producer to the distribution centre. This is mainly done to reroute the truck to either add or reduce its number of loading destinations. If the truck needs to be rerouted or its position identified, the logistics department at BAMA trading calls up the truck driver using mobile phone. At the distribution centre, the delivery truck carrying various BAMA products may also be rerouted or the location of the vehicle be inquired about. In some cases, the truck may have left behind some goods and would need to return. Picking goods at the distribution centre may be delayed, e.g. due to late arrivals from suppliers, something the truck driver, for some reason, may not be aware of. The distribution centre may then reach the truck driver using mobile phone.

Tracing products

Tracing Corona strawberries from the retailer involves an upstream search for information through the flow of goods shown in figure 4.18 below:

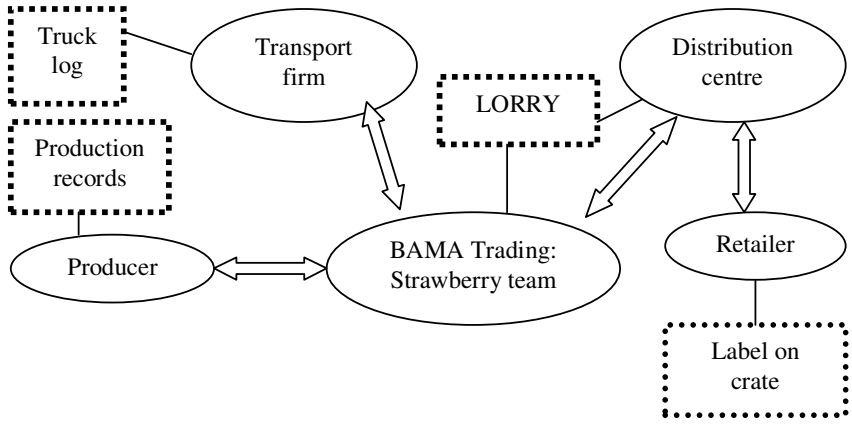

Fig. 4.18 Tracing Corona strawberries (boxes indicate sources of information)

Figure 4.19 shows the actors and information involved in product tracing. Tracing a product is a search process to locate the needed information from a specific actor in the logistics network. Tracing Corona strawberries is in practice carried out only by personnel at BAMA themselves when products of faulty quality have been detected, mainly at a distribution centre or at the

BAMA Trading terminals. This is done to inform the producer if a production deficiency has been detected, or inform the transport company if the damage apparently has occurred during transport. Corona strawberries were previously often damaged upon arrival at the distribution centres. This damage is reduced by about 15% thanks to the use of IFCO crates. Some amounts of strawberries are, however still not accepted due to production failures that influence product quality. Additionally, transport damage does occur even when using an IFCO crate since Corona strawberries are extremely vulnerable to shock and temperature changes during transport. Tracing is used to help improve the quality of the production and transportation activities. Consumers in supermarkets seldom inquire about the origins of the Corona strawberry since this is a product consumers are familiar with.

The paper label that has been slid into in the slot on the IFCO crate or stamped on a cardboard crate provides the basic mode of tracing Corona strawberries. This label identifies the producer and the product is visible to both those handling the strawberries and the consumer. A simple sensory control by smelling and checking the visual appearance of the strawberries in the basket is carried out to determine the quality of the strawberries. Comparing the production location with transport records at BAMA trading may help identify the actual transport route. If additional information regarding production modes is requested, the farmer must be contacted. In the store, the plastic baskets containing 500 grams of Corona strawberries provide no informational text to the consumer. The farmer stores detailed production records using KSL quality standards in compliance with government requirements. BAMA says it aims to be able to document all vital product information concerning any domestic BAMA product within 2 hours after a consumer query has been made at a retailer's location. The process starts by the retailer phoning the distribution centre, and the distribution centre calls the strawberry team at BAMA Trading, who in turn contacts the producer. Then the information must be communicated back to the retailer.

4.3 Dole Bananas

This second case narrative concerning Dole bananas follows the same basic structure used to describe Corona strawberries. Accordingly, in 4.3.1 this section first describes important features regarding the Dole banana product, followed, in section 4.3.2, by a description of the various types of packaging used to carry this product. Section 4.3.3 is an overview of how the product is distributed, including the most important actors and facilities involved in the flow of goods. Then, in section 4.3.4 the transformation of Dole bananas and

the types of packaging used to carry out different logistics activities are described, followed by section 4.3.5 covering the role of information with regard to this transformation of goods. Finally, in section 4.3.6 the issue regarding tracking and tracing of Dole bananas is covered.

4.3.1 Product

The banana was introduced on the Norwegian market in 1905. It is a tropical fruit with origin in Southeast Asia. The banana, along with for instance papayas and mangoes is a climacteric type of fruit. This means that bananas have the ability to continue the ripening process after being harvested by turning starch into sugar. It is one the world's longest cultivated plants.

Banana consumption increased steadily until the 1980's and has since stabilised. Norwegians eat on average 77 kilos of fruit per person per year; bananas represent 20% of this amount. Only the Swedes exceed the Norwegian per capita consumption of bananas, 19 kilos per year. The banana has been developed through cultivation into different varieties to meet market demands regarding types of product form quality.

The current Dole banana for eating "as-is" marketed by BAMA belongs to the Cavendish type as do almost all currently marketed bananas world-wide. More specifically Dole produces and distributes a banana-type named "Valery" which has remained unchanged in its appearance since the early 1970's. This is a large fruit especially adapted to meet consumer demand in industrialised nations and is well suited for harvesting in an unripe condition, transport to distant markets and ripening process manipulation at a banana ripening facility, before being distributed to retailers. The main recent developments are related to improving harvesting qualities of the banana plant; this has not affected the banana fruit product itself. The Valery banana represents close to 100% of the bananas sold on the Norwegian market.

The bananas consumed in Norway come from Central and South America. They grow on the banana plant and are harvested in clusters. The bulb is the root of the plant that produces bananas over a longer life span. The banana plant consists of 3 different fruit bunches containing numerous clusters that grow simultaneously with a 6-month difference in degree of ripeness. The upper clusters have longer banana fingers than the lower ones. The nature of the banana's growth permits continuous harvesting year-round. The banana has a thick peel covering the soft meat of the fruit. In a way, the banana can be regarded as having a natural type of packaging. The product is harvested unripe.

The fruit with its soft peel and structure is vulnerable to damage from the environment during harvesting, transportation, and storage. To prolong the lifetime of bananas demands cold storage at 13-14 degrees C is required before going through a production process at the banana ripening facility. This temperature is regulated to ensure ripening adjusted to the transport time. After leaving the banana ripening facility, the banana requires a storage temperature of 15 degrees C. The colour of the banana peel changes from green to yellow to black depending on the degree of ripeness. Based on the colour of the banana peel, a particular banana's stage of ripeness may be roughly determined.

Bananas of the Cavendish type vary greatly depending on growing conditions. The Central American grown bananas are usually regarded as the highest quality varieties. Bananas are certified by government standards into different classes. The class 1 bananas must have a minimum finger length of at least 20 cm. and the cosmetic bruises must be smaller than 2 sq. cm. Dole, however, does not permit its bananas to have bruises that are larger than 1 sq. cm.

Bananas may be damaged by growing conditions and transport-related causes. A fungus named sigatoka is the most common fungus species attacking Cavendish-type bananas. Also, crown rot (at the top area of the banana finger), latex covering which blackens through contact with oxygen, and transport damages such as "burns" from packaging and having the end of the banana fingers rub other bananas in the same cluster or the sides of cartons are common hazards to banana product quality.

4.3.2 Packaging

Dole offers banana boxes of 15 different kinds that are all made from cardboard. Each packaging type containing the same type of Dole bananas has a unique GS1 product code. Clusters of bananas are placed into a see-through plastic bag at the banana plantation in the Tropics, and put into a box measuring 50 cm. in length, 40 cm. in width and 24 cm. in height. Each box is specified to carry 18,4 kilos, and this weight standard is printed on the box. BAMA orders all its bananas in this type of box, which is also the most common type, accounting for over 80% of the volume supplied by Dole Hamburg. Most other box types vary only in size. However, one type is designed without a lid so that it may be used for retail display purposes in addition to being a D-pack used for distribution purposes.

Pic. 2: Dole banana boxes on pallets

The banana box used to distribute bananas to BAMA, contain usually clusters of 4-7 fingers, with no more than one cluster containing 3 fingers in each box. A cluster of about 5 fingers is regarded as a good quality standard and clusters are cut, seeking to meet this norm when packing. The bananas remain in their box from they are packed until they are unpacked at the retail location. Banana boxes are placed onto ISO standard "fruit" pallets measuring 120 cm x 100 cm. 6 boxes are placed on each level of the pallet and 48 boxes are stacked onto one pallet weighing 980 kg, of which the bananas weigh 878 kg making them a relatively heavy fruit and vegetable product. The boxes are then fastened to the pallet with strapping wire.

The pallets are painted red on the ends to help them be circulated within a closed system used by Dole. Painting the pallets helps DOLE to prevent losing them to use in other supply chains. Dole produces the boxes in Costa Rica at DECAR, a Dole-owned company. The box has holes on its side allowing for ventilation of the goods. This is especially important when bananas are in the ripening facility. The production, which is carried out by providing a combination of temperature regulation and ethylene gas, can then take place there without unpacking the boxes.

The boxes are printed with the Dole company logo in bright colours that includes information about product type, Cavendish bananas Class 1, and the minimum weight of the contents. When the bananas are packed, a large, red sticker is attached to each box with information containing a 3-digit code for the plantation. In addition, a GS1 standard transport label is used that contains the product code and a GLN (location identity) and SSCC (unique identification of the logistics unit) based code at the packing station. The GLN code is not yet fully developed since it does not indicate the plantation where the bananas were harvested. The GS1 code is used by Dole Hamburg and BAMA to identify the product, farm, packing date and location, and the shipping date. Dole is working on using GS1 codes also to identify the plantation.

4.3.3 Distribution

The actors and facilities involved in the distribution of Dole bananas are described in figure 4.19 below:

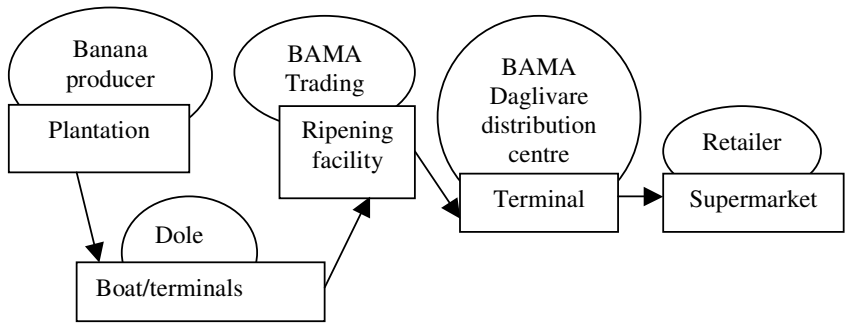

Fig. 4.19 The flow of Dole bananas (Arrows indicate the flow of bananas)

The case describes the flow of bananas from Costa Rica to Oslo. Additionally, a large amount of Dole bananas is supplied from Honduras, Columbia, and Ecuador. While Dole bananas supplied from Honduras and Columbia are comparable to the Costa Rican Bananas, the Ecuadorian bananas regarded as being of lesser quality and demand a longer transport time. The flow of Dole bananas from Costa Rica takes place during the entire year. Within Dole, bananas account for 70% of the value of its sales. Every Monday, a banana ship carrying about 120 000 mainly 40 cm x 50 cm. boxes of bananas, docks at the Dole terminal in Hamburg having sailed from Moin, in Costa Rica, with a stop at Turbo, Columbia, to load additional bananas. Dole Fresh Fruit Europe is located in Hamburg and is primarily a

marketing organisation that also handles logistics and product quality control operations for Northern Europe. It is this actor that handles the business relationship with BAMA regarding bananas. Other fruits, mainly tropical fruits and some citrus fruits are also handled within this business relationship. Dole has two terminal facilities one in Hamburg and one in Antwerp in Belgium. Dole uses only the Hamburg terminal to handle Dole bananas destined for Norway. BAMA sold bananas for 280 million NOK in 2003, representing 5-6% of their total revenue. The banana is the most important product within the BAMA group, measured both in volume and value. The import of bananas varies only slightly through the year, summer representing a slight fall in volume. The supply of Dole bananas normally fluctuates less than 10% from the average. Bananas are vulnerable to weather and growing conditions, and tropical hurricanes or severe rainfall occasionally influence the harvest volume. Then bananas must be provided from other sources within the Dole network. Dole supplies BAMA with only class 1 banana products and is an important customer for Dole since BAMA is a significant actor in the Norwegian fresh fruit and vegetable market with its 50% share. In addition, Dole's customers in the larger markets within EU consist of many smaller firms. The fruit and vegetable market in Germany especially, is more fragmented and is managed by a number of smaller companies.

Dole Bananas demand the use of a specialised banana ripening facility. This production facility may only be used to ripen bananas. The facility at Ulven produces about 26 000 crates per week, and the Bergen facility 5000 crates per week. The distribution through the ripening facility at Ulven is what has been investigated in this study. At BAMA Trading, one person handles the product management of the Dole Bananas; the other banana-related employees within BAMA work at the banana ripening facility. Of the products marketed by BAMA, bananas utilize the largest amount of specifically designated personnel.

Bananas are a generic product type, representing a commodity that is traded on the world market, and prices are set according to fluctuating world supply and demand. Prices are set once a week in negotiations between Dole Hamburg and the banana product manager at BAMA Trading and normally vary +/- 20%. Dole Hamburg must, in turn, relate its initial price demand to BAMA with the overall supply from its competitors. In reality, the market consists of a small and limited number of large actors. Production is relatively stable since bananas are harvested on a year-round basis in a tropical climate zone. Natural disasters and transportation difficulties may pose a threat to supply that in practice occurs only occasionally. As mentioned, due to BAMA's preferred position as an important customer,

Dole usually always manages to supply the ordered amount of bananas to BAMA. Delivered volume varies slightly from week to week and this variation is related to variations in price. The marketing department at Dole in Hamburg uses much effort in determining the market price based on comparing orders with supply and prices used by competitors. Consumption patterns vary seasonally with relatively minor fluctuations. Prices are set at various stages through the flow of goods between the different actors; by Dole in Costa Rica, Dole Hamburg, BAMA Trading, and by BAMA distribution centres. BAMA Trading may also choose to trade ordered bananas with other Northern European banana distributors or with other Norwegian distributors. When bananas are traded domestically this is commonly done at the Økern market if the bananas have already arrived at the ripening facility at Ulven.

4.3.4 Transformation of Dole Bananas and its Packaging

The transformation of Dole bananas and the various forms of packaging used to contain this product is shown in figure 4.20 as a transvection:

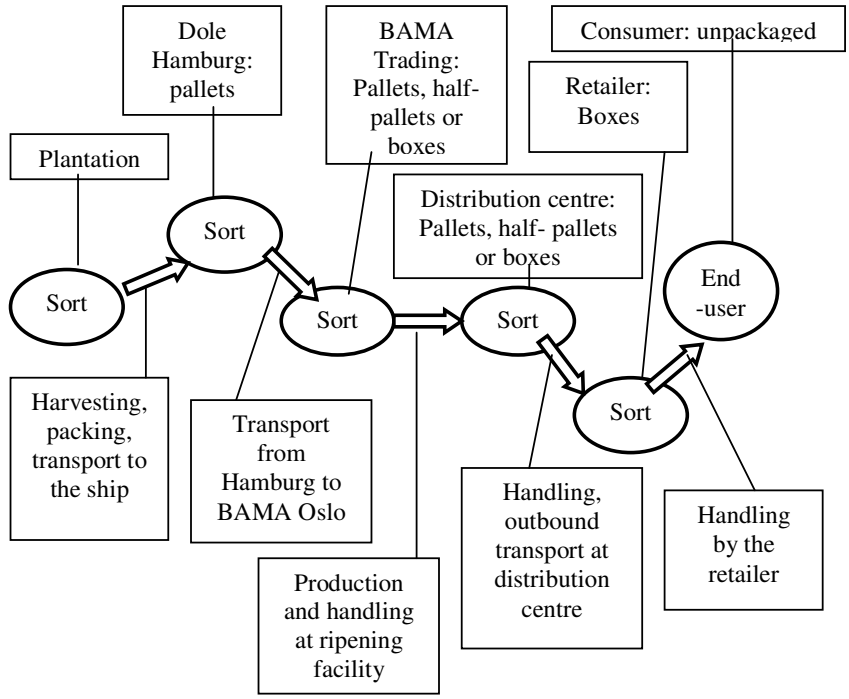

Fig. 4.20 The transforming activities and types of packages used in the flow of Dole bananas

Figure 4.20 shows that pallets are the main type of packaging used. Outbound handling from the ripening facilities is carried out in units of pallets, half-pallets or boxes. Banana boxes are received at the retailers and may be bundled together as a pallet or half-pallet. Here, the boxes are unpacked. The volume contained in the boxes, combined with number of pallets, remain unchanged through the flow of goods. Dole bananas use approximately 3 weeks from harvesting at the plantation to delivery at the retailer. This time frame may vary a few days by manipulating the production process at the banana ripening facility.

Harvesting, packing, and transport to the banana ship

Bananas are picked manually in an unripe condition at the banana plantation and transported hanging on a conveyer wire system to a packing station used by a cluster of different plantations in the vicinity. There, bunches of bananas are rinsed, dried, cut into clusters; a small brand-label sticker is attached to each banana, the banana is placed in a plastic bag and packed into boxes. The label is a small, brightly coloured sticker containing the Dole logo and reading "Dole Costa Rica". Packing bananas is a manual process that demands experienced labour. The quality assurance manger at Dole Hamburg stated; "You will seldom succeed if first emptying a box of bananas yourself and then trying to repack the same quantity back into the same box." A total of 48 boxes are then stacked 6 on each level onto pallets and strapped together using one strap for each level. Long plastic corner boards are fastened in the height of the pallet of goods to secure the goods further.

Each pallet is provided with a transport label and each box with a small sticker similar to those used to make price tags at stores. These labels are used because they are considered simple to use when handling goods. The sticker is very small and has two rows of digits containing information about the plantation location and packing facility, as well as the SSCC pallet code. Each pallet has a unique SSCC identity number in numerical text and bar code form. Additionally, a label is glued on containing the SSCC numerical pallet code without bar code, the packing date, packing station, and the plantation number. The label also includes copies of this sticker. One extra label is provided for use should the contents of the box be split into two packages. Furthermore, smaller stickers are provided that are attached to transport documents. This mode of labelling is at present only used when packing in Costa Rica and not used in Columbia. The pallets of bananas are transported to the harbour terminal at Moin, Costa Rica, and loaded directly onto the ship. Some are also loaded into reefer (temperature regulated cargo holding) containers at the port terminal.

Shipping and receiving at the Hamburg terminal

Four vessels are chartered to handle the transport from Costa Rica and Columbia to Hamburg. Each vessel is given a time frame of 4 weeks to make the return trip. The ships average about 12 000 DWT each, and carry an average of 4500 pallets of bananas and are reefer ships carrying only bananas. The transport by ship takes 12 days but may be delayed due to heavy weather in the North Atlantic. The "banana ship" has a slanted bow providing minimal resistance in the water and is designed to move at 22 knots, which is a relatively high speed for a cargo vessel. The ship contains four storage hatches, each having four storage levels on top of each other, and there are 16 compartments on the vessel in all.

The temperature is set at 13,3 degrees Celsius, and the oxygen level is reduced from the normal 20% to 2-3%. A representative of DOLE Hamburg described this process of reducing the level of oxygen as "putting the banana to sleep". This inhibits the occurrence of product quality failure due to uncontrolled ripening and also gives the banana an additional day or two before the ripening process starts. To avoid transport damage and to direct the cold air into the storage compartment, the mode of stowing the goods is vital. The goods are placed as close to each other as possible and pieces of cardboard, foam, and large, red airbags are used to fill in the spaces left open between the pallets. Especially the forward, slanted compartment is difficult to stow. Each compartment also has a number of pillars making stowing more difficult. The storage compartments are refrigerated, and the reefer containers on deck are connected to the ship's electrical power supply. Other competing banana distributors often use one of the storage hatches on the vessel. The different firms alternate using the forward storage hatch.

During transport, the temperature in the storage compartments is continuously registered and controlled and the bananas ripen gradually. The vessel arrives at the Hamburg terminal about 7:00 every Monday. Upon arrival, the pallets are registered, using the bar-coded labels on the pallet, and a temperature control is carried out. At the Dole terminal in Hamburg, quality control is carried out on samples from this shipment. The pallets are unloaded layer by layer, from one compartment after the other. Bananas destined for Norway are among the first to be unloaded since the vessel carrying these goods leaves at 13:30 from Kiel, about a 2 hours drive from Hamburg. All the pallets of bananas on the arriving ship are considered interchangeable and no destination information is provided on the pallets or boxes.

Transport from Hamburg to BAMA Oslo

The transport from Hamburg to the Ulven banana ripening facility takes one day and starts each Monday in Hamburg. BAMA orders complete truckloads provided by Nor-Cargo Thermo or containers provided by COLOR Line. 30% of the order is in truckloads, and; and the rest in containers. Each container holds 24 pallets, thus 10 Reefer containers represent an order of 11520 boxes of bananas. A weekly delivery to the BAMA ripening facility at Ulven consists of approximately 30 000 boxes. This amounts to approximately 25% of the bananas delivered by the vessels calling at Hamburg. The truckloads sent by Nor-Cargo Thermo are transported directly by road to the Ulven banana ripening facility. The containers are pulled by a semi-trailer from Hamburg to Kiel where they are placed in the COLOR Line passenger ferry that sails daily to Oslo. In Oslo, each container is attached to new trucks and moved the short distance from Oslo port to the Ulven Banana ripening facility.

Production and handling at the ripening facility

All bananas arrive on pallets on Tuesdays at the Ulven banana ripening facility. BAMA has previously rented and may still use the services of a banana ripening facility in Gothenburg, Sweden. In Norway, there is a shortage of such capacity. The facility runs at 110-120% of normal capacity continuously all year. The Ulven facility consists of 26 rooms that are adjusted to provide varying progression rates in the ripening process. Each room stores up to 24 pallets and contain up to 1152 crates in total. The holes in the sides of the cardboard boxes allows for the injection of ethylene, a natural gas. In addition, the ripening facility regulates the temperature to speed up or slow down the ripening process. At this facility, the bananas ripen in 6 days on average. The ripening process may be shortened or prolonged by 2 days depending on the temperature applied. At the ripening facility, the treatment of bananas is highly automated. When the trucks or containers arrive, these are unloaded, the documents checked and compared with labels for each pallet, and the pallets are placed into the storage compartments. A visual control is done to see if any of the boxes are damaged. A temperature control of one of the boxes is carried out as well. Bananas are loaded onto trucks containing a combination of other goods from the BAMA Trading terminal located a few kilometres away from the Ulven banana ripening facility. Outbound trucks are loaded in accordance with orders registered in whole or half-pallets of bananas. BAMA Storkjøkken customers may order a smaller amount of bananas measured in a certain number of boxes, in which case the pallets must be broken up in order to accommodate for this delivery.

Handling and outbound transport at the distribution centre
As pallets of bananas arrive at the distribution centre terminals, they are controlled by counting the number of boxes received. A visual control of the state of the boxes is done and a temperature control is carried out manually. Bananas are stored at a designated place in the terminal, the same as with all the products distributed year-round. Here, the bananas may be stored up to one for a very limited number of days, less than a week. They are then distributed in the same manner as Corona strawberries to the retailer customers based on picking lists created by customer orders. These orders are registered as number boxes of bananas.

Handling by the retailer
The bananas are received at the store in the same manner as Corona strawberries, either on pallets, or in individual boxes on pallets together with other goods. However, bananas are delivered all year, and almost every delivery throughout the year contains at least one box of bananas. Dole bananas are unpacked for the first time usually by person responsible for produce in the supermarket, and are then placed on a display shelf. Sometimes, if capacity is limited, bananas are displayed in the box placed on the floor of the store. This form of display hampers the promotional effect of the visual display of bananas. At the store, the sticker on the banana is the only label visible to the consumer.

4.3.5 Information Directing Delivery of Dole Bananas

This part shows how information is provided and used at sorts to transform the Dole bananas as described in the previous part.

Long-term production planning
Dole bananas are distributed based on long-term planning for this product. This is described in fig. 4.21 below:

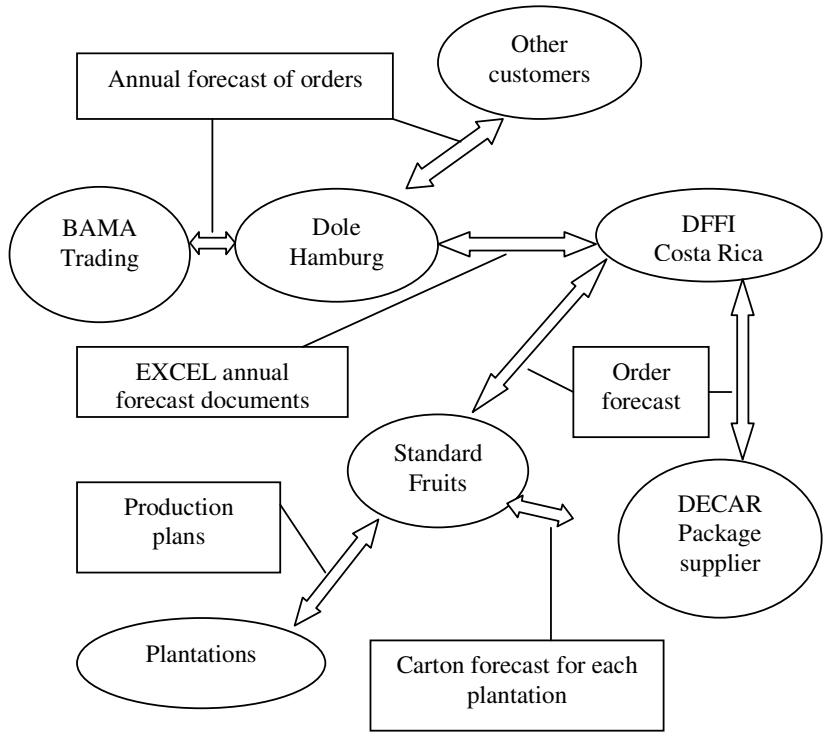

Fig. 4.21 Long-term planning of Dole bananas (Double-headed arrows show information exchange)

Dole Fresh Fruits Europe in Hamburg handles long-term production planning of Dole bananas in cooperation with its plantation suppliers. Dole Hamburg has a business relationship with Dole Fresh Fruits International (DFFI) located in San Jose, Costa Rica. This is the logistics actor within Dole who handles orders and supplies of bananas and other Dole fruits from Central America to customers world-wide, although mainly in Europe and North America. In Costa Rica, DFFI maintains a business relationship with Standard Fruits de Costa Rica, a Dole owned company that owns and runs banana plantations, the trucks that transport bananas and the banana packing stations. Standard Fruits is the production organisation with offices in San Jose, Costa Rica, and is responsible for the ownership of its facilities and long-term quality of the services it provides. It does not handle the day-to-day operations at its plantations. Dole Hamburg only very seldom has contact with Standard Fruits directly. Production of bananas by Standard Fruits is stable and based on forecasts supplied by DFFI. Dole owns about

70% of the plantations supplying Costa Rican bananas to Dole. Standard Fruits handles business relationships with its own plantations and the independent plantations. DFFI also handles the business relationship with DECAR regarding the supply of packaging including boxes, straps and corner boards used to stabilise pallets of banana boxes.

At the end of each year, BAMA Trading provides Dole Hamburg with a week-by-week forecast of the expected orders for the coming year. Due to competition from the German low price chain LIDL, which markets bananas at very low prices, BAMA is countering this retail competition by ordering an increasing amount of more low-grade, Ecuadorian bananas that are not supplied by Dole. There is no contract regulating the business relationship between BAMA and Dole. Dole Hamburg receives the annual plans from all its customers, all of whom Dole Hamburg has long-term business relationships with. The annual plans are entered into an EXCEL spreadsheet and a copy of this sheet is sent to DFFI in Costa Rica as an e-mail attachment. DFFI uses this information to inform its various suppliers, including Standard Fruit and DECAR, to coordinate annual plans for supplies of bananas from each plantation and the required packaging as well as other logistics facilities used to handle bananas.

Ordering by the retailer

Ordering by the retailer provides the document that is the basis for assigning goods to logistics activities that supply retailers with goods. The actors and information involved in ordering by the retailer are shown in fig. 4.22 below:

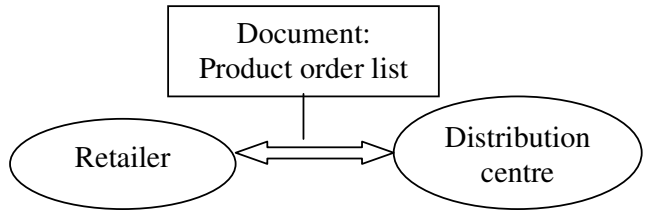

Fig. 4.22 Ordering Dole bananas

Ordering Dole bananas by the retailer involves the same procedures and documents as ordering Corona Strawberries. Dole bananas may be displayed for a few days in the store, and therefore smaller stores do not order bananas every day. Bananas are ordered by the number of boxes, pallets or half-pallets. Each day before 15:00 in the afternoon, the person in charge of produce at the supermarket checks the current supply of bananas, and can tell by the colour of the bananas whether some should be replaced. This person then fills in the order-list and sends it by fax to the BAMA

Dagligvare or BaRe distribution centre. Here, the orders from various supermarkets are accumulated and registered into the OLFI information system.

Informing to harvest, pack and transport bananas

This section focuses on how information is exchanged influencing how activities are carried out upstream in the flow of Dole bananas directed to BAMA. The actors and information involved in harvest, packing and transporting bananas are shown in figure 4.23 below:

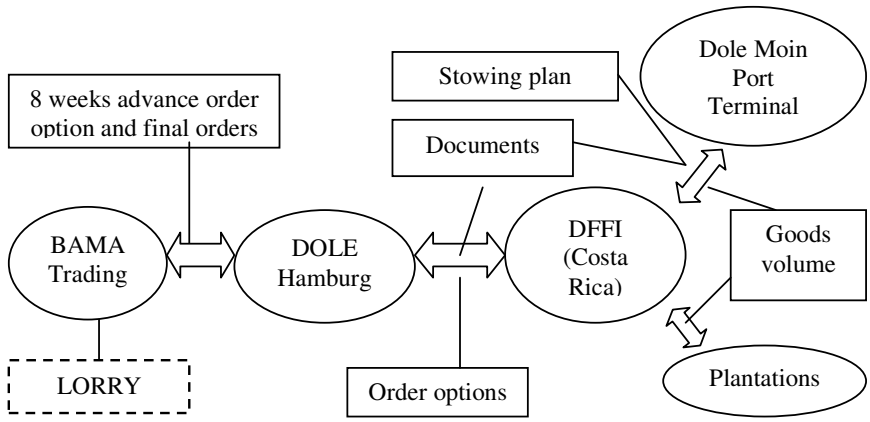

Fig. 4.23 Informing about transport from the banana plantation

BAMA Trading confirms or adjusts orders according to the annual forecast of Bananas once a week. These order confirmations or adjustments are placed 8 weeks before delivery. Normally, they are adjusted to within 10% of an average of the annual predetermined forecast. Dole's customers, according to Dole Hamburg, strive to place orders as close to the annual plans as possible. This order is coordinated with orders from other customers of Dole Hamburg and adjusted on the EXCEL spreadsheet. This new, adjusted total demand for bananas is then e-mailed as an EXCEL spreadsheet to DFFI in Costa Rica where data are coordinated with orders from other Dole sales offices around the world. DFFI then creates harvesting plans for each plantation, giving them the information needed to have the necessary amount of packaging materials and create transport plans within Costa Rica for the designated week.

Based on the 8-week order adjustment from BAMA, bananas are first earmarked with ribbons at the plantation where they are harvested. Many vessels sail from Costa Rica to various world-wide destinations with banana

cargo on different days of the week. Therefore, harvesting and transport in Costa Rica are carried out continuously. The ship bound for Hamburg sails every Wednesday from Moin. Customers may adjust orders within 3 days of the ship's departure in order to alter harvest volumes of bananas. About 24 hours prior to sailing, the bananas designated for transport are harvested, packed, and transported to the port where they are continuously loaded until the planned volume has been loaded on board. DFFI sends the Dole goods handlers at Moin transport documents and a stowing plan. Stowing plans are created based on drawings of specific units of packaging required to be unloaded in a certain sequence upon arrival in Hamburg. Also, Dole Hamburg makes stowing plans to secure the correct stowage of goods to secure against transport damage. DFFI also supplies Dole Hamburg with documents containing the necessary product information in accordance with EU demands.

Four documents are created for the transport: a bill of lading, a manifest describing the goods in further detail, a document stating the fruits' sanitary condition, provided by the Costa Rican Government, and a document proving the country of origin of the bananas (called GSP). These documents are faxed to Dole Hamburg and copies are sent to Dole at Moin to follow the vessel. The original documents are sent by DFFI to Dole Hamburg via DHL courier and arrive after two days.

The bananas are still owned by Dole and are therefore also Dole's responsibility. These bananas may be traded among different actors in Dole's industrial network of customers; this also includes the quantities earmarked for specific customers. Every Thursday and Friday, while the goods are at sea, Dole has its sales days for these bananas. The exact amount of bananas registered in specific sizes of boxes combined into pallets is then sold to BAMA. BAMA Trading registers the amount ordered into the LORRY information system.

Coordinating deliveries to distribution centres and retailers
The coordination of supply from Dole and demand from BAMA Trading for volumes for Dole bananas involve the following actors, business relationships and documents shown in fig 4.24 below:

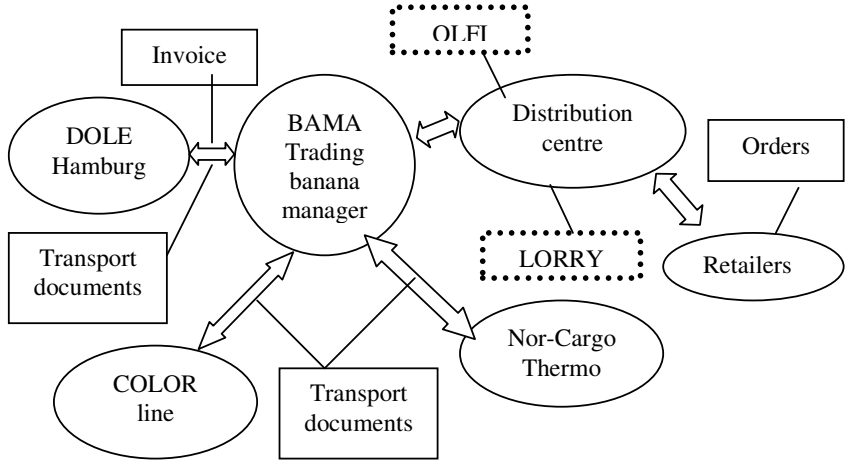

Fig. 4.24 Coordinating deliveries

The BAMA Trading banana product manager is the person responsible for operating the banana ripening facility in Oslo. Goods are collected at Dole's terminal in Hamburg ex works. BAMA Trading uses the ordered volume to coordinate transport by Nor-Cargo Thermo and COLOR Line from Hamburg to Oslo. This information is registered in LORRY and the logistics department uses it to order the necessary transport capacity from both Nor-Cargo Thermo and COLOR Line. Transport documents are created based on the information in LORRY and faxed to the transportation providers. Upon arrival at the Banana ripening facility, the products are temperature-controlled and the volume is checked against documents. Transportation damage is registered and may be used as a basis for a complaint to Dole Hamburg. This very seldom occurs. Information about the received volume of bananas is registered in LORRY, the temperature registered in a temperature log, and product damage is reported to Dole through the product manager.

Supply of Dole bananas is registered in LORRY and coordinated with orders recorded in OLFI measured in boxes of bananas. However, bananas are at this time being kept at the banana ripening facility, and the daily volume ready for supply may be manipulated a few days in advance by adjusting the temperature in the various compartments of the facility. If the supply is too

high, BAMA Trading may offer promotional campaigns to the distribution centres, meaning reduced price by accepting a higher volume. A salesman at the distribution centre carries this form of promotion out by phone with the produce responsible person at the specific supermarket. The banana product manager in cooperation with supermarket chain representatives, plans larger promotional campaigns: larger volumes of bananas are offered at a lower price. Unexpected excess supply may also be sold on the open market at Økern Torv. Small, independent fruit and vegetable retailers usually market these products.

Informing to deliver Dole bananas to the retailer

To deliver goods to retailers information must be provided to a sort that involve the following actors and information as shown in fig. 4.25 below:

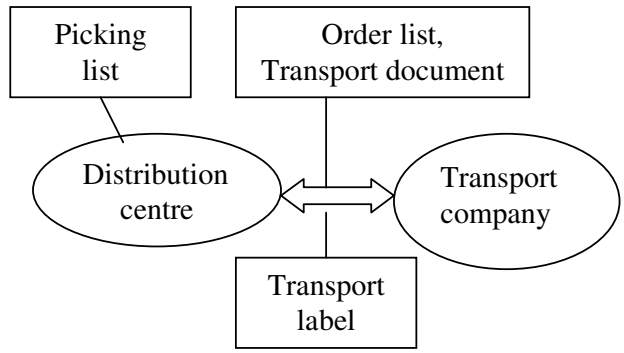

Fig. 4.25 Informing to deliver (Picking list is provided and used within the distribution centre)

The picking and delivery of Dole bananas from the distribution centre terminals are done in the same way as with delivering Corona strawberries. A picking list and transport label are made and used to create new logistics units destined for a specific retailer according to an order. The distribution-truck driver receives order lists and a transport document used to control the transport label on the goods against this transport document, and the goods are then delivered to the retailers according to the documents provided to the delivery truck-driver.

Informing about Dole bananas by the retailer
The following types of information exchange at the food retailer involving Dole bananas are shown in fig. 4.26 below:

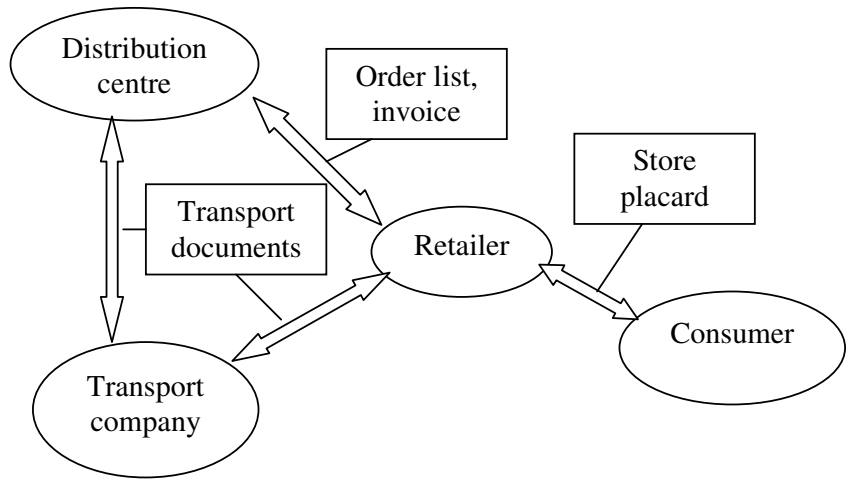

Fig. 4.26 Informing about Dole bananas at the supermarket

Receiving Dole bananas is done in the same manner for all of BAMA's products. In the store, bananas are displayed unpacked. A placard hanging over the bananas or a price label states the name of the product and price per kilo. The sticker on the banana informs the consumer about the brand, "Dole", and its country of origin, Costa Rica. At the cash register, the sales of bananas are registered in kilos. Therefore, inventory control must be carried out manually using a visually based estimate done by the produce responsible person in the store.

4.3.6 Tracking and Tracing Dole Bananas

This part starts with a description in 4.9.1 of when and how Dole bananas are tracked. This is followed by a description in section 4.9.2, covering the location where, when, and how Dole bananas are traced is covered.

Tracking goods
Tracking Dole bananas involves the following actors in the BAMA logistics network as shown in fig 4.27 below:

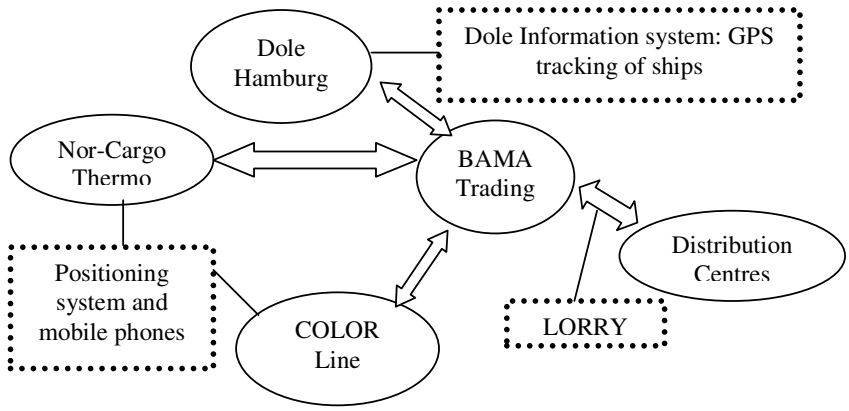

Fig.4.27 Tracking Dole Bananas (Dotted boxes indicate type of information system used to locate goods)

In the same manner as for Corona strawberries, Dole bananas may be tracked when located at various facilities within the BAMA logistics network. Bananas are transported and stored alongside Corona strawberries and other BAMA products. Therefore, tracking bananas after leaving the banana ripening facility usually involves first locating units of goods consisting of different products. Documents with information about bananas will often also contain information regarding other types of products.

If Dole bananas are tracked before arriving at the banana ripening facility, it will involve sending a query to Dole Hamburg. Dole uses its information system to verify the exact location of the ordered bananas. The earmarking of bananas 8 weeks prior to delivery is only registered in Dole's information system. The actual goods are only marked using ribbons indicating the time of harvest and are not earmarked specifically for BAMA during transport from the plantation to the Hamburg terminal. Dole is, however, working on using GS1 codes to be able to provide a GLN and SSCC-based identification of goods during packing, which may be used to ascribe specific goods to BAMA when located in Costa Rica. Thus, BAMA may order bananas from a specific plantation. Bananas may be tracked while growing at the plantation and while in shipment, but they have no specific destination ascribed to them. It is the total weekly production volume ordered that may be tracked from 8 weeks in advance until delivery in Hamburg. This information may be used by BAMA if they wish to trade bananas that they already have an option to purchase, since it provides the accurate location of goods they then may attempt to resell on the world market.

Tracking a shipment of Dole bananas is also done to verify the approximate time of arrival at Hamburg port. The ship carries GPS equipment, and containers equipped with temperature monitors and storage compartment monitors are linked to the ship's computer and may provide information regarding temperature and location of the goods. A product may be delayed often due to storm, and this may cause some cosmetic damage to the packaging and products. When Dole Hamburg becomes aware of this delay, it informs BAMA Trading who, in turn, provides this information to its transporters, COLOR Line and Nor-Cargo Thermo, in order for them to coordinate the information with their transport plans.

During transport from Hamburg to Oslo, Nor-Cargo trucks also carry temperature monitors and have GPS systems. Moreover, the truck drivers carry mobile phones. When the COLOR Line containers are loaded onto the COLOR line ferry at Kiel north of Hamburg, the container carrying bananas is tracked by contacting the crew on-board the ferry. Tracking Dole bananas between Hamburg and Oslo is seldom carried out. Previously, when a portion of the bananas was transported by rail, the shipments were sometimes delayed and BAMA Trading had to make a query to the rail operator.

Tracing products
The network and information sources involved in tracing Dole bananas are shown in figure 4.28 below:

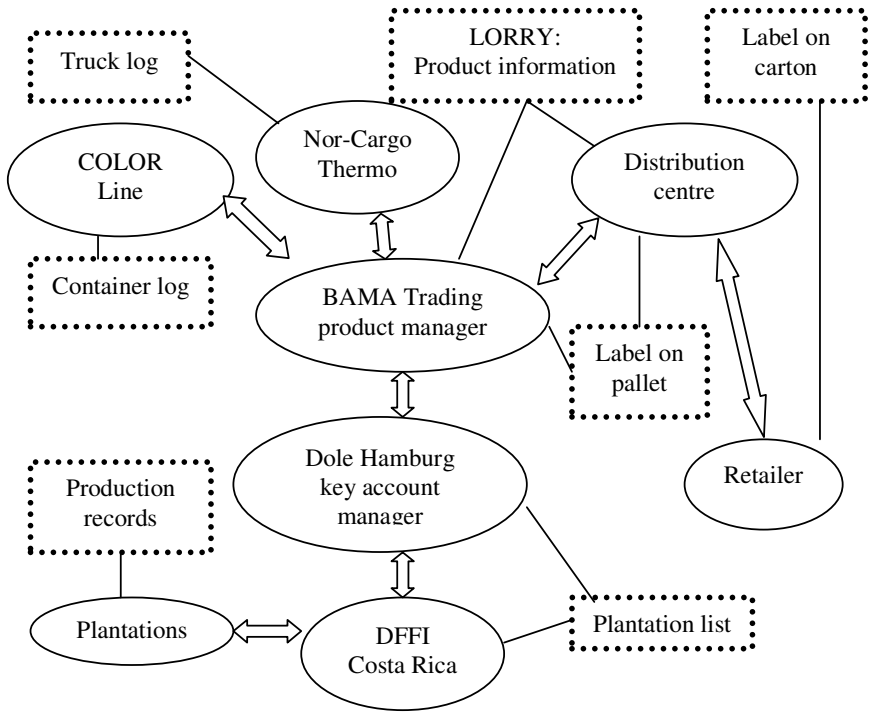

Fig. 4.28 Tracing Dole bananas (Boxes indicate sources of information)

Dole Hamburg is responsible for securing and providing product traceability information within its logistics network through its key account manger. Upon arrival at the banana ripening facility at Ulven, less than 1% of the products are damaged on an annual basis. Therefore, there is little need for BAMA Trading to trace the origin of product damage. Dole, handling transport to Hamburg, and Nor-Cargo or COLOR Line, handling transport from Hamburg to Oslo, give documentation of temperature control during transport. Temperature conditions are monitored in a transport log. The transport operator registers and stores this information. Later, upon demand, it may be communicated through a printout of the registered temperature log.

The sticker attached to the banana gives information about the product, including brand name and country of origin. In addition, the transport label on the banana box contains more detailed information concerning time of harvest and location by indicating the plantation identity. Information concerning goods is registered and communicated using a GS1 standard SSCC code in a bar code form on distribution packaging labels mainly.

If documentation is required for more detailed information regarding, for instance, production modes, use of additives, or labour situations at the plantation, BAMA Trading must make a query to Dole Hamburg and inform them of the SSCC code and the plantation number on the box in question and wait for a reply. Both Dole Hamburg and DFFI have a list of plantations related to each code with additional contact information. However, it is DFFI that handles the business relations with each plantation regarding quality issues. If a more long-term production quality issue involving a greater number of Costa Rican plantations is brought up, it will involve Standard Fruit as well. Production in Costa Rica is carried out and controlled in accordance with Costa Rican Government-set production quality standards. Documentation of this is based on the document stating the fruits' sanitary condition. Should additional information be necessary, or if the origin of a product discrepancy is sought, Dole Hamburg must convey the nature of the discrepancy together with the plantation number to DFFI in Costa Rica.

It is then DFFI's responsibility to inform the plantation and discuss necessary actions. BAMA Trading is informed in advance about overall production modes at Dole plantations. Representatives from BAMA Trading visit the Dole facilities and the plantations in Costa Rica annually and may therefore inform others, based on their first hand observations and experiences with banana production and its initial leg of transport. Should a consumer demand more specified product information, this must be done in the same way as when tracing Corona strawberries from the retailer to BAMA Trading. At BAMA Trading, the product manager is responsible for contacting Dole Hamburg who is responsible for providing the necessary information. When the product manager for bananas receives this information, he or she conveys it to the distribution centre that, in turn, informs the retailer. Communication is carried out using a combination of telephone, fax, and e-mail.

These two cases have described how Corona strawberries and Dole bananas are distributed, with BAMA viewed as a central actor involved in the use of packaging and the role of information exchange. The next chapter describes, in the same manner, the distribution of TINE Lettmelk and Marian fish filets with TINE viewed as the central actor.

5 The TINE Cases

This chapter continues the empirical part by focusing on cases involving TINE and the two products TINE Lettmelk and Marian fish filets. It follows the same basic structure of the preceding Chapter 4. First, in 5.1, the TINE network and the information system TINE uses to distribute its products are described. This is followed by 5.2 with a description of the TINE Lettmelk case, and 5.3 with a narrative concerning the Marian fish filets case.

5.1 TINE

5.1.1 The TINE Network

TINE is a producer owned dairy cooperative. In 2004, approximately 17 976 (the number is steadily declining) producers of cow-milk and 548 producers of goat-milk owned TINE. About 200 years ago, the first dairies were established moving milk production from the farm to a specialised production facility. In 1856 in Tolga, in the interior of Eastern Norway, 40 farmers established the first dairy cooperative. These were inspired by cooperative ideas within farming in England at that time. Gradually, more dairy cooperatives were established that owned and operated milk production facilities. In 1881, a nation-wide organisation of dairy cooperatives in Norway (Den Norske Meieriforening) was established. This organisation is the root of the nation-wide organisational form of TINE as we know it today.

The independent cooperatives expanded and smaller cooperatives were merged into larger ones. This period of expansion lasted until the 1960's/70's. Then, gradually, a period of rationalisation started and has continued until today. In 2002, 11 large, independent, regional dairy cooperatives were merged into one large corporation, TINE BA,and this is the organisational unit that is owned by the producers and is the corporative "heart" of the TINE network.

Altogether, TINE employed 5549 persons in 2004, and had an annual turnover of 1.41 billion NOK. The TINE network consists of 5 regional departments and several completely and partially owned companies within the food industry. TINE is, accordingly, a large and complex organisation that produces and distributes a large range of food products. It distributes supplies of raw materials and goods produced by other companies to consumers in Norway and exports mainly cheese products to consumers in other countries. This production is organised by independent companies

owned by TINE. TINE links the supplies of different agricultural raw materials with the needs of consumers. The interconnecting function of TINE is illustrated in figure 5.1 below:

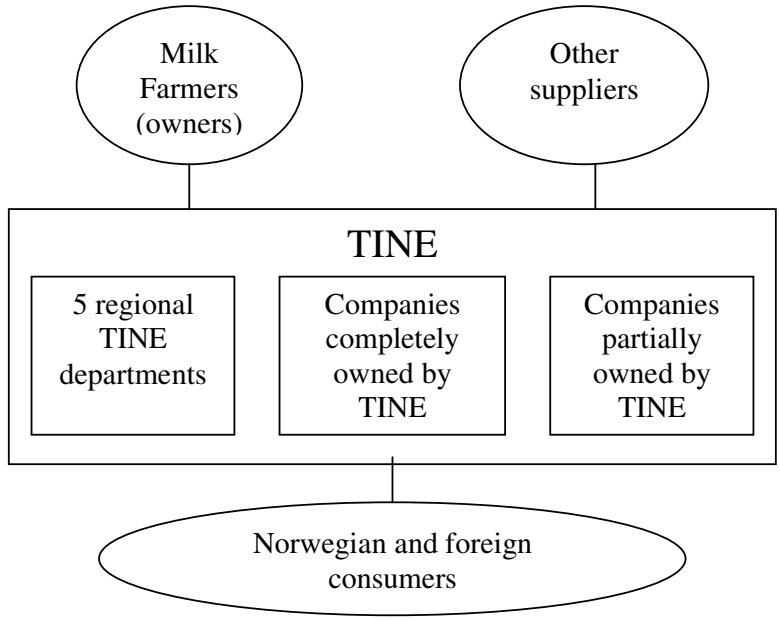

Fig. 5.1 The interconnecting function of TINE

Mainly raw-milk based dairy products; juices and deserts are produced at the 5 regional departments. The other companies in the TINE logistics network market and /or produce a range of other food products such as ice-cream, margarine, and pre-prepared dinner meals. Companies partially owned by TINE, may also aim to use raw materials supplied by TINE's dairy farmers. TINE's logistics facilities are used to distribute many of these products from other producers; they always distribute the goods produced by the TINE departments themselves. Other companies in the TINE network are free to choose whether to distribute their products within TINE's network. In practice, a large part of these products are distributed alongside the goods produced at the TINE dairies. TINE also distributes unpackaged, processed milk to the food industry. The sales and distribution of these products are carried out apart from the main distribution of its packaged and branded goods. The TINE network is shown in the figure 5.2 below:

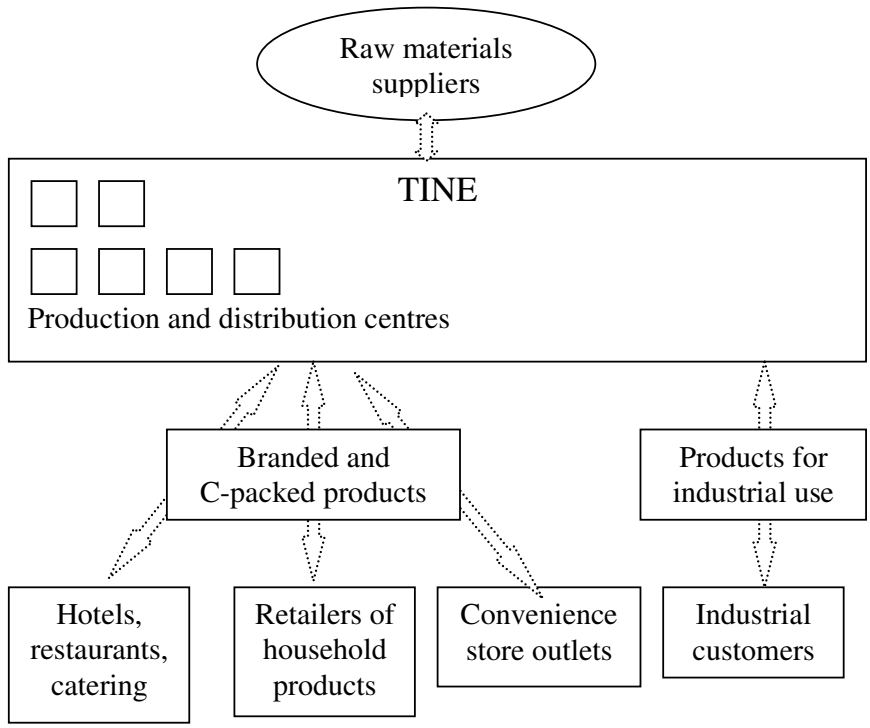

Fig. 5.2 The suppliers and customers of TINE (Double-headed dotted arrows indicate business relationships)

The two products described in this chapter are currently distributed only on the Norwegian market and are packed and distributed to Norwegian food-retailers; the integrated nature of the food-retailer network in Norway was shown in the description of the BAMA network and also applies to this network. TINE maintains business relationships with all the Norwegian retailers. This is because TINE, as a former monopolist, still has a dominant market position regarding production and distribution of dairy products. They compete mainly with smaller, more specialised producers. Low-fat milk is also marketed by the recently started Q-Meieriet, a small producer with a market share of less than 10%. On the supply side, raw-milk production and fisheries are major Norwegian industries regulated through government supervised quota systems.

Within TINE, there are about 53 production facilities (2004 figures) organised into 5 regions. TINE is gradually reducing this number of facilities in an effort to rationalise production and distribution of its products. In 2003,

three production facilities were closed down. Many of the facilities are specialised towards the production of only one or a limited number of TINE products. TINE themselves group their products into either "solid" or "liquid". Examples of liquid products are juices, milk, pudding desserts, and yoghurt; solid products are mainly cheeses. In 2004, 23 dairies produced various milk products, including TINE Lettmelk. These dairies are commonly termed by TINE internally as "liquid-dairies". They also function as distribution centres within TINE. Products from the other dairies must be transported to these distribution centres for delivery to customers.

Raw-milk is supplied to all dairies for production. These "liquid-type" dairies are organised as a single actor unit consisting of different departments. It is possible to group these departments into two: one primarily related to supply and production, while the other is mainly concerned with distribution to customers. The dairies are actors managing and operating supply, production, and distribution facilities located adjacent to each other. The supply and production side of the dairies exchange information with suppliers, inbound logistics, production, and product quality control at the laboratory. The dairy's role as a distribution centre includes handling customer relations, materials handling activities at the terminal, and the outbound transport of products to customers. The dairies own, manage, and operate a fleet of tank trucks that are used to supply raw-milk to the dairy and the fleet of delivery trucks. Other transport firms carry products from the other companies to the TINE dairies. To distribute its products from the distribution centres to its retailers, TINE cooperates with GILDE, a meat producer, and PRIOR, a poultry product producer, through an agreement termed LFD (Landbrukets Ferskvaredistribusjon). The TINE network actors used to supply goods, including the flows of goods, are shown in figure 5.3 below:

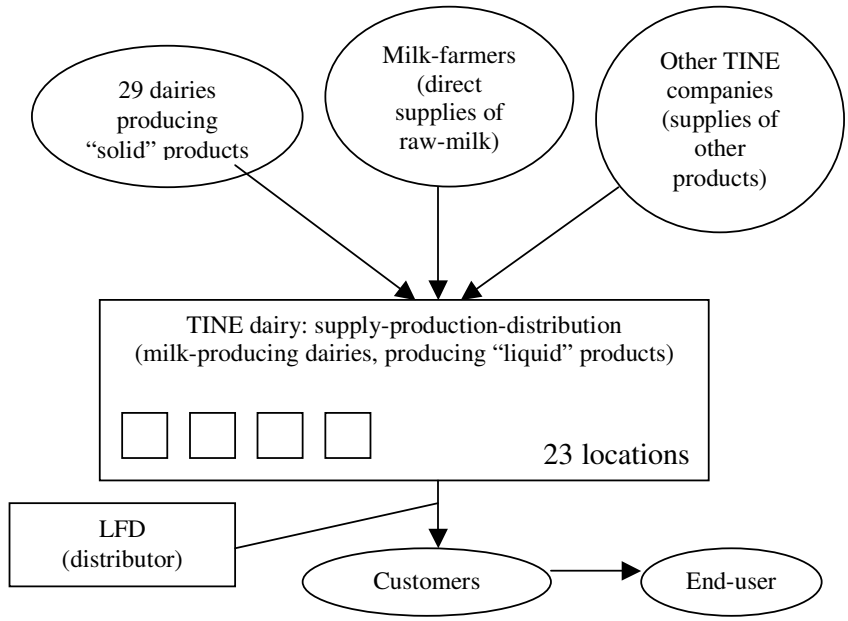

Fig. 5.3 Overview of the actors and the flow of goods in the domestic network of TINE (Arrows indicate the direction of the flow of goods)

Each distribution centre consists of the following main departments that manage the flow of goods in different manners:

- Production: the production process
- Logistics: terminal and inbound and outbound transport operations
- Sales: customer relations and order handling
- Laboratory: raw-material and product quality control
- Organisation: supplier (farmer) relations

Within the LFD agreement, either a PRIOR, TINE, or GILDE distribution vehicle is used to transport their combined products to their shared customers. Currently, LFD is not an organisation, rather a way to coordinate deliveries of each other's products and they have their own separate order routines and documents. PRIOR, GILDE, and TINE, therefore, need to exchange information to create transport documents and the appropriate package labelling necessary to carry out LFD operated delivery to their customers. The cooperation is mainly technical in nature, organising how TINE, GILDE, and PRIOR products share terminal and transport facilities. Where and how the trucks are loaded is organised regionally.

While product development and marketing of TINE Lettmelk are managed by TINE, Marian fish filet products are developed and marketed by Fjordland. This company within the TINE network is completely owned by TINE (49,7% share), GILDE (29,7% share), HOFF (11,4% share), and PRIOR (9,2% share). HOFF is a producer of potato-based products such as potato chips. Fjordland's turnover in 2003 was 607 million NOK, up from 500 million NOK in 2002. Fjordland was established by TINE in 1994 mainly to develop and market margarine-type products. Fjordland does not manage or operate production facilities and uses mainly raw materials supplied by the owners in its products. Fjordland develops and markets 8 different brands, with some important products being Yoplait yoghurts (produced under license from the French brand-owner), Fjordland ready-made dinners, and Bremyk margarine. Marian Seafood merged with Fjordland in 2004 and retained Marian as a brand name of its fresh seafood products. Fjordland generated 405 million NOK (2003) worth of product sales through TINE/LFD and 200 million NOK worth through other networks. Marian products constitute a small percentage of Fjordland's total revenues.

The main business relationship and the contents of the information exchange within these relationships in the logistics network of the distribution centres are shown in the figure 5.4 below:

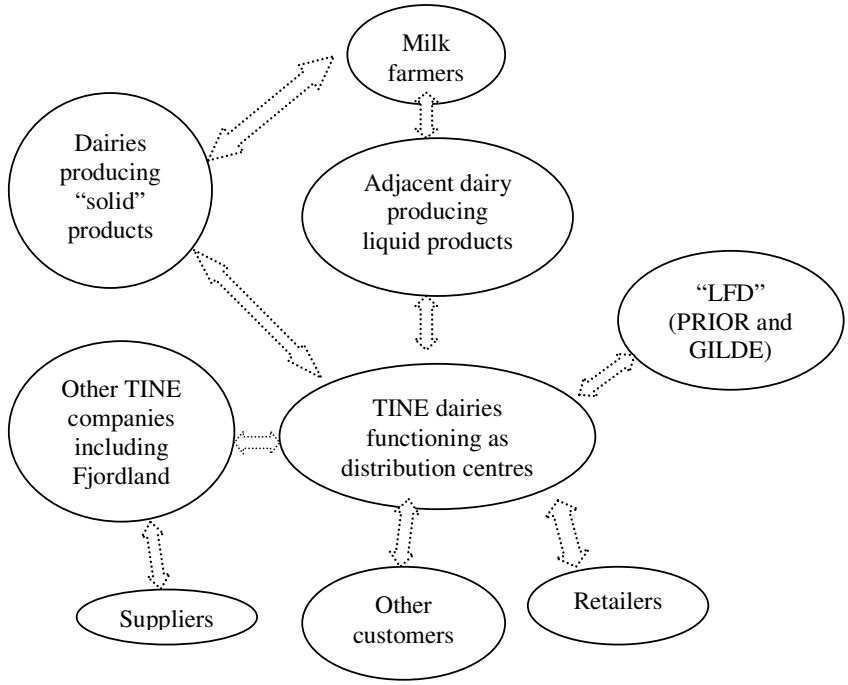

Fig. 5.4 The TINE network (Shows actors in circles and business relationships with dotted double-headed arrows)

5.1.2 The TINE Information System

TINE uses a standard MOVEX v.12 ERP information system that is supplied by Intentia. This system was gradually taken into use during the autumn of 2003. MOVEX is part of Intentia's complete ERP solution, representing this ERP system's supply chain management module. It aims to increase visibility and synchronise operations in the supply chain. The MOVEX system covers warehouse management, stock replenishment, and transport management. It is linked with production planning and other administrative information resources of an ERP system. MOVEX allows all actors involved in the distribution of TINE's goods to exchange information. The basic and important function of the MOVEX ERP system is to provide product forecasts to TINE dairies. TINE's products are of such a character that "just-in-time" solutions are not workable since production volume from the cow may not be adjusted on a daily basis. Milk products are highly perishable and must be consumed a short time after production. Cheese takes several weeks to produce, and when finished is less perishable than milk products.

Therefore, production and distribution must be planned. Logistics planning is carried out centrally and the product forecasts are processed in MOVEX. MOVEX is a national system that ties all of TINE's 53 (2003) production and distribution facilities together with the corporate headquarters where logistics planning is carried out. All actors are on-line, using MOVEX with individual actors granted a type of access defined in accordance with work functions. The role of MOVEX and the types of information handled using MOVEX in the TINE network are shown in the figure 5.5 below:

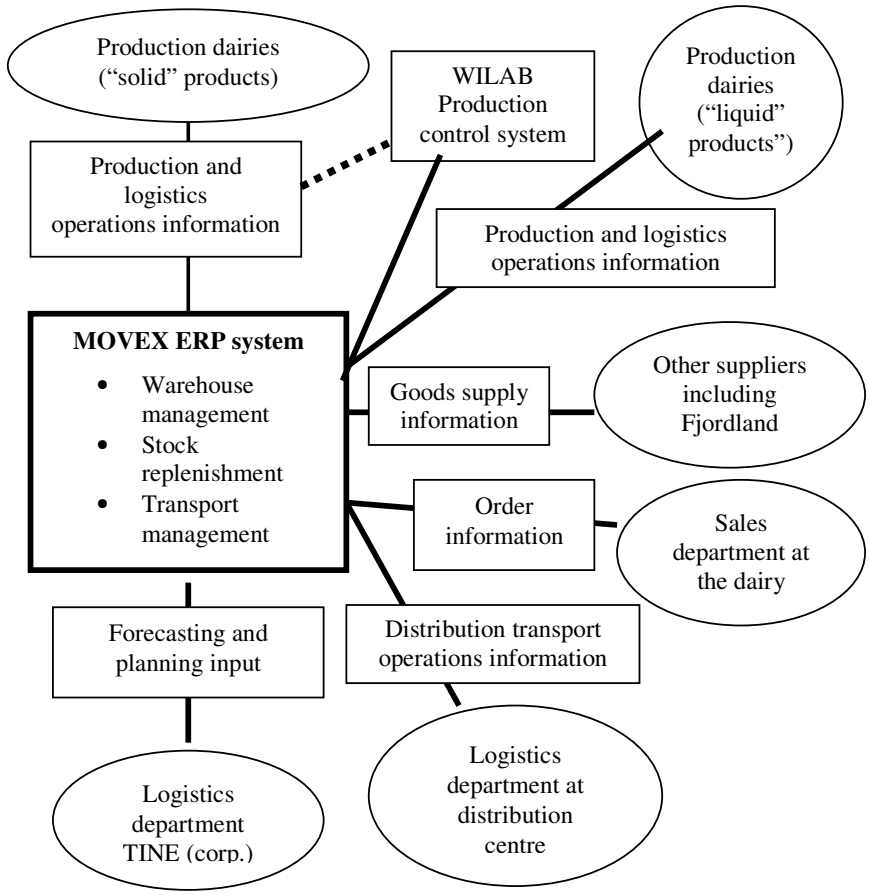

Fig. 5.5 The main types of actors using MOVEX and the main contents of information exchange in business relationships in the TINE network. Data from WILAB may be communicated to MOVEX.

MOVEX is a logistics system that is used by TINE to distribute products from its distribution centres to its various types of customers. Other information systems are also linked to this system regarding supplies of raw-milk production control at the dairies and supplies of finished products from other suppliers, such as Fjordland (including Marian products). The WILAB production control system is an internal system used at the dairy to monitor and control production. This system automatically exchanges information with MOVEX regarding production volume of orders and the finished products. As regards the distribution of Marian products through the TINE Network, Fjordland, together with producers of these goods, supplies information to TINE distribution centres, where this information is used as input into MOVEX to coordinate delivery of goods to retailers.

5.2 TINE Lettmelk

This part consists of a description in 5.2.1 of important features regarding the TINE Lettmelk product. In 5.2.2, this is followed by a description of the various types of packaging and other facilities used to contain this product. In 5.2.3, an overview of how this product is distributed, including the most important actors and facilities within the supply chain, is given. This is followed, in 5.2.4, by a detailed description of the transformation of goods and package forms used. Section 5.2.5 covers how information is used to direct the flow of goods, and finally, in section 5.2.6, the use of information about how goods are tracked and traced is described.

5.2.1 Product

TINE Lettmelk (Low-fat milk, the Norwegian formulation is used since this is the brand name of the product) is a liquid type, perishable food product. TINE Lettmelk was an innovative product when it was introduced in the early 1980's as a healthy alternative to whole milk. It has a richer taste than skimmed milk and filled in the product line between whole milk and skimmed milk. It is a perishable, liquid product that demands a continuously refrigerated environment of 4 degrees Celsius at all times. Refrigeration extends the durability of the product from just a few hours after milking the "raw-milk" (untreated milk straight from the cow) to up to 14 days. The total milk production, including all product types, constitutes 28% of TINE's revenues, and is therefore also its most important production measured in value. In addition, milk products are low-value, high volume commodities, meaning they take up a relatively higher percentage of space than other products at the TINE facilities. At present, Lettmelk has a market share of more than 50% of the various TINE milk products.

Milk is an organic product that comes from the cow. Cows start to milk when they give birth, and somewhat more than half of the cows studied on a farm at Fet in Akershus county are producing milk daily. The way the cows are fed, milked, and cared for in general influence the quality of the raw-milk. The production of milk is carried out in accordance with strict quality standards administered by Mattilsynet, the Norwegian Government food safety control agency. Mattilsynet controls all types of food products in all their states during the flow of goods. In Norway, quality control systems for farming in general are set by the organisation KSL (Kvalitetssikring i Landbruket) such as in the case of the farmers producing Corona strawberries. The quality control system used by TINE is based on KSL and adapted for milk production. Quality standards consist of the measured fat content, cell-count, protein content, and the bacteriological state and are tested regularly at the dairy. During the entire scope of its flow, milk in all its forms is temperature-controlled.

5.2.2 Packaging and Containment Facilities

In its raw form, milk is stored in tanks. Raw-milk is used to manufacture different dairy products by TINE. Lettmelk demands the highest quality sorting of the raw-milk; lower quality is used for cultured products such as sour milk (buttermilk), cottage cheese, and yoghurt. Tanks used to store raw-milk have refrigeration devices and are located at the farm, on the truck, and at the dairy. In its finished form, milk is poured into cartons that are grouped onto plastic trays holding 10 1-litre milk cartons. Lettmelk is packed into a variety of consumer-level packaging sizes and shapes. The product is packed into 1½, 1, ½, and ¼ litre Pure-Pak cartons and 10 litre bag-in-box type dispenser cartons. This case focuses on the 1-litre carton, the most common TINE Lettmelk packaging type used. This package size accounts for somewhat over 50% of the TINE Lettmelk volume produced. The 1 litre carton is predominately distributed through food-retailer outlets to consumers. It is printed using pink and white colouring with text communicating product information and TINE contact information, including a telephone hotline for customer queries. Also, one side of the TINE Lettmelk carton contains a text with information, or it has an entertainment value that is not directly related to the product. On top of the arch, numerical codes are stamped indicating the place and exact time of production. One code indicates which dairy, including the production line, where the milk has been produced. The best-before date is the most obvious information stamped and indicates a date ten days after production.

Pic. 3: TINE Lettmelk consumer packaging in roll-rack containers

Raw-milk is stored in tanks at the farm, on the truck, and in silo tanks. The milk tanks may be used for any liquid product and have devices to keep the milk at the required temperature of 4 degrees Celsius. The tanks are, in practice, only used to contain milk. At the TINE Øst dairy facility, 7 silo tanks with a capacity of 100 000 litres are used. Silo tanks are filled up gradually and the volume stored in the tank is registered. Finished Lettmelk products are filled into specialised 1-litre Pure-Pak drinking cartons. The arched-top Pure-Pak carton is used because it is believed to symbolise freshness and high quality, compared with the main competing carton type, the brick-like TETRA-Pak. This consumer perception of freshness is related to the practice that the Pure-Pak carton is only used for less durable, liquid food products. The 1-litre carton is stacked on plastic trays containing 10 1-litre cartons each and roll-rack containers holding 160 1-litre cartons. Milk cartons on blue plastic trays or cartons not on trays are loaded into roll-rack containers. These trays and containers are designed specifically to hold 1-litre, standard shaped Pure-Pak cartons of milk or juice products. The 1½ litre size, which was designed more recently, is adapted to also fit onto the trays and roll-rack containers.

The roll-rack is a relatively small, manually handled, grid-like container on wheels and with a brake. It measures 42 cm in width, 67 cm in depth and 124,5 cm in height. The roll-rack is a flexible container with shelves on both sides that are hinged along the walls of the container making it possible to split half the container horizontally, as well as split the container in a vertical fashion. The roll-rack may also be folded in a way that allows the racks to be pushed one inside the other horizontally comparable to how shopping carts are placed together, to save storage space for unused roll-racks. Roll-rack containers are used to carry a variety of TINE products and to store and transport these products in the dairy terminal and on trucks to retailer facilities. Milk cartons may also be placed into roll-rack containers without using plastic trays when they carry one type of milk product exclusively.

5.2.3 Distribution

The facilities and actors involved in the distribution of TINE Lettmelk are described in fig 5.6 below:

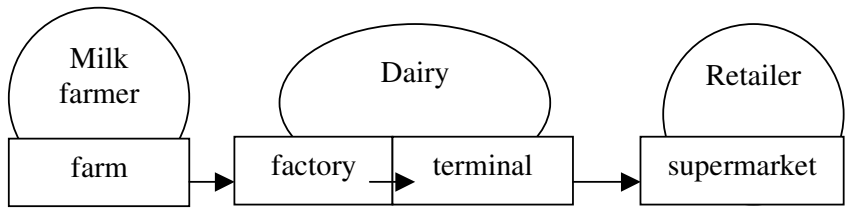

Fig. 5.6 The flow of TINE Lettmelk (Arrows indicates the direction of the flow of milk between facilities)

Production and distribution of Lettmelk are carried out by what is termed by TINE as the dairy (Norwegian: "meieri"). In fig. 5.6, the dairy is considered an actor that operates a production and an adjacent terminal facility. Accordingly, the dairy also functions as a distribution centre within the TINE network.

Lettmelk is produced year-round. The volume supplied by the milk-producers is planned in accordance with the milking state of individual cows. An important function of a milk-farmer is to deliver an annual volume of milk in accordance with the volume designated through the quota system to the dairy farmer. The "organisation department" at the TINE dairies assists the farmer with this planning process. On the demand side, the central logistics department provides long-term and short-term production forecasts

based on anticipated customer demand. The annual demand for milk products in general is declining. This is due mainly to changes in consumer preferences; consumers are switching to other drink products. Per litre prices for raw-milk to the producer are set through annual agreements. This price, which in 2003 was NOK 3,53, is set in accordance with the volume quota system and includes the provision of government subsidies. The finished 1-liter Lettmelk product has, when promoted from a regional TINE distribution centre, a fixed price and is never promoted through price reductions. Most other TINE products are occasionally offered at a discount to retailers. In stores, however, prices for TINE Lettmelk may vary and are slightly lower where they carry both Q-Meieriet Lettmelk and TINE Lettmelk as opposed to stores that carry TINE Lettmelk only.

5.2.4 Transformation of TINE Lettmelk

The transformation of TINE Lettmelk and the various forms of packaging used to contain this product are shown in the following figure 5.7:

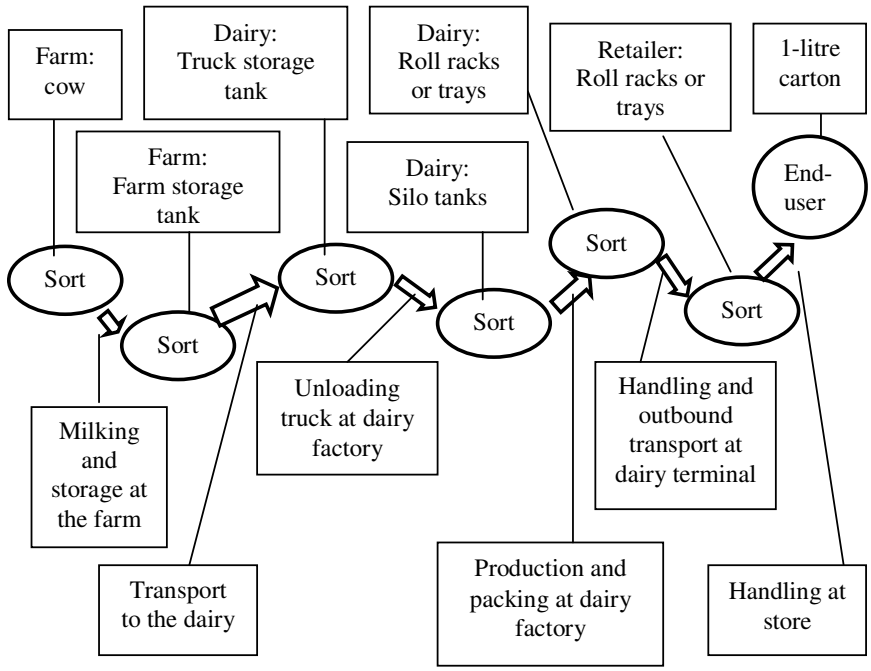

Fig. 5.7 The transforming activities and types of packages used at sorts in the flow of Tine Lettmelk

Figure 5.7 describes how TINE Lettmelk undergoes production in two phases: when the cow is milked, and at the dairy factory. Within the supply chain, the raw-milk is transformed through production at the dairy factory into a finished consumer-packed product. The total time from milking until the best-before date runs out is approximately 13-14 days. The following sections cover the specific activities transforming TINE Lettmelk and the container facilities used to transform this type of goods in the supply chain.

Milking and storage at the farm

Each morning, the cows that are producing must be milked; otherwise they will suffer. The milking equipment is manually attached to the cow's udder and the pump is switched on. Milk is then pumped into a tank located in a room adjacent to where the cows are held. This tank is refrigerated and has gauges indicating temperature and the volume of milk contained. Control samples are taken from each individual milking cow every month by the central quality control at TINE's livestock control facility in Ås. These samples are placed into small plastic cups and sealed with a lid. On the lid, a label, printed by the truck's computer, is attached that contains identification information of the specific cow, including a numerical code, a bar code, and a text with the name of the cow. The samples are collected on a tray and the tray is also labelled with information indicating the producer of the milk using text, numbers, and bar-codes.

Transport to the dairy

The TINE tank vehicles normally arrive within an interval of two hours some time before noon 3 times a week. The dairy farmers need not be present when milk is collected. The truck driver enters the unlocked production facility and attaches the pumping equipment on the truck to the storage tank in the barn. When the milk has been loaded into the truck, it gets mixed with deliveries from other producers. The truck driver takes a sample from the milk tank at the farm and places it in a sealed plastic cup which then is affixed with a label containing identification information in numerical, textual, and bar-coded form. Then the truck follows its route, stopping at other farms to collect milk, before arriving at the dairy.

Unloading trucks at the dairy

Tank vehicles carrying raw milk arrive at the dairy each day except Sundays, the first truck at around 11:00. TINE owns and operates 340 such trucks; each truck has a capacity of 15 000 litres which may be doubled by attaching a trailer wagon. Samples are taken from the milk in each truck and analysed at the laboratory before being pumped into one of the 7 silo tanks, which may contain up to 100 000 litres each. The milk may be pumped out within an hour if the quality is accepted. If not, the samples from each of the

producers are tested to trace the farm that is the source of the quality failure. The delivered milk is assigned to one of the seven silo tanks in accordance with the milk's quality and a "FiFo" (first-in-first out) storage policy.

Production and packing at the dairy

Raw-milk is pumped in a continuous manner into the production lines. TINE Øst runs a dual-shift production schedule and produces about 30.9 million litres of low fat milk annually. 11-12 thousand litres of milk are produced at the TINE Øst Oslo dairy per hour. Milk flows continuously through the production equipment. No additives are used in the production of low-fat milk. During the production process, the raw-milk is separated and the level of fat regulated and given a heat treatment by bringing the raw materials to 72 degrees Celsius. The milk is pasteurised and homogenised, cooled down, packed, and then automatically loaded onto roll-rack and/or plastic tray containers.

Handling and outbound transport at the dairy

Terminal workers collect products ordered by retailers at a designated location, and these products are placed at a location dedicated to a specific delivery route. 25-26 thousand individual products are picked up every day at the TINE Øst dairy. They are retrieved from a specific location at the dairy and loaded, either on pallets or roll-racks, and then moved into containers at the dedicated location in the dairy. Some goods are collected on roll-racks containing only one type of product. These products are placed at a special location in the dairy terminal. Here, the racks are placed in aisles, one for each product. At the TINE Øst facility, the floor of this terminal location is tilted, allowing the racks to roll automatically into a convenient position for the truck driver to pick up. Most retailers in the Oslo area receive unbroken roll-rack containers of TINE Lettmelk. However, most other TINE products are placed manually onto the roll-rack containing a mixture of different products. About 30% of the goods picked at the TINE distribution centres are contained in "non-mixed" roll-rack containers. Each of these is designated to a single retailer. The containers bound for the different customers are loaded on two levels into the delivery truck in a manner that allows for an easy unloading sequence. All delivery trucks are of approximately equal size and have a refrigerated storage compartment designed to carry roll-rack containers on two levels. The truck carries all the TINE products, as well as products for the meat producer GILDE and poultry producer PRIOR in accordance with the LFD agreement.

Handling at the store
At the store, roll-racks with goods are unloaded and empty roll-rack containers returned. These are in a folded condition stacked horizontally inside each other. The truck carrying products in roll-racks is received at the back of the store. Each retailer receives between 1 and 30 roll-rack containers. Smaller stores must retrieve trays of low-fat milk from a container carrying other products, while the larger retailers receive a number of entire containers loaded with TINE Lettmelk. The goods are then moved into the store display area, although milk is usually stored for a few hours until the remaining previous supply is sold out. The retailer does not keep a buffer inventory of milk products. The consumers get TINE Lettmelk, together with other dairy products, out of a refrigerated area, usually displayed behind a glass door.

5.2.5 Information Directing Delivery of TINE Lettmelk

This part shows how information is provided and used at sorts to transform the TINE Lettmelk as described in the previous part.

Negotiating production volume of the farm
The basis for producing and distributing TINE Lettmelk is that a more essential long-term planning is carried out. The amount of raw-milk produced at the dairy farm is regulated in accordance with government subsidy initiatives involving the following actors and type of information communicated, as shown in fig. 5.8 below:

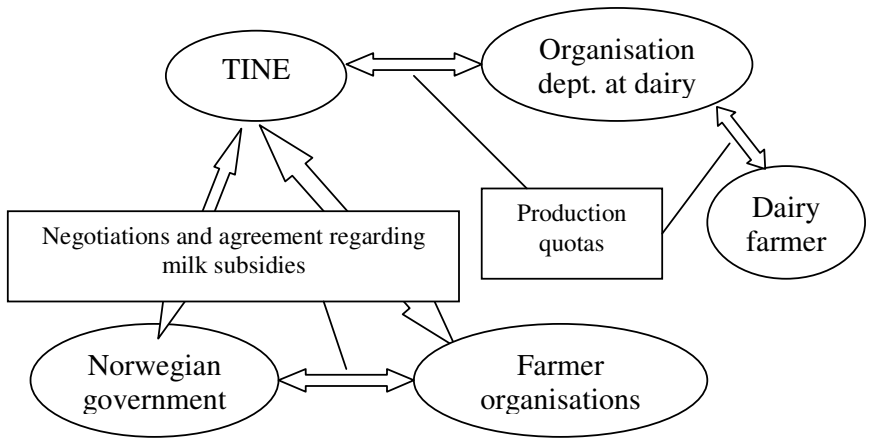

Fig. 5.8 Negotiating production volume of the farm (Double-headed arrows indicate information exchange)

Each year, the farmers' organisations and the Norwegian Government negotiate an agreement regarding farm subsidies. The amount of these subsidies also regulates the total volume of raw-milk that is produced. This agreement represents the basis for calculating raw-milk process and production volumes at each farm producing raw-milk. At each dairy, the organisation department informs farmers helping them to produce in accordance with production quotas.

Production planning at the dairy
Production planning plays an important coordinating function by laying the grounds for carrying out sorts. This activity involves the following actors and types of information as shown in fig. 5.9 below:

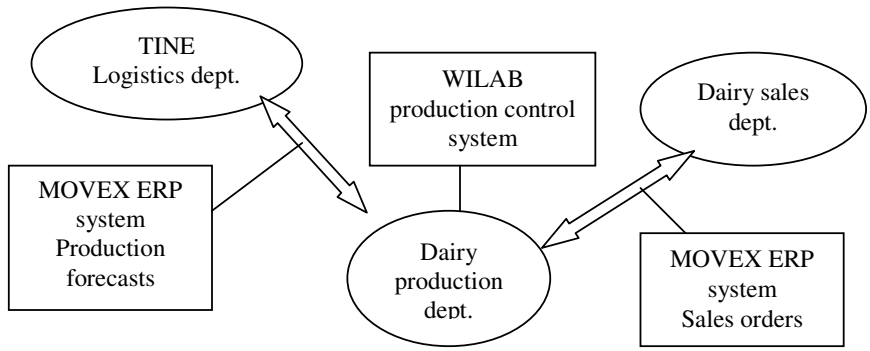

Fig. 5.9 Production planning of Lettmelk

At the dairy, production of milk goods starts each morning based on a forecast. These forecasts are made using the MOVEX ERP system by logistics planning personnel working in the TINE Logistics department and are based on historical data that are adjusted for promotional campaigns, holidays, and market trends. The sales department receives orders after production has started. Around noon, the total demand of the day becomes apparent and production volume is adjusted so that the production of TINE Lettmelk meets the orders of that day.

Information about collecting raw-milk at the farm:
The main actors and types of information involved in collecting milk at the farm are shown in fig 5.10 below:

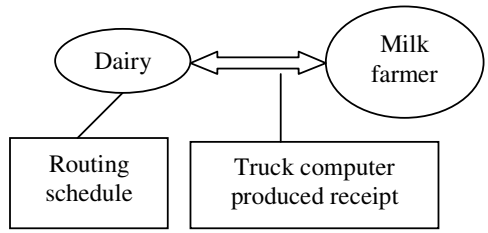

Fig. 5.10 Information about raw-milk collection at the farm

The truck driver follows a set transport route. Each farm is visited 3 times a week by the milk collection truck. This truck has an onboard computer that registers the milk collected at the farm facilities. The truck computer is also provided with information to be communicated to the farmers. It produces a receipt informing about the amount collected, quality assessment of the previous collection, and other handy reminders from the regional TINE dairy the farmer is affiliated with. The truck driver has a mobile phone that may be used to re-route the truck or provide last-minute information to the truck driver. The truck also has an on board compartment that stores trays of raw-milk samples. From each delivery, two samples are placed into small cups that have a bar-coded label attached produced by the truck computer. Once every second month, each farm also delivers a set of similar cups of samples, one from each producing cow, attached with labels produced by the truck computer and previously provided to the farmer. These samples are sent to the TINE livestock control department at Ås.

Ordering by the retailer:
The actors and types of information involved in ordering from a retailer are shown in fig. 5.11 below:

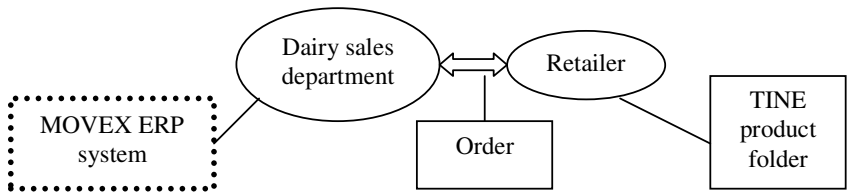

Fig. 5.11 Ordering TINE Lettmelk

The dairy sales department has representatives who every morning call up customers according to a phone list provided by the MOVEX ERP system. TINE Øst supplies milk to various kinds of customers; HORECA (Hotel-

restaurants-catering), small kiosks, and food-product retailers, for instance, are important customers. The food retailers expect the daily call from TINE at approximately the same time each day. Prior to this call, the retailer personnel must estimate the needed volume of TINE products to be delivered later that same day. This takes the staff at a large, full assortment supermarket about ½ - ¾ of an hour every morning. The retailer has a binder containing a product list that includes product presentations, names, and numerical product codes used to assist in the daily registering of the stock of TINE products.

The retailer orders TINE products through a manual process. TINE Lettmelk is one of about 250 products covered on the order list provided to each TINE customer. On the list, each product is indicated with a 4-digit product number, a text describing product name and type, including the size of the consumer packages, and the quantity of consumer packages in each distribution-level package which at this stage of the flow functions as a logistics unit. TINE Lettmelk is registered in units of blue plastic trays or roll-racks. During the daily morning phone conversation, the sales representative at TINE promotes products that according to statistics may be selling poorly, attempting to discuss reasons for this and also trying to sell a few extra units of each product. TINE Lettmelk is viewed as a simple and well-known product. Product queries or quality complaints regarding TINE Lettmelk are therefore rare; hence, TINE Lettmelk is, in fact, only discussed with respect to order volume.

Informing about delivery to retailers:
Informing about delivery of goods to the retailer involves the following actors and types of information as shown in fig. 5.12 below:

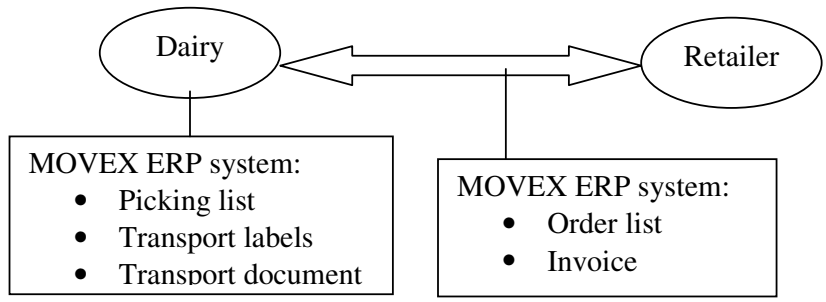

Fig.5.12 Informing about the delivery to the retailer

The MOVEX ERP system creates all the documents and labels needed to deliver Lettmelk to retailers. When orders from all the customers have been

received, the information system automatically creates picking lists that are used to load the various trucks. These lists are used by about 40 terminal workers at TINE Øst Dairy in Oslo to place the various products ordered by each customer at a designated location assigned to a specific truck. The information system also produces a transport document that is used by the truck driver. This document contains information concerning the time and date of the transport, how many roll-rack containers and other packaging forms are loaded, the destination of each of these packaging units, and the name of the supplier, a TINE dairy.

The driver uses this freight bill to deliver the packages according to a designated route. The number of locations on a route varies from 2-35, depending on the size of the orders. Visual discrepancies in product quality are written on the freight bill. A transport label containing only destination information used by the truck driver is attached to roll-rack containers holding an assortment of products. Roll-rack containers carrying only one product type are not provided with a label. The driver must pick up the quantities of entire roll-racks at a designated location in the terminal. The freight bill used by the driver contains the names and quantities of the different items that have been ordered and which of these are contained in the transport. The driver uses this document, together with the freight bill, to verify the goods in the transport. The dairy sends a monthly invoice to each of its retailers based on the order lists.

Informing about the product by the retailer

At the store, the retailer informs consumers about TINE Lettmelk, based on information received from TINE. This information exchange involves the following actors and types of information shown in fig. 5.13 below:

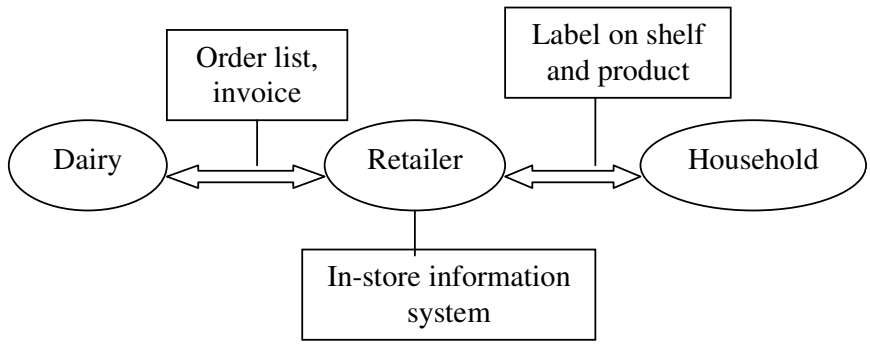

Fig. 5.13 Informing about TINE Lettmelk at the supermarket

A retailer representative receives the goods and signs the order document at the supermarket. The goods are then moved into the store display area. The truck driver returns a copy of the signed order to TINE Øst. The retailer has already registered the ordered amount in the store computer system, and now the delivery is verified. Later, the retailer receives an invoice for the delivered amount at regular intervals. When TINE Lettmelk is purchased, this is registered in the store computer system. Even though both orders and sales are registered in this system, it is not used to calculate the inventory of TINE Lettmelk. The retailer usually places TINE Lettmelk carried in the roll-rack containers behind a glass door of the store's refrigeration compartment. The only information provided at the retailer's to the customer regarding TINE Lettmelk is a label that reads "TINE Lettmelk" and the volume of the packaging, together with the price, and is located in the close vicinity of the compartment containing the products. At the store, the consumer selects the milk product, which is displayed together with other TINE and competing dairy products.

5.2.6 Tracking and Tracing TINE Lettmelk

This part starts with a description of when and how TINE Lettmelk is tracked, followed by a description of where, when, and how TINE Lettmelk is traced.

Tracking goods
The following figure 5.14 shows the actors, information exchange and type of information media involved in tracking TINE Lettmelk when in transport:

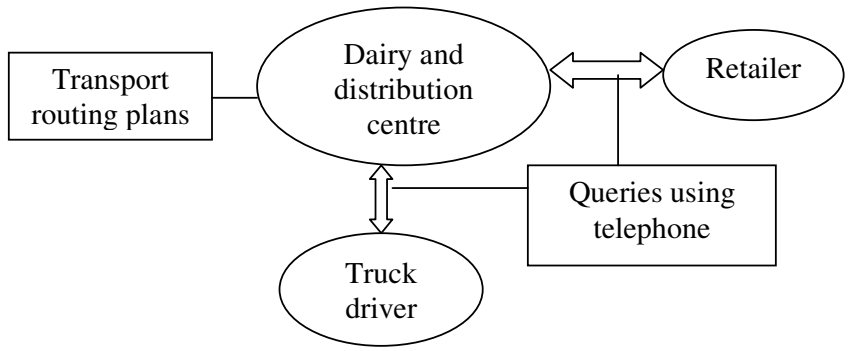

Fig. 5.14 Tracking Lettmelk when in transport to and from the diary

The milk farmer produces a planned or expected quantity of milk daily. Therefore, there is no need to track milk at the farm since there is always

some amount of milk produced more or less in accordance with the quota system there. The flow of TINE Lettmelk consists of two distinct parts using different types of facilities to contain goods. Prior to production at the dairy, raw-milk is stored in a variety of tanks, and after production at the dairy the produced milk for consumption is packed in consumer packages that are combined with other-use packaging. There are three main areas where milk potentially may be tracked. First, milk may be tracked in its state as a raw material in transport between the producer and the dairy. Second, milk may be tracked when it is in storage and production at the dairy facility. Third, milk may be tracked in transport to the retailer.

The truck driver transporting raw-milk to the dairy follows a pre-defined transport route. Thus, the approximate location of a truck may be estimated. If, for some reason, it becomes necessary to alter this route while the transport of raw-milk is underway, the truck driver may be contacted through mobile phone.

During production, milk from one specific silo-tank is always used, and it is therefore possible to ascertain whether milk from one specific farm is in production. This milk is, however, mixed with milk from numerous other producers. In the same manner, milk that has been filled into a carton may also be traced to milk from a specific silo. The production of milk is highly automated and controlled by the WILAB system, which system registers the volume of milk that is in the production process. In practice, tracking milk in production involves identifying which silo tank was used as the source of raw-milk.

At TINE Øst, tracking Lettmelk is carried out predominantly when a quality discrepancy has been detected. Only a few such incidents were reported in the past years and involved detecting a fault with a packaged, finished product that already had been delivered from the terminal facility. Quality control is carried out at the laboratory at TINE Øst. In most cases, a faulty product will still be in storage at the TINE Øst terminal when a test may reveal product quality discrepancies. In repeated or more serious cases, involving large volume of goods, a retailer may report product failures to the sales department at TINE Øst.

Tracking during transport from the distribution centre to the retailer is done using the MOVEX ERP system. This includes using continually updated transport routing plans with precise information regarding what type of goods are delivered to different retailers on a specific truck. If a product such as low-fat milk needs to be stopped en-route to its retailer destination, a form of, what is called by TINE “a detective’s work”, must be carried out since

MOVEX does not automatically provide tracking data. The personnel at TINE Øst, checking the MOVEX order, must go through freight bills, picking lists and production schedules, using the time of production as an indicator to estimate according to pick-up times of the products, which retailers most likely will be receiving a specific faulty batch of goods. Then the truck drivers carrying these goods must be notified by mobile phone to stop delivery. If delivery has taken place the retailers must be notified by phone. TINE admits this is not an efficient way to carry out tracking and says it would rather use its resources at developing production, storage, and goods handling routines to eliminate the need for tracking goods.

Tracing products

The following figure 5.15 shows the actors and main types type of information facilities involved in tracing TINE Lettmelk:

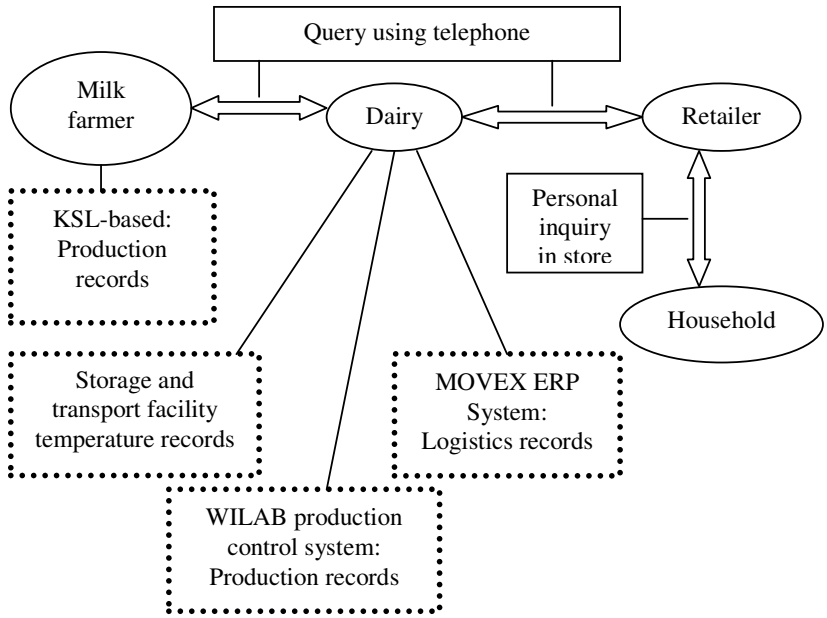

Fig. 5.15 Tracing TINE Lettmelk (Dotted boxes indicate types of information systems)

A limited amount of product information follows Letttmelk downstream through the supply chain. This information may be provided through documents provided from information systems at the same location as where the product is at present located and being handled. Here it is predominately

information carried by the package and documents sent in relation to the shipment of goods that provide this information. If more detailed product information is needed, it must be sought by locating the actor that has the appropriate data records. Lettmelk is usually traced to a specific business unit upstream in the flow of goods.

At the farm, production is carried out in accordance with KSL-developed standards. Production of milk from each individual cow is registered to show its feeding and veterinary aspects. Consultants from TINE assist the farmers in organising how to ensure production quality and register this information. The farm, therefore, may provide detailed information about production of raw-milk at the farm by accessing its, usually, paper-based production records.

Raw-milk is mixed into silo tanks at the dairy. The information provided on a carton of low fat milk may be used to trace this product to a specific production line at a dairy, as well as the exact time of production down to the minute. By comparing the information stamped on the carton with information from the WILAB production control system, the silo tank used to produce a specific product may be located, and thus also which farms delivered the milk from this silo tank. TINE Lettmelk is monitored by the MOVEX ERP system during transport, handling, and storage. This system does not register the storage temperature of TINE Lettmelk is stored in since these temperature logs are registered individually at the specific facilities.

If it becomes necessary to trace a carton of milk back to the farm, this will involve finding out which trucks pumped milk into a specific silo tank used on the date of production, and then finding out which farms this milk was collected from. Should there be an immediate need to locate a quality discrepancy reported from a retailer or consumer, the individual samples taken from each farm location may be used. The contents of the truck and the silo have, however, already been tested, hence it is only if a mistake has been made in this testing that such procedures will be used. This way, quality discrepancy from a 1-litre carton of milk may be traced back to an individual cow. This process is time-consuming and involves several different actors and informational resources.

Product tracing is mainly used to detect the origin of product discrepancies. However, queries may be posed just to receive detailed product information not provided by the packaging. Consumers and retailers are the two actors in the supply chain that most likely may demand such information. Retailers have an established communication link with the sales department at TINE

Øst, and, occasionally, retailers call by phone seeking more detailed information about product characteristics.

TINE could not account for any actual direct consumer enquiries regarding the specific features of its milk products. Often, such information is related to the use of new products, such as "Biola", a new form of yoghurt made from a specific type of culture. Lettmelk is, however, an "old" and well-known product that is not, in practice, involved in such queries. If consumers wish to enquire about the milk product, the most obvious source of information is on the milk carton. The combination of stamped and printed information on the carton provides the basic product characteristics information that a consumer may wish to know. If the consumer seeks more information, a phone number is printed on the carton. This is a toll-free number where consumers may make queries to a representative at the sales and marketing department of TINE regarding any TINE product. It is regarded as vital mainly when it comes to securing product traceability in accordance with government and consumer requirements.

5.3 Marian Fish Filets

This presentation of Marian fish filets follows the same basic structure used to describe TINE Lettmelk. This part consists of first, in 5.3.1, a description of important features regarding the product. This is followed, in 5.3.2, by a description of the various forms of packaging used to contain this product. In 5.3.3, an overview is given of how this product is distributed, including the most important actors and facilities within the flow of goods. Section 5.3.4 describes the transformation of goods and packages used to facilitate this transformation, and is followed by section 5.3.5, covering how information is used to direct the flow of Marian fish filets. Finally, in 5.3.6, how tracking and tracing Marian fish filets are carried out is accounted for.

5.3.1 Product

Marian fish filets is a recently developed, fresh fish product. It was originally produced in Fosnavåg, in Western Norway, by Sunnfisk, a company that went bankrupt in mid-2004 and closed down. Fjordland, therefore, negotiated a new agreement for production with Aker Seafoods, and in the beginning of September 2004, it was started up at Aker Seafood's facility in Hammerfest. Each product consists of 300 or 360 grams of premium quality fish filets. The raw material used in the production must never be more than 2 days old. The product consists of three varieties: 1) "Koketorsk" (Cod for cooking), 2) "Steketorsk" (Cod for frying), and 3)

"Seifilet" (Filet of Saithe. Saithe is similar to Pollack, having white to greyish colour meat and is common in Northern European cuisines and used for frying or in casseroles). Koketorsk contains four 90-gram pieces from the centre portion and loin of the cod. Steketorsk consists of two 150-gram pieces of the tailpiece of the cod. Seifilet comprises two 150-gram pieces of the Saithe filet's tails. Fish filets that come from low fat, white fish species are products that are well known to Norwegian consumers. The type of packaging used to contain Marian products is an innovation to Norwegian consumers since fresh fish has never previously been displayed in an industrially produced, fresh and packaged form in Norway. Marian fresh fish is vacuum-packed into consumer packaging. The oxygen content is removed to prolong durability of the product. This treatment does not influence the taste of the product. Marian products have limited durability and must be stored at 4 degrees Celsius. Fjordland guarantees the retailers that they have 5 sales days before the best-before date expires.

5.3.2 Packaging

When fish have been gutted and cleaned onboard the fishing vessel, they are placed in large, reusable, plastic crates measuring 50cm x 80cm. Pallets are not used on board, but when the crates are unloaded, pallets are used for handling purposes only, with crates fitting on a EURO pallet, leaving 20 cm. of empty space lengthwise on the pallet. At the factory, fish from the trawlers are stored in plastic fish tubs that may contain up to 400 kilos of fish placed in ice-cold water. These tubs are moved around the storage and production facilities using a forklift and are adapted to the EURO pallet in size. The production facility has about 100 of these containers.

Marian fish filet is packed into consumer packaging that measures 19cm x 14cm and are 5 cm high. This is an open, black coloured plastic cup-like holder covered with a see-through, thick plastic film, with a label attached. This label shows a colour picture of a prepared fish product and uses black text on a combination of white and light-blue background. The consumer package label contains a mixture of information printed prior to production and information that is stamped on during production. The label contains product information regarding type of product, GS1 numerical and bar code, brand name, and other necessary information about product contents. The label also informs about a product quality guarantee that allows the consumer to receive money back should the product not meet expectations. The label also gives general instructions on how to prepare the product. A more detailed and "fancy" recipe using the product as the main ingredient is provided on the package. The stamped-on information is located in specific spaces on the label. This information contains the lot number, the best-before

date, and a code indicating the time and location of production. The lot number represents a batch of fish that is caught by a specific fishing vessel on a specific date and may also be used to identify the location where the fish was caught.

Pic. 4: Marian fish filet consumer packaging tray and labelling

The consumer packages of Marian fish filets are placed into plastic GILDE-reusable meat containers. GILDE is the largest Norwegian producer of meat products. These measure 40cm x 60cm, and 4 of these GILDE meat containers are adapted to fit on each layer of containers stacked onto a EURO pallet. A GILDE meat container may hold up to 3 layers of Marian C-packs with 5 packages in each layer. Each GILDE meat container carries a transport label with an EAN bar and numerical product code indicating the contents of the container. On the pallet, a transport label with an EAN SSCC bar- and numerical code is attached giving a unique identity to the goods as well as their destination.

Pic. 5 Gilde meat containers that are also used to distribute Marian products

5.3.3 Distribution

The main actors, facilities and flow of goods in the distribution of Marian fish filet products are shown in figure 5.16 below:

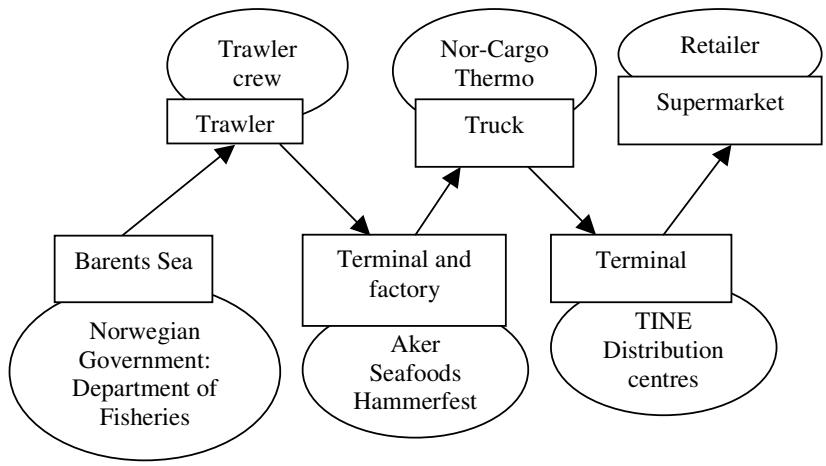

Fig. 5.16 The main actors and facilities involved in the distribution of Marian fresh fish filet (Arrows indicate the direction of the flow of goods)

The flow of Marian fresh fish filet is distinct from other modes of distribution within TINE. Fjordland had to find a new solution for distributin g its Marian products since these products are based on raw material that is different from its other products.

Norwegian consumers usually purchase fresh, white fish filets from a specialty store, from the fish counter at larger supermarkets, or from a mobile fishmonger using a van to visit households or park at a convenient location. Along the coast, many households are involved with the fishing industry or have relatives supplying them with low-priced fish directly from the fishing industry. Many households also carry out an extensive amount of hobby fishing using their own leisure boats. The alternative is to purchase the same types of products frozen.

Fresh fish that never has been frozen is considered superior in quality to frozen products. This is especially important in recipes where the fish flavour is supposed to be distinct, such as with oven or pan-fried, boiled or steamed pieces of fish. In Norway, many consumers do not have easy access to retailers selling fresh, white fish. In addition, some consumers regard purchasing fish in this unpackaged manner as unnecessarily time-consuming or even unappetising. Marian fish filet is a packaged consumer product that may be supplied to any retailer with cold storage display facilities, thus allowing even smaller retailers to offer fresh, white fish products to their customers.

Marian is produced by Aker Seafoods Hammerfest and the fish used by the Aker Seafoods production facility is caught in the Barents Sea outside Hammerfest. The Hammerfest production facility has for decades been producing packaged, frozen consumer fish products, using modern industrial methods by a company previously called FINDUS. This is still the brand name of some fish products. The production of FINDUS products is unique. FINDUS represented a pioneering effort in fish production distribution because it used principles of mass production and vertical integration. FINDUS had its own fleet of trawlers and controlled distribution to retailers in markets all over Europe through Nestle's industrial network.

Aker Seafoods still has 7 associated fishing-trawlers that supply the Aker Seafoods production facility in Hammerfest exclusively. These ships are owned 40% by Aker Seafoods, 40% by Hammerfest municipality and 20% by DnB, a large Norwegian bank. Of these vessels, two are completely idle, one is a reserve vessel, and the last four vessels are active. These are large fishing trawlers with limited production facilities onboard. They are at sea for 5 to 7 days and deliver catches on Mondays, Tuesdays or Wednesdays,

and on Fridays. If the trawlers fish close to shore they are at sea for 5 days; if further away, they use one day to reach the fishing location and one day to return.

Each vessel has a production quota. To secure product quality, the fishermen are paid an extra bonus in accordance with the quality of the catch delivered. Important raw-material quality indicators are gutting, discolouration due to bleeding, and freshness due to temperature control. The catch is stable from November to September. During the months of September and October, catches are lower due to natural causes. Fish species migrate, and during these periods, fewer fish are present in the areas where the fishing fleet of Aker Seafoods does its fishing.

Aker Seafoods has invested in a production line that at present is only used to produce the Marian products. The volume is small, representing less than 1% of the volume produced by Aker Seafoods. However, the Marian products represent the freshest and best quality class of the raw-material fish, being maximum 2 days old and coming from the finest pieces. In the case of cod, the Marian products take about 30% of the premium quality raw material. The Marian products are sold mainly in the Oslo region, and the total volume distributed is low. Therefore, production is carried out only 2 days a week, on Mondays and Fridays. On October 18th, 2004, production at the Hammerfest factory totalled 48 GILDE-meat containers, and each destination, a TINE distribution centre, was assigned one pallet. Most distribution centres received 2-5 GILDE meat containers; 8 did not order any Marian products that day.

Fjordland is responsible for the Marian brand name and product development of Marian products. Fjordland, however, does not catch, produce, or physically distribute the products. The Marian products that are produced at Aker Seafoods Hammerfest are distributed directly to 22 TINE distribution centres. These are the TINE sales dairies that produce milk.

Nor-Cargo Thermo carries out transport from Aker Seafoods Hammerfest to the regional TINE distribution centres (dairies). One truck transports the Marian products together with other products to the Nor-Cargo Skårer facility where the goods are further distributed to the various TINE distribution centres. At these distribution centres, the Marian Products are handled together with other TINE, GILDE, and PRIOR products and distributed in accordance with the LFD arrangement. Marian products have a durability of 10 days from catching the fish on the trawler until the best-before date expires.

5.3.4 Transformation of Marian Fish Filets

The transformation of Marian fish filets and the various types of packaging used to contain this product are shown in the following figure 5.17:

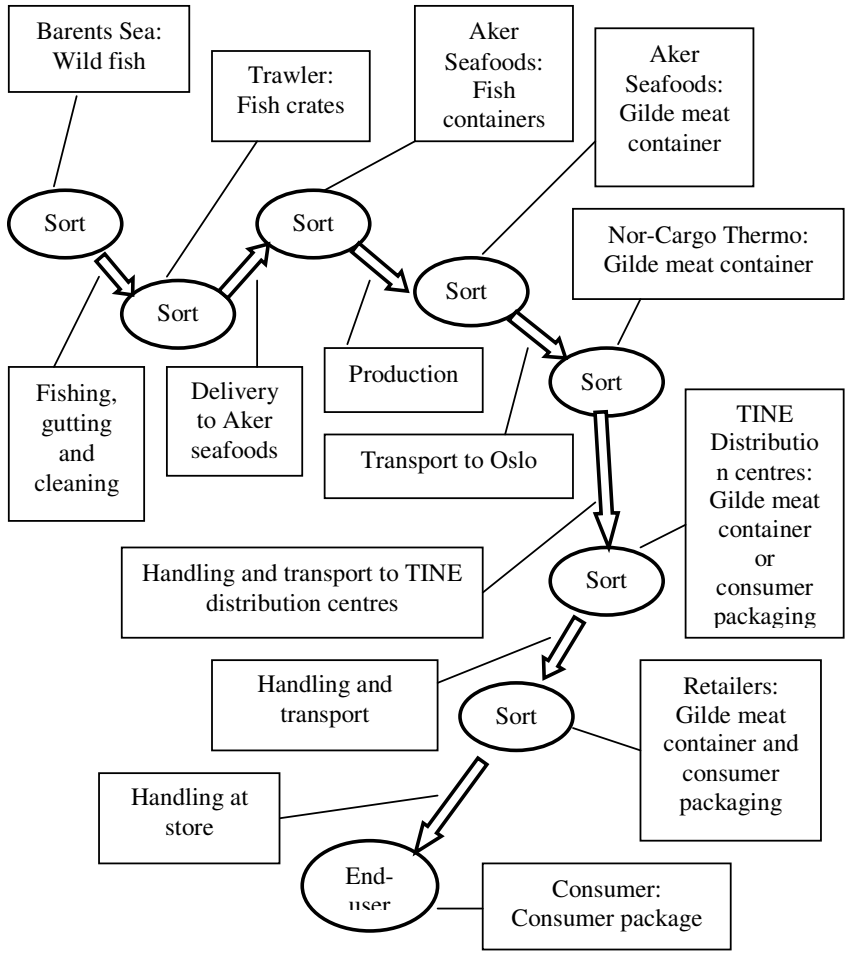

Fig. 5.17 The main transforming activities and types of packages used in the flow of Marian fish filet

The figure shows how the finished packed fresh fish filet products are transformed from a fish inhabiting the Barents sea until it is placed on the shelves of a Norwegian supermarket. The Marian fish filets in the consumer

packs are parts of the original fish. Marian fish filets are physically transformed but not combined with other products or given additives other than the nitrogen and carbon dioxide that is injected into the consumer package to reduce the rate of material decay. The following sections describe how Marian fish filets are transformed in the flow of goods to the end-user.

Fishing, gutting and cleaning

The fishing vessel is a trawler. Fish are caught in a net where the openings in the net are regulated in accordance with government-set specifications to hinder catching smaller and younger fish. The net is in the sea for 2-5 hours. The catch is then hauled on board and is sent through an opening on deck into the holding room. There the fish is beheaded and gutted and hung so that the blood runs out of the meat. This is done to secure a white colour of the meat. It takes about 30 minutes for blood to drip out. When this is done the fish is cleaned, sorted, and then registered according to species and size. Ice is placed at the bottom of the fish crates and the fish above this. A label with a colour code is placed on top of the fish. There is one colour for each day of the week. Ice is then placed on top of the fish and the paper label. A lid is used to cover the contents of the crate and the crates are then placed in the ship's refrigerated storage room.

Delivery to Aker Seafoods Hammerfest

After 5-7 days at sea, the trawler returns to its base at Rypefjord on the outskirts of Hammerfest where the Aker Seafood's terminal and production facilities are located. Beside these facilities is a deep-water pier that the trawlers use. The fish crates are unloaded using forklifts and moved into the arrival terminal area indoors. Fish of the same species, within the same size margin, and caught on the same date, are collected into a plastic fish tub. The fish are loaded onto a conveyer belt that dumps them into a the large plastic fish tubs used at the production facility. Ice-water is poured into the tub to help preserve the fish. Fish is usually kept for 2 days in these containers. Cod or saithe that were caught less than two days previously by the trawler are used to produce Marian fish filets. The fish are kept for only a few hours in the fish tub before entering production. The empty fish crates continue on the belt and undergo an automated cleaning process. After cleaning, the fish crates are put in a storage room until being loaded back onto a trawler.

Production at Aker Seafoods in Hammerfest

The fish is emptied from the plastic container into a filleting machine. Aker Seafoods uses only fresh raw material meaning no frozen fish is provided from the trawlers and used in their production. All the production and terminal facilities at Aker Seafoods Hammerfest are refrigerated. These 20-year old machines are run by one person and automatically remove the skin

and bones from the fish. The filets are then sent to a trimming line. Here, 32 persons manually trim the fish on one production line. They remove remaining skin and bones and cut the fish into the appropriate pieces. Marian fish filet products contain loins (upper part of the fish), centre portions (belly), or tails.

The fish filets go mainly to three different product categories. Aker Seafoods delivers fresh fish that is packed in Styrofoam-based fish containers measuring 40cm x 60cm. These products are distributed to fish processing industries, mainly in Europe, or to sales from fish counters in European supermarkets. Aker Seafoods also packs fish filets in various types of consumer packages that are frozen. These products are marketed under the FINDUS brand.

The Marian products represent a unique production process and are packed using equipment that at present is only used for these products. New machinery is used to pack the goods into consumer-level packaging. This packing process is highly automated using new equipment. The filets are packed into consumer packages and a label is attached. The production takes only a few minutes and as the consumer packages come out of the machine, they are placed into GILDE-packs. When these are full, they are moved onto Euro-pallets, which, when full, are placed in the terminal storage area.

Handling and transport to the TINE distribution centres

Nor-Cargo Thermo transports most of the pallets of Marian fish filets to their terminal at Skårer outside Oslo. Nor-Cargo Thermo operates a fleet of trailer-type long haul transport vehicles. All their trucks have 2 refrigerated storage compartments that can be separated by folding doors. Monday and Friday afternoons, when Marian products are produced, Nor-Cargo Thermo drives a truck out to the loading ramp at Aker Seafoods' Hammerfest facility and picks up pallets of Marian products together with products from Aker Seafoods. The truck may carry both frozen and fresh products since it has two main compartments and each of these compartments may have a different storage temperature. The transport takes 38-40 hours; the goods sent on Monday arrive on Wednesday, and the goods sent on Friday arrive on Monday. Nor-Cargo Thermo uses a double set of drivers to ensure continuous, refrigerated transport that follows the shortest route, through Finland and Sweden, a distance of more than 2000 km, to the Nor-Cargo Thermo terminal at Skårer outside Oslo. The goods are transported together with other fish products from Aker Seafoods and other suppliers. At the Skårer terminal, the Marian goods are loaded onto other vehicles bound for TINE's various distribution centres in the Southern part of Norway. These vehicles carry mainly TINE products.

Handling and transport from TINE distribution centres
Marian Fish filets are usually received at the TINE distribution centres early in the morning and immediately moved to the area where they may be picked up for delivery the same day. The GILDE meat containers are usually broken, meaning that individual consumer packages are placed into a roll-rack container together with other products distributed through LFD. The Marian fish filets are then placed together with TINE cheese products, mainly, onto the same roll-rack. If a retailer has ordered a large amount of different Marian products, these are collected into one Gilde meat container. The roll-racks and Gilde meat containers are placed in the designated location at the terminal and transported out later in the morning to the retailers in accordance with LFD.

Handling by the retailer
Roll-rack containers are unloaded off the delivery truck and the Marian fish filets are immediately placed in a refrigerated counter together with other refrigerated fish products. The three different products are placed in separate locations next to each other. This area is usually close to where meats and poultry products for dinner purposes are also displayed. The products must be sold within 5 days of arrival or they have to be disposed of as waste.

5.3.5 Information Directing the Delivery of Marian Fish Filets

This part shows how information is provided and used at sorts to transform the Marian fish filets as described in the previous part.

Production and distribution planning
Production and distribution planning are carried out by Aker Seafoods in order to secure a necessary supply of raw materials. The actors and information involved in this relatively long-term planning regarding Marian fish filets are shown in fig. 5.18 below:

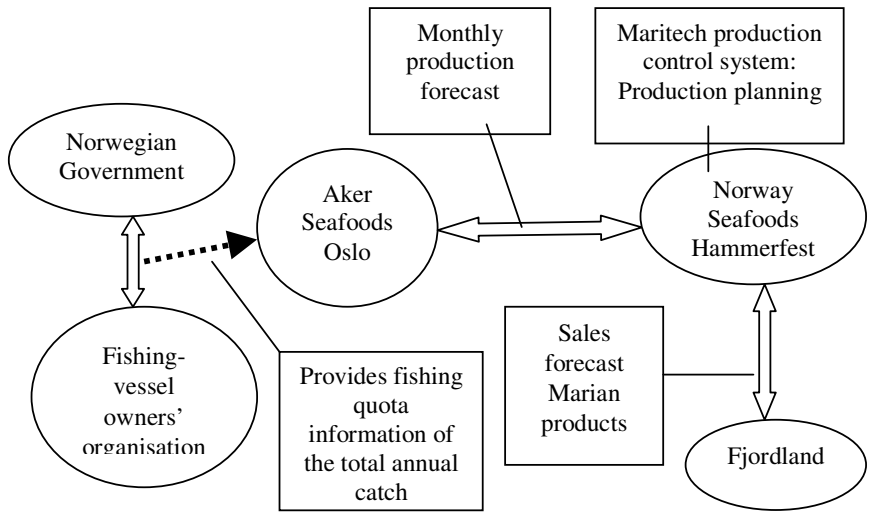

Fig. 5.18 Production and distribution planning of Marian fish filet (Double-headed arrows indicate information exchange)

The supply of Marian products is managed using weekly forecasts made by Fjordland. Marian is a new product that consumers are relatively unfamiliar with. Forecasting demand for Marian products is therefore a challenging task. The forecast is used by Fjordland to inform Aker Seafoods of expected orders for the coming week. Aker Seafoods uses this information in its own production planning. In practice, however, the actual production volume of Marian products is based on orders, and the forecast from Fjordland therefore serves mainly a supporting role to Aker Seafoods Hammerfest. The supply of raw-material fish from the trawlers is based on an annual agreement negotiated between the Norwegian Government's fishery department and fishing vessel organisations. An annual fish quota for each of the fish species is assigned to the individual active trawlers used by Aker Seafoods. The fish quotas, together with the total anticipated demand for all of Aker Seafoods' products, are used to make a monthly production forecast for Aker Seafoods Hammerfest. This production forecast is created at the head office in Oslo and then e-mailed to Aker Seafoods Hammerfest. This information is used in a Maritech production management system which system is an information system that is not interlinked with other information systems and used to manage, control, and register the production of fish at the Hammerfest production facility.

Informing about the delivery of fish from the trawler

The following figure 5.19 shows the actors and information involved in informing about delivery of fish from the trawler:

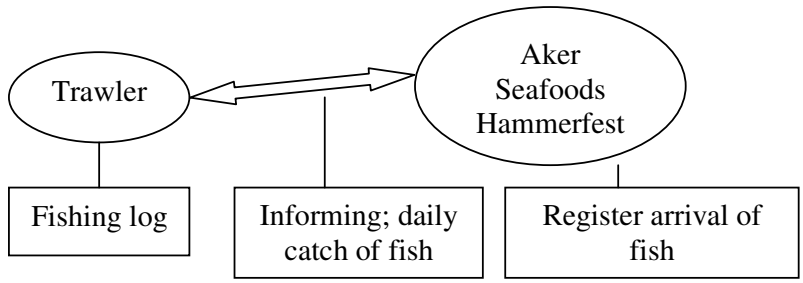

Fig. 5.19 Informing about the delivery of fish from the trawler

The trawler carries a fishing log. This log is used to register the volume of the catch of each species, the location of the catch, and the time when the trawl containing the fish was hauled on board. The fishing log is a paper-based system and information is registered manually in a book. The trawler informs Aker Seafoods daily of the volume of the catch of each species and size. Either a GSM mobile phone or satellite-based phone system is used for this communication, depending on how far out at sea the trawler is. This information, together with the expected arrival time of the trawler, is used to plan the actual production. Upon arrival at Aker Seafoods Hammerfest facility, the fish crates are counted to get an overview of the volume and sizes of fish delivered of each species.

Ordering by retailers

Ordering and informing about delivery of Marian fish filets to retailers involves the following actors and information as shown in fig. 5.20 below:

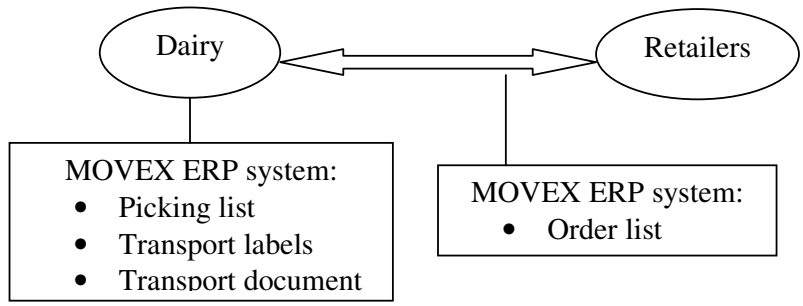

Fig. 5.20 Informing about the delivery of Marian fish filets to retailers

The retailers place orders in units of consumer packages containing Marian fish filet products of “Seifilet”, “Steketorsk”, or “Koketorsk”. When the Marian products arrive at the TINE dairies they are handled based on the same order-based information as that used to handle TINE Lettmelk and other products distributed by TINE dairies (distribution centres). This involves using the MOVEX ERP system, which creates all the documents and labels needed to deliver Marian fish filets in the same manner as TINE Lettmelk is delivered to the retailers. The basis for these documents and labels are customer orders, where Marian fish filet is kept in the same order form as Lettmelk, but with a different product code and text.

Informing to produce

Information is provided from different sources laying the foundation for production of Marian fish filet products at the Aker Seafoods Hammerfest factory. Information used to carry out production involves the following actors and types of information as shown in fig. 5.21 below:

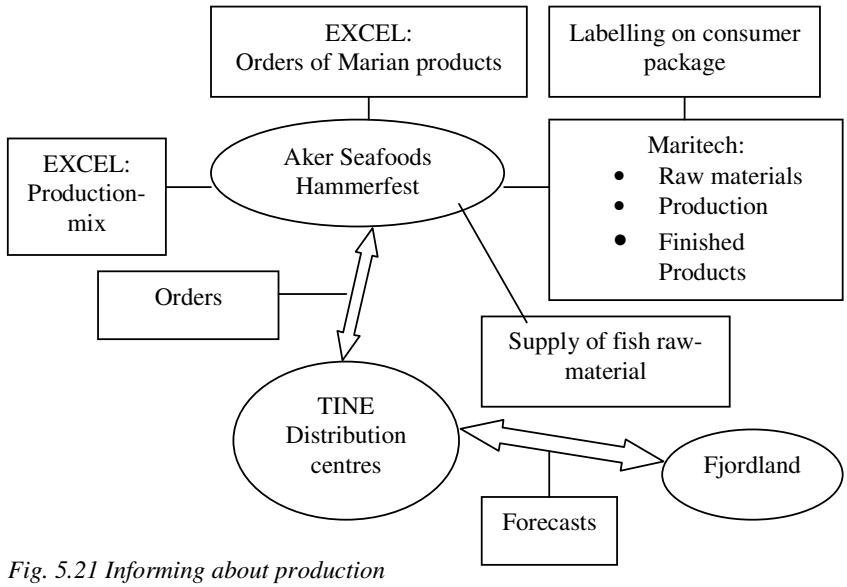

Fig. 5.21 Informing about production

The fish supplied by the trawlers are registered into the Maritech information system. Aker Seafoods Hammerfest receives orders from each of the TINE dairies. The dairies place these orders based on forecasts for each of the Marian products made by Fjordland. This information is registered in an EXCEL data sheet and used to calculate the volume of production of each of

the three Marian products. Furthermore, another EXCEL data sheet is used by Aker Seafoods to calculate the combination of its entire range of different goods produced on that certain day. This system is, however, not used to inform about the planned volumes of the different Marian products, which are thus produced based only on the received orders. The product-mix that is to be produced is then registered in the Maritech information system together with orders for Marian fish filet from the TINE dairies. This system then assigns different types of fish raw material to various modes of production and packing. The Maritech information system accordingly provides information regarding how much and what raw material has been used, how this raw material has been produced, and how much finished product have been packed in various kinds of packaging. The Maritech information system is also utilised to operate the production line that packs Marian products. This line also produces the labels on the consumer packages of Marian products. The Maritech information system is an isolated system and does not register order information from TINE distribution centre customers.

Informing about transport from Hammerfest to TINE dairies

While the catching of raw material and the production of the Marian white fish products are located in Northern Norway, markets for these products are located mainly about 2000 km away, in the Southern part of Norway. Information about this long distance transport is therefore important in order to be able to supply customers. The following actors and information are involved in informing about transport Marian fish filets from Hammerfest to the TINE distribution centres as shown in fig. 5.22 below:

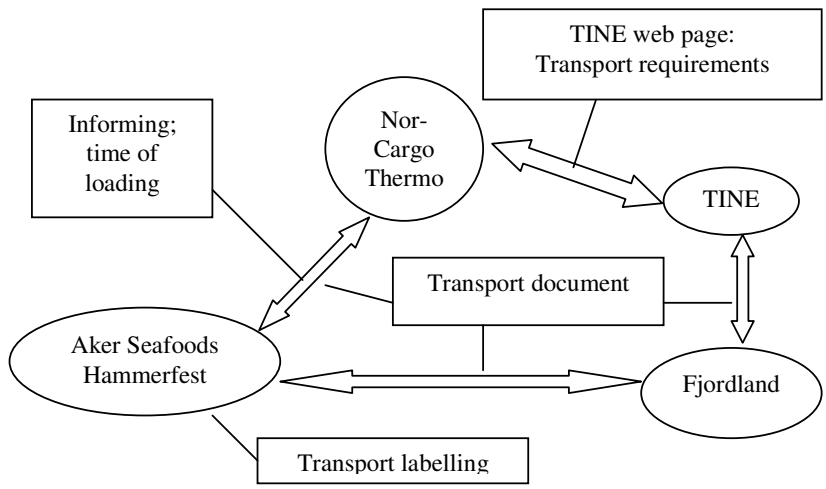

Fig. 5.22 Informing about transport from Hammerfest

Aker Seafoods Hammerfest uses one of its EXCEL data sheets to register information regarding the orders of each Marian product to each of the 23 TINE dairies that function as distribution centres. This EXCEL sheet calculates the number of Gilde meat containers needed and how many pallets of Gilde meat containers are to be sent to each TINE distribution centre. A paper copy of this EXCEL sheet is made and provided to the terminal workers handling the finished Marian products. Based on the EXCEL data sheet, transport labels are created manually using the data screen. The consumer packages are placed into labelled Gilde meat containers, and Gilde meat containers are placed onto labelled pallets in accordance with this information. At the same time, a transport document is created. This document is also sent to Fjordland in Oslo where this information, together with other transport information, is entered into TINE's web-based information system. Nor-Cargo Thermo must access TINE's web-page daily themselves to receive orders regarding transport services needed from them. Based on this information, Nor-Cargo Thermo in Hammerfest plans the loading and transport of its trailer from Hammerfest to Oslo. When Aker Seafoods reaches the end of the daily production of Marian products a call is made to Nor-Cargo Thermo's representative in Hammerfest requesting that a trailer come to pick up the goods at an agreed-upon time. When the goods have been loaded onto the truck the driver is handed a transport document that he/she signs and brings with the goods to the Nor-Cargo Thermo terminal at Skårer. When the goods arrive at the terminal facility, information provided from TINE's web- page regarding the distribution of its various products is used to handle the Marian products from Hammerfest, together with other TINE products. New transport documents are then provided for transport to different TINE dairies. The labelling on the distribution and transport packaging remains unchanged.

Informing about the product by the retailer

Informing about Marian fish filets at the supermarket involves the following actors and information shown in fig. 5.23:

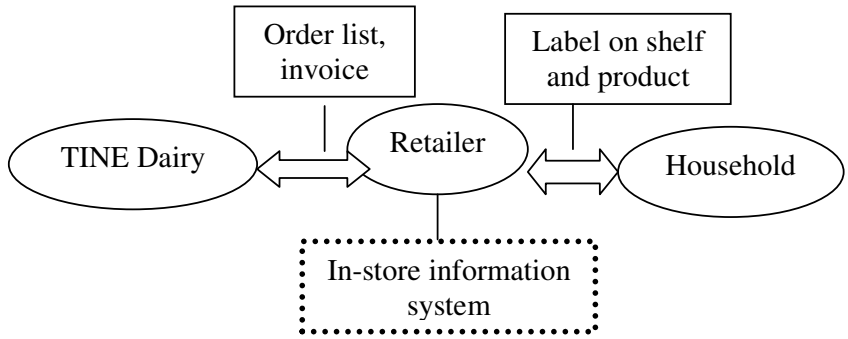

Fig. 5.23 Informing about Marian fish filets at a supermarket

Marian Fish Filets arrive at the retailer facility together with TINE Lettmelk and are received in the same manner using a common order document. The Marian products are then moved into the store display area. When Marian products are purchased, it is registered in the store computer system, and the need for stock replenishment is carried out manually in the same manner as for TINE Lettmelk. Marian products are displayed with a label reading the name of the product and price on the shelf or inside a counter of the refrigerated area. The consumer selects the product based on this label, together with product information on the consumer package label. Marian Fish filets are displayed in the store together with a wide range of other fresh meat, poultry and fish-based products. Marian Fish filets is a new product choice, and informing the consumer is therefore important as regards sales to households.

5.3.6 Tracking and Tracing Marian Fish Filets

This part starts with a description concerning when and how Marian fish filets are tracked, followed by a description of where, when, and how Marian fish filets are traced.

Tracking goods
The following figure 5.24 shows the main actors and information facilities used to track Marian fish filet:

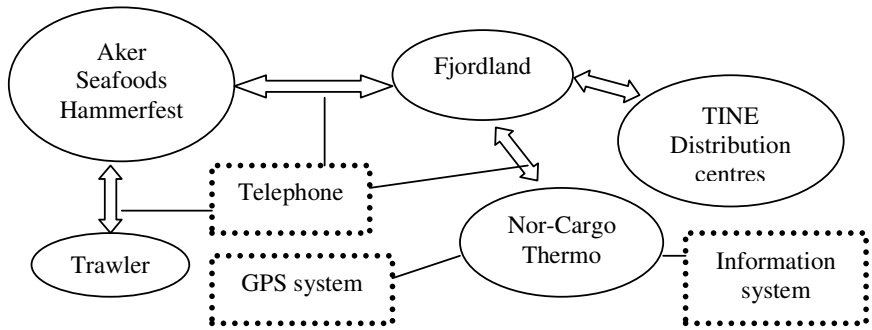

Fig. 5.24 Actors and information involved in tracking Marian fish filets

Tracking goods may already be carried out at sea. When Aker Seafoods Hammerfest telephones the trawler asking about the volume and types of fish that are caught, it may be regarded as a form of tracking. This is a form of tracking used to coordinate production, and this information may be handed on to Fjordland upon request if they ask about the possibilities for meeting order requirements in volume.

Since Marian fish filet has only recently been introduced to the Norwegian market, there was at the time of this study no experience regarding tracking this specific product. This part therefore describes possible incidents based mainly on experiences Aker Seafoods has had with its other products.

If products are missing upon arrival at the TINE distribution centres the location of these goods will be tracked and this information then communicated to Fjordland, either by telephone or e-mail. Fjordland, in turn, will then telephone a query to Nor-Cargo Thermo asking where the goods are and when they may be expected. Nor-Cargo scans all its goods upon arrival and departure at the Skårer terminal, and therefore knows when the goods have been registered there. If the goods have not yet arrived, GPS and mobile phones may be used to locate the trailer carrying the product. If the trailer has experienced difficulties during transport from Hammerfest to Oslo, this will usually already have been reported and registered in the information system of the transport firm.

The transport from Hammerfest to Oslo is long, and during winter, transport along this route may be problematic do to weather conditions. The truck may also experience accidents, mechanical problems, or illness among the

drivers. If Nor-Cargo Thermo mishandles Marian products they may be wrongly located on another vehicle, and this truck must then be tracked. When this information is provided to the key account manager for the TINE account at Nor-Cargo Thermo, she or he may then let Fjordland know the location of the goods, who again informs the TINE dairies.

Tracing products

The following figure 5.25 shows the actors and information facilities used to trace Marian fish filets:

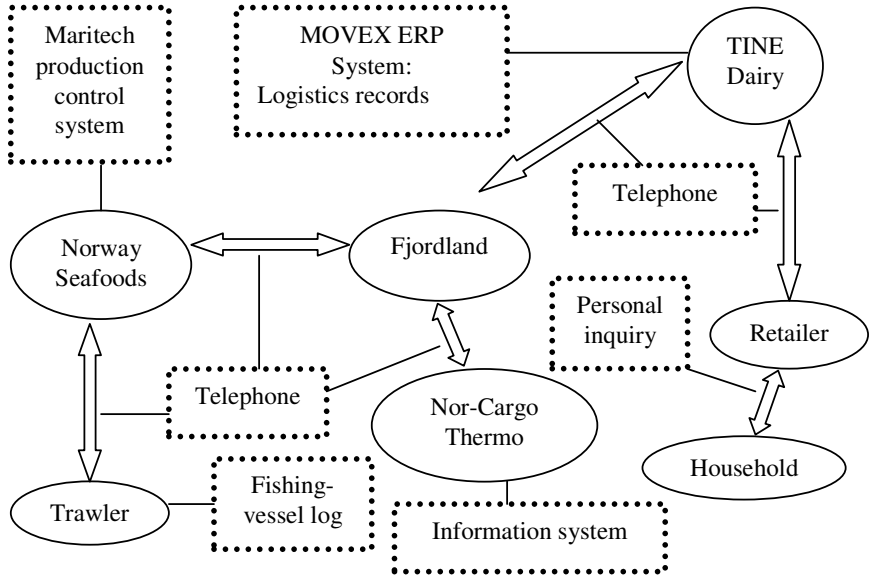

Fig. 5.25 Actors and information involved in tracing Marian fish filets

A limited amount of product information follows Marian fish filets downstream through the flow of goods. This information may be provided through documents and on labels carried by the packages at the same location as where the goods are located. This information is previously described and used to transform the goods through logistics activities. If more detailed product information is needed, the person tracking the product will try to obtain this through the actors in the supply chain thought to be able to provide it.

Since Marian fish filets are new products there is no practice regarding how it is traced. Tracing may be done by locating and communicating to actors upstream in the supply chain until the necessary information is provided. Tracing Marian fish filets is then facilitated by telephone. This involves locating the actor who has the necessary information asking him or her to document the necessary product characteristics. This is because information regarding the flow of Marian fish filets is registered in different information systems that do not automatically communicate with each other.

At the TINE dairies, information regarding the transport and handling of Marian Fish filets may be accounted for using the MOVEX ERP system. The state of Marian fish filets is registered here upon arrival at the distribution centres and registered as delivered at the retailer facility. The main type of information provided by the system is the time and location variables of the goods when operated by the TINE dairies. Information regarding the goods' temperature must be sought manually by accessing containment (transport, terminal and storage) facility temperature logs.

Nor-Cargo Thermo may provide information from their information system by accessing temperature logs of the truck storage compartments and the time used for transport. The trucks carry a GPS system allowing for on-line control and adjustment of the storage temperature in the trailers' up to 4 different compartments. However, this information is registered only on board in the truck log. This logged information is stored apart from Nor-Cargo Thermo's information system and must therefore be manually accessed upon request. Information regarding loading and unloading and transit handling information from the Skårer terminal is stored in the information system based on registration when the bar-coded labels on packaging are scanned.

Aker Seafoods may provide production information based on production records registered by the Maritech information system. At present, this system provides product traceability based on the consumer package label. On this label, the exact time of production on a specific production line at Aker Seafoods is described. It is possible to trace the fish back to its state as a raw material in the fish tub prior to being placed into production, by using the Maritech information system. In addition, this system accounts for how the fish has been transformed during production, the persons involved in this process, and the time used.

The consumer package label contains information regarding the country of origin and the lot number. This lot number is used by Aker Seafoods Hammerfest to first determine the trawler that caught the fish. It may then

be compared with the trawler log and based on the information on the catches of fish registered, the area, and date where the fish used in the specific product was caught. A map is used to determine the sector and sub-sector where the fish is caught. However, the borderline between these sectors are of limited value since fish migrate or move between sectors and the sea is a liquid substance that is not contained within a sector.

Aker Seafoods had one incident last year in which another of its products, due to a product discrepancy, was traced to their facility. The detection of this mistake involved also tracking other goods produced from the same batch, and having these products disposed of. This incident is comparable to what potentially could happen if a retailer was to discover a problem with the quality of Marian fish filets.

Part Three: Analysis

This part contains the analysis and concluding discussion regarding the findings of the case studies. The four product cases have described the distribution of four different fresh food products. These products have similarities regarding both the limited time frame in which they are distributed as well as unexpected variations in supply. As for seasonal importance, this only impacts to a considerable degree on the distribution of Corona strawberries. This part focuses on analysing the use of the package as an information resource based on the preceding case narratives regarding the distribution of these products.

This use will therefore be analysed based on empirical data regarding the distribution of perishable goods where supply is prone to some degree of unexpected variation where distribution frequencies have a tendency to increase in the downstream part of the supply chain. First, in Chapter 6 through 8, a more detailed analysis of the provision, transformation, and use of information related to the package is given and is followed by a concluding discussion in Chapter 9.

- **Chapter 6:** Focuses on the interplay between goods, packages, and information. This analyses the provision side of the package as an information resource.

- **Chapter 7:** Concerns how the package plays an interconnecting role between the transformation of goods and the transformation of information.

- **Chapter 8:** Is about the use side of the role of the package as an information resource involving the adaptation of information to different user needs.

- **Chapter 9:** Consists of a concluding discussion regarding three key overall aspects of the role of the package as an information resource that have emerged through the course of this study. The chapter also suggests some paths for further research related to this issue.

6. Using the Package to Provide Information

This chapter discusses, based on the empirical part, how a package, together with other resources, is used in combination to create information about goods. This combining of resources through the package involves highlighting how the two communicative functions of the package as an information carrier and information source together contribute to the provision of information to various actors in the supply chain. The chapter is divided into four sections, starting with Section 6.1 discussing how the package interplays with goods, while Section 6.2 concerns how the package interacts with information about combinations of packages and goods. In 6.3, a discussion is provided of how the package is used to describe goods and identify goods. This involves how the two communicative functions of the package as an information carrier and information source are interrelated.

The discussion in this chapter is based on an understanding that has evolved through this study, that the package is an intermediary resource that links goods with information. When focusing on the use of the package as an information resource, the interplay between packages and goods functions to characterise goods while the interplay between the package and information is used to identify and register logistics units. This view of the package as an information resource is shown in the figure 6.1 below:

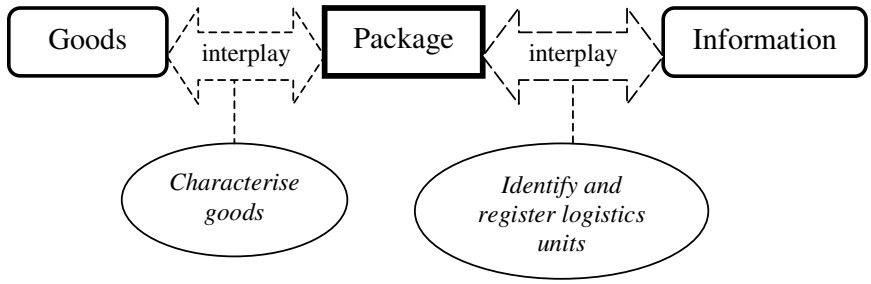

Fig. 6.1 The intermediary role of a package as an information resource

Characterising goods involves not only describing the form features of goods, but also includes describing features of packages used to contain goods. The identified package entity is a logistics unit. This is the outer layer of packaging discussed in Section 2.3 that is visible to personnel and used together with goods identification devices. This interplay between goods and the package is the basis for characterising features of goods through the

logistics unit and involves the communicative function of the package as an information source. The other interplay in figure 6.1 between packages and information involves identifying and registering goods into an information system, an activity often involving the use of labels or tags, and is therefore related mainly to the communicative function of the package as an information carrier.

6.1 Goods and Packages

This section places focus on how goods and packages are combined. The influence of specific features of goods discussed in Section 2.3, and how they are contained in packages are analysed. The reason to account for this aspect of goods in a supply is that this involves analysing more specifically how product features may influence the use of the package to carry goods, which later again may influence how goods are informed about. This informational aspect of how packages carry goods is considered in the following section 6.2.

First, the physical features of goods regarding the degree of technicality, bulk, perishability, and how goods are combined with other types of goods are discussed. These features were discussed in section 2.3.2, as influential in relation to packages. Then, after this analysis, the use of the logistics unit to combine goods and packages at different packaging levels is analysed. This involves discussing how the interplay between packages and goods relates to the issue of characterising goods. The physical features of the package, combined with features of goods, are viewed as influencing the provision of information in a supply chain.

6.1.1 Technicality of Goods

Technicality is about features of the technological complexity of the product (Stock and Lambert 2001). The studied fresh food products are organic products whose aim is usually to have their natural form features preserved when taken out of their original environment. Production influences the degree of technicality of goods since this activity transforms features of materials. In many cases, production also involves the packing of goods. Goods' features primarily influence how products are packed in consumer packages, the packaging level generally used to contain the material features of the goods. TINE Lettmelk and Marian fish filet are two products that have undergone production that transformed mainly their form features. Dole bananas undergo production in the ripening facility that physically does not intervene with the materials contained in the banana boxes. In the case of

Corona strawberries, harvesting and packing the goods are the only form of production activity that is accounted for. The studied goods are, with the exception of DOLE bananas, packed in consumer-level packages more directly adapted to the technicality of the goods than other packaging levels.

All the studied products are highly vulnerable to quality deterioration through environmental influences; this may be regarded as one aspect of the technicality of these goods. The Marian fish filet case shows how a technically advanced form of consumer packaging plays a vital role in protecting a technically less complex material. Therefore, consumer-level packages play an important role in protecting the types of goods that have undergone production. When the technicality of foods is increased by production, it may change the vulnerability features of goods to environmental influences and increase the importance of the role of packaging to protect these goods.

The borderline between consumer packages and goods is vague in the three cases where this form of package is used. Consumer packages may in many cases be regarded as part of the product itself. It is the use of the plastic basket to contain Corona strawberries that transforms this raw material into goods that may be distributed and a product that may be marketed to an end-user. The combined technicality of goods and consumer packages influence how goods are contained in distribution- and transport-level packages. Consumer-level packages may, accordingly, be regarded as playing a "buffer" role between the material aspects of goods and the outer levels of packages and goods containment facilities.

The two mainly physical functions of packaging, protection, and utility, influence how distribution and transport packages are used to contain consumer packages. Bananas demand specially adapted banana boxes since they are not contained in consumer packages, while the other goods may rely on more generic forms of outer-level packaging. In the case of roll-rack containers having a standardised shape that efficiently contain cartons of TINE Lettmelk, this is adapted to fit in a range of different goods containment facilities and be wheeled manually from facility to facility. 12 baskets of Corona strawberries fit perfectly into the applied size of the IFCO crate, and these crates are in size and weight designed to accommodate manual stacking. The stacks of IFCO crates are combined with a perfectly fitted EURO pallet to create a logistics unit. The pallet, in turn, is modified to fit into a certain size containment facility and adapted for use by forklift equipment. The containment of goods in consumer packages, therefore, also facilitates the protection of goods in distribution and transport-level packages. Hence, consumer level packages are viewed as buffers between

goods and outer layer packages, influencing the suitability of combining different types of packages.

Technological complexity of goods includes both the technical aspects of the physical features of goods and packages used to contain goods since the borderline between goods and packages is regarded as unclear. Technicality is closely interrelated with the different physical functions of the package, primarily the protection function. Protection is provided through the basic packaging of the goods, and how they are contained also influences their technical complexity. In addition, through their technicality packages influence utility by how they are combined with each other and with features of different logistics facilities.

6.1.2 Bulk of Goods

"Bulk" is used here in accordance with Stock and Lambert's (2001:83-84) classification of product characteristics to describe the size and shape of goods, including value features. The degree of bulk shows how much space a logistics unit demands in a containment facility measured in relation to its value. TINE Lettmelk is a low-value, heavy liquid material that must be contained in some form of package. Marian fish filet and Corona strawberries are lightweight materials and relatively high value goods, considering they are food products. Dole bananas is a premium grade product, but bananas are generally of a relatively low value. They are moderately heavy, demanding much space compared with other goods, as they are a high volume BAMA product . Also, consumer-level packages apportion products influencing how packages are used to divide the goods into logistics units employing distribution- and transport-level packages. This is most apparent in the case of TINE Lettmelk, which is offered in a range of different sizes adapted to customer needs. The bulk of goods are influenced by a combination of goods and package form and value features, since the degree of bulk at the consumer-level is, in part, a result of the size of the packages and smaller package sizes usually are higher priced than the larger ones.

Since the shape of packages, together with form features and the value of materials contained in packages, distinguish the bulk of goods, bulk influences the use of logistics facilities such as storage compartments, forklift trucks, conveyor belts, and temperature-regulating machinery. There is a need to economise the handling of goods since all the studied fresh food products are high volume, low value products. Distribution-level packages containing goods must have shape, size, and weight features adapted to manual handling. Corona strawberries are manually harvested, placed into

baskets and then into IFCO crates that must be lifted and stacked at several different locations on the farm. TINE Lettmelk in its raw-milk form is stored in tanks; the size of the tanks may be large since pumping equipment is used to transport liquid material making the handling of large volumes an easy process.

In all the cases, distribution centres and retailers rely on extensive manual handling of logistics units. Therefore, the number of consumer packages contained in the distribution units is limited by the size of units that must be handled manually. The form of packaging used is also dependent on the weight of the material since the outer-layer package structure must be strong enough to carry the goods through varying degrees of "rough" handling and transport. Packaging must also be adapted to storage facility features like refrigeration devices. In the case of Corona strawberries, IFCO crates, which are made from a strong plastic material, also provide protection of the goods; their grid design facilitates the beneficial use of cooling equipment in storage and transport facilities. The banana box, a common cardboard box with holes on it sides and adapted to transport and banana ripening facilities, fits on standard pallets. It is only the holes that actually discern this box from other distribution-level package forms.

With the exception of Dole bananas, distribution and transport packages have, in the studied cases, a form that is used to contain a variety of material structures. The cases do not indicate whether the value of the goods influences how goods are contained in outer-level packages. The IFCO crate is designed to contain the relatively more valuable Corona strawberries, as well as most forms of other fruit and vegetable products. The value and purpose of distribution as related to the logistics unit lie mainly in the goods, while the role of the packages is to contain this valuable material in a cost-efficient manner. Marian fish filet is an exception here, since the consumer-level packages used increase the value of these goods more distinctly than that of the other products, through facilitating a longer shelf life. Therefore, it is primarily the use of consumer packages that represents a potential for influencing the bulk of goods. Hence, product characteristics, including features of consumer-level packages, are used to account for the basic features of the bulk of goods. Distribution- and transport-level packages mainly reflect the core feature of combining goods the same or different types of goods influencing the bulk of a logistics unit. In the cases regarding distribution of fresh foods, the characteristics of logistics units include the value and form features of the goods contained in the packaging. The degree of bulk is, accordingly, measured mainly as a combination of goods and package features.

6.1.3 Perishability of Goods

Perishability involves how time reduces the quality of goods. Fresh food products are in general more perishable than most other types of products. The studied goods have a short durability, ranging from 24 hours for Corona strawberries to 3 weeks after harvest for DOLE bananas. The colour of the Dole banana peel indicates its freshness. The banana peel is described as a form of natural consumer-level package, a containment form that changes over time. Corona strawberries, with a very short durability, are contained in simple plastic baskets that allow for display and ventilation of the goods. IFCO crates carrying baskets of strawberries are also designed to make provisions for the necessary ventilation of many other agricultural products as well.

At the consumer package level, the Marian fish filet package helps prolong the life of the product TINE Lettmelk cartons do not influence the durability of the contained material. The grid-like construction of the roll-rack and IFCO crates allows for ventilation of the contained material when placed in temperature-regulated facilities. At the consumer level, the package form may be adapted to influence durability of the material. At the distribution level, the package form and materials used to produce the package are, to a limited degree, adapted to facilitate temperature control within goods containment facilities. Time-wise, consumer packages therefore influence the degree of perishability of a product more directly through what kind of material they contain. Distribution- and transport-level packages mainly influence perishability through protection and ventilation of unpacked or consumer-level packed goods when placed in temperature-regulated facilities. The perishability of goods is thus characterised by a combination of goods and package features. The physical features of different packages together with features of goods combined into logistics units influence the degree of perishability.

6.1.4 Combination with Other Goods

Products are, in most cases, distributed together with other goods in at least part of the supply chain. As discussed in Section 2.3, the width and depth of the product line influence the number of closely related goods that are distributed. This, in turn, influences the complexity of logistics activities through an increase in the number of logistics units that need to be handled in the flow of goods. Some supply chains, such as the flow of bananas, consist of banana boxes containing only the same type of Cavendish bananas until the goods reach the Norwegian distribution centres, while Marian fish filet is combined with other goods through the entire scope of this flow of

goods. A common feature of all the cases is that as goods approach the retailer, the number of different kinds of goods that are combined increases. The presence of different goods at various facilities influences how they are contained in packages and how they are handled.

This increase in complexity represents an example of a conflict between marketing and logistics aims regarding the flow of goods as discussed in Section 2.1.3. Different varieties of products may be created for marketing reasons. These products may seem similar but are often discerned from each other by slight degrees of variation in the materials used and consumer packaging features. The consumer-level packages are used to differentiate products within a common product line. TINE Lettmelk is distributed in a range of different package sizes and is, in addition, one of many different milk products that include an extra light type of Lettmelk with lower fat contents. Other varieties of milk include flavoured milk, whole milk, and cultured milk. All these products are offered in different consumer-level package forms. The 1-litre TINE Lettmelk carton is the most used form of consumer-level packaging to contain different TINE milk products.

Bananas are cut into bunches when packed in Costa Rica, each bunch containing a number of fingers. These Cavendish type bananas may be sold as a single finger or as a set of fingers; the consumer breaks off the number of fingers wanted when purchasing bananas in the store. Discounted, consumer-packed bananas in 1-kilo plastic bags are supplied by a competitor of Dole's and distributed through BAMA to the same retailers that market Dole bananas. Here, the consumer packaging contributes to distinguishing this product from Dole bananas, thus helping retailers differentiate price when purchasing the product. The minimal use of different consumer-level packaging of bananas reduces the strength of the product line, since, to the consumer, unpacked bananas are not obviously discernable from other products. The extent of the banana product assortment is influenced by the cultivation of alternative banana species and is limited to a small range of bananas for cooking purposes and baby bananas.

Corona strawberries are supplied in one standard 500 gr. consumer package size. However, other types of berries may be supplied in the same type of plastic baskets, while the consumer packages used for Marian fish filet are unique to this product. In addition, Marian fish filet itself represents a choice of three different white fish material types: the "Steketorsk", "Koketorsk", and "Seifilet" products. A consumer is unable to discern these products from one another without the help of the packaging. To the consumer, trays of Marian fish filet also resemble the packages used to contain a range of other fresh fish, meat, and poultry products. The shape of this consumer package,

therefore, does not contribute to differentiating these goods from others. Labels are necessary to tell these and other types of products apart in the retail environment. When the type of goods is visually discernible to the consumer through the design of consumer packages, it also helps end-users distinguish different products from one another. Alternatively, when the contents are not in clear view, the consumer packages must carry labels, as is the case with TINE Lettmelk, Marian fish filet, and Dole bananas.

At the distribution and transport level, the different product varieties are grouped into separate distribution packages, and these higher levels of packages are, to varying degrees, adapted to the different package sizes. In the case of TINE Lettmelk, the roll-rack is designed to contain 1-litre Pure-Pak cartons. The more recent 1½ litre carton is also adapted to fit the roll rack container, while the other sizes are less well fitted to the roll rack. Different forms of consumer packages are used to increase mainly the selection of a product offering, while variations in the material form of the product, combined with the use of different consumer package forms, influence the scope of the product assortment. The use of a large range of consumer-level packages also increases the complexity of combining and stowing these goods into distribution-level packages. Roll-racks are distribution-level packages that are used to contain an assortment of products, facilitating their distribution from TINE distribution centres to retailers. At BAMA, pallets are used to contain a variety of distribution-level packed goods.

When different types of goods are combined at logistics facilities, it increases the number of packages that have to be handled. This issue involves both marketing and logistics aims. Some degree of conflict may be encountered here concerning how to reach the aimed for efficient distribution when it comes to providing the extent of product lines marketing managers perceive demanded by consumers. In addition, different types of packages have to be combined with others, which is especially pertinent further downstream in the flow of goods. An increase in the number of different types of goods that are combined at logistics facilities increases the complexity of logistics activities. More types of goods that may have different handling requirements need to be identified and controlled. It is therefore essential that packages facilitate the differentiation of goods. Also, different goods being contained into a logistics unit increase the complexity of this unit.

6.1.5 Packaging Levels and the Logistics Unit

A logistics unit is here understood as combining goods with different packages at different levels. The logistics unit plays a vital role in the supply chain as a facilitator for goods' identification. Accordingly, the logistics unit represents the link between the information system and the flow of goods. The interplay between packages and goods in the logistics unit is described principally as a *"Pandora's box"*. This Pandora's box consists of goods at the inner core, followed by the consumer-level packages as the inner package form, distribution-level packages at an intermediate level, and transport packages usually at the outer level. In most cases, the transport level packages, such as pallets of goods, function as a logistics unit. Sometimes it is difficult to classify the package level, for instance the case of roll-rack containers, since products are often packed directly into these package forms. In other cases, intermediate distribution package forms, such as trays and boxes, are used.

The description Pandora's box is not completely appropriate, since, while the toy contains one box placed within another, each level of packaging used usually contains a set of packages at a lower level placed in containment facilities as described in fig. 6.2 below:

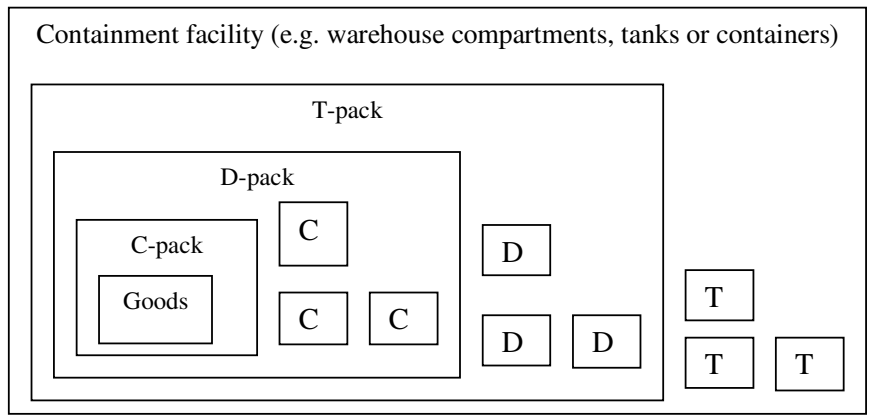

Fig. 6.2 Packages containing goods at different levels

Based on fig. 6.2, a logistics unit may be constructed in a variety of ways by combining several numbers of packages at different levels of goods. A logistics unit is the entity that is handled with relation to logistics activities. In principle, a logistics unit may be a single consumer package. In most of

the described cases, however, the logistics unit is a form of transport package, such as a pallet or a roll-rack container, containing a number of distribution packages.

While packages function primarily to protect the contained goods, it is more accurate to use the term “logistics unit”, rather than “packages”, to describe the entity that provides utility regarding logistics activities. This is because the logistics unit is a specific type of package that plays the role of identifying goods and is characterised by the outer layer package used in different logistics facilities. Various types of containment facilities, such as packages and storage tanks, are described in the cases. Both raw-milk tanks and logistics units have in common that they are not bound to a specific place. However, while a raw-milk tank contains a variable amount of goods, packages, and therefore also logistics units, usually contain standard volumes of goods. The weight of a pallet of bananas may be measured by multiplying the standard amount of 48 banana boxes on a pallet with the average weight of each box.

The interplay between product features and packages determines how a logistics unit is created in a specific manner, influenced by features of the goods they contain. A logistics unit may therefore be regarded, not only as a type of packaging used to identify goods, but also as having an additional role in the utility function of packaging.

Features of goods regarding technicality, bulk, perishability and combining with other goods also influence the use of packages in a supply chain. The technicality of packages, combined with the technicality of goods, facilitates the creation of a logistics unit. Bulk is related to the shape and value of the packages and influnces how goods are handled in relation to facilities. Perishability has an impact on the time the logistics unit may remain in the chain and the time used in relation to various logistics activities. Combining different types of goods in a logistics unit, increases the complexity of identifying goods impacting thereby also on logistics activities. Together, these factors (technicality-bulk-perishability-combining with other goods) influence how goods are transformed in a flow of goods.

Since it is logistics units that are identified and registered into an information system, these units represent the link between the information system and flow of goods as discussed in Section 2.3. Therefore, when *characterising* goods, the logistics unit is the form of goods that is first accounted for. Characterising goods may thereafter resemble peeling an onion, uncovering features of the different layers of goods. While an onion layer is a single entity, each level of packaging, however, reveals a higher degree of

complexity, since a logistics unit may consist of various types of packages containing different types of goods within each "layer" of packages combined at the same level. For instance, a roll-rack containing a variation of goods is the package form primarily received at the retailer's from a TINE distribution centre. Within this roll-rack, a tray of TINE Lettmelk, a number of consumer-packed Marian fish filet, and other consumer- and distribution-level packed goods are combined which increases the complexity of characterising identified goods. The contents of a logistics unit are controlled by comparing the received goods with their descriptions as provided through an information system based on plans and orders. The logistics unit, therefore, plays a core role in first identifying, and thus facilitates also characterising goods. This leads to the next phase concerning how the package more precisely interplays with information.

6.2 Information and Packages

This part moves the focus to the interplay between packages and information. While the preceding Section 2.1 discussed features of the interrelationship between packages and goods involving how goods are characterised, this section places focus on how goods are identified and registered through packages. As described in fig. 6.1, the outer layer of the goods represented by the logistics unit is visible to supply chain actors and is therefore the identified entity in the flow of goods. This section discusses how the identification of goods involves a combination of features regarding information contents, information carriers, documents and labels, and the information system. These characteristics of information are here discussed sequentially.

6.2.1 Information Content about Goods

Information content is, in accordance with Kogut and Zander (1992), viewed as facts regarding the physical properties of goods and packages, combined with facts regarding their time and place features. This type of information content may be provided through identifying goods in the supply chain or be based on information provided through orders and forecasts. Information concerning goods is regarded as a core element since descriptions of the type of goods and packages are the information elements that, together with other facts, provide complete information about products. The reason for combining various kinds of information on goods is to be able to provide information that is adapted to user needs. This aspect of informing about goods is discussed more thoroughly in Section 8.3. For instance, simply describing goods would not enable an actor to carry out logistics activities.

Information about the form features of goods must therefore be combined with information regarding how goods are to be transformed through activities, where goods have been and are at present supposed to be, and the destination of the goods. These location features are also described with regard to time.

Packages play a vital role in providing a description of products. When e.g. TINE Lettmelk has been packed into 1-litre PURE PAK cartons it is transformed into a "product". This product may then accurately be characterised by a specific volume determined by the standardised type of consumer packages used. Additionally, this type of package has form aspects that also are part of the overall product type. When TINE Lettmelk is placed in roll-rack containers, it gives the product a logistics role naturally denoting TINE Lettmelk as "goods" rather than products. In the case of TINE Lettmelk, the logistics unit consists of trays of milk and roll-rack containers. Information directing this flow of goods is no longer about the 1-litre PURE-PAK cartons, but about roll-rack containers carrying this type of goods or products. The product plays a sublime physical role as a part of a logistics unit; this is evident since it is primarily the roll-rack logistics unit that is reported on in connection with logistics activities. Informing about logistics units of TINE Lettmelk also involves whether only TINE Lettmelk is contained in a specific roll-rack container, or this container carries an assortment of products.

The product retains one important role when it comes to informing about goods; this involves providing a *name* used to classify different types of goods. Describing TINE Lettmelk as a logistics unit, accordingly, involves combining the product name with a description of the goods contained in the packages. The package here contributes to characterising the features of the packed goods (weight, volume, size, overall shape) and how a logistics unit consists of a combination of different packages containing goods. This role is related to the communicative function of the package as an information source.

6.2.2 Information Carriers

Information contents are stored and communicated through texts, numerical codes and symbols. These are, consistent with the discussion in Section 2.3, termed information carriers. Several of the cases show how GS1 codes play an important role in facilitating the provision and use of information about goods. GS1-based numerical codes are widely used in the cases to identify products and goods. Codes are commonly used throughout the supply chain; hence, they represent a kind of unifying technical language. In the studied

cases, the application of GS1 codes is shown as used on consumer-level packages of Marian fish filet and TINE Lettmelk. Pallets and boxes of Dole bananas and Marian fish filet use GS1 transport codes in their labelling.

In some of the product cases, numerical codes are not used on the labels, leading to increased manual handling of the identification of these goods, such as when Corona strawberries and Dole bananas are registered by the cashier at a supermarket, and when IFCO crates of Corona strawberries or roll-racks containing only TINE Lettmelk are identified. The numerical code may be used to provide other information such as descriptive text and numerical data related to manual handling procedures. Text found on consumer packages is used to inform and influence the consumer; a numerical code is incomprehensible to him/her. Text also accompanies codes in documents used in orders, transport, and picking goods.

Bar codes on labels based on GS1 numerical codes are used when goods are registered or assigned, permitting an increased level of automatic information processing and exchange. This is evident when Nor-Cargo Thermo scans goods, including Marian products, when loading and unloading its trucks. The only manual handling involved in this identification process is when moving the goods into a visible range of the scanner, and when controlling the information on the barcode with documents, verifying that the right goods are in the right place at the right time according to distribution plans. When bar coded labels on goods or products are scanned they are automatically registered into an information system. Text is then used to facilitate manual communication, as numerical codes are less comprehensible without additional information or mechanisms to translate them into text. Retailers order a large number of products every week and have limited time to learn the codes used for each product. Texts are therefore used when the information is read manually; a barcode is used with a reading device. Based on this registration a text may be provided in a document, either electronically or in paper form, for manual reading.

Of the studied products, only Corona strawberries are not labelled using codes. When retailers order Corona strawberries they do this based on Corona strawberries having a GS1-based code within the BAMA information system. It is not possible to control goods automatically through identification since the label on the IFCO crate does not carry the same code as the documents. Therefore, Corona strawberries must be registered manually. Based on this registration the data may be interpreted into codes allowing for automatic exchange of information within BAMA's OLFI and LORRY information systems. Symbols printed on packages are to a limited degree accounted for in the cases, mainly in combination with texts in

company logos. This is most evident on consumer packages where symbols are used in the print design and the design of the labelling used.

Bar codes depend on electronic devices to scan and communicate information about the goods. Both texts and bar codes are used, together with printed numbers, to provide complete information. Texts facilitate manual exchange of information, and numerical codes help specific numerical aspects such as weight and volume of the goods. The use of GS1 codes as an information carrier allows information to be processed and communicated automatically in an information system. At the same time, information about goods still needs to be exchanged manually between actors using texts. The dual aspects of using standardised information carriers, either in manual or more automated communication about goods, are shown in fig. 6.3 below:

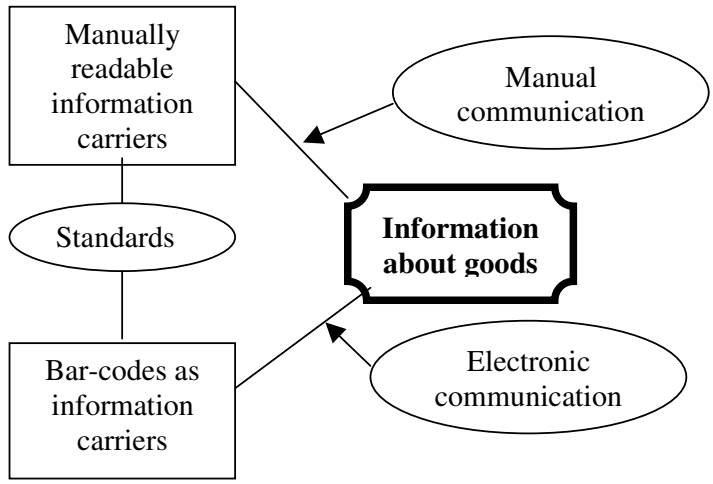

Fig. 6.3 Information carriers used for manual or electronic communication about goods

6.2.3 Documents and Labels

Documents are used to organise information contents provided through information carriers. Documents containing information about goods are adapted to different user needs and involve information about how to carry out different logistics activities, track goods, trace products, and how to

market goods. Documents represent the media form that links data from an information system to its use as information by actors.

A label also represents a form of document. The reason to use the label is that this document form is vital when it comes to identifying goods through a logistics unit. A “label”, therefore, denotes a document attached to the package while “documents” (used here as a device to classify types of information) denotes all other forms of documents. The label has two aspects related to time. First, it needs to be created and attached to the package. Later, this label is used to identify goods by controlling documents with the previously attached label. At a sort, documents and labels are created and used to assign goods downstream in the materials flow, thus also transforming the goods. Documents and labels interplay when goods are controlled.

When goods are identified information contents on the label are compared with information contents in the document. If GS1 codes are used, the information may be bar-coded allowing for a higher degree of automated control of goods. A label containing an SSCC GS1-based code provides a logistics unit with a unique identity that lets documents be identified more precisely. In addition to eliminating human error that may occur when identifying goods manually, the use of GS1 codes increases the speed of identification and registration into an information system, which, in turn, increases the level of precision regarding informing about goods. When a package is identified, it receives a unique identity that may be related to other types of information, such as product name and description and time and place features of the goods. This improves the capacity to control the transformation of goods in a supply chain accurately.

In some cases, goods are not identified through the use of labels. Then the registration or counting of the packages is the only form of identification. Corona strawberries are identified when they arrive at the distribution centres and Dole bananas arriving at the Dole terminal in Hamburg are controlled by a count of pallets and possibly also distribution packages. Banana boxes, although they are labelled with GS1 transport labels, are not identified through the use of labels. When a label does not support the identification of a unique entity, such as when using SSCC codes, or the goods are unlabeled, the goods should be regarded as interchangeable when picked up at a terminal or storage facility. This means that when a retailer orders Corona strawberries, the IFCO crate that is picked up according to this order may come from any one of the different strawberry producers. When whole containers of TINE Lettmelk are picked up at distribution centre terminals, this product contains mixed goods supplied by different

dairy farmers. Even if the goods may be identified precisely, they are picked up at the terminals according to volume rather than unique entities that might have been made identifiable through e.g. SSCC codes.

A label is an information resource that may potentially be used to identify goods accurately. The most evident use of labelling in the case of Corona strawberries and TINE Lettmelk is identifying the goods when tracing the product. If different goods are combined into a logistics unit, labelling is required. In these cases, goods consist of combinations of different packages, and a transport label containing a detailed list of the different goods is used to control these against the documents. Each logistics unit is different from the other and must be identified accurately in order to have the right goods delivered to the right place.

Grouping the necessary amount of homogeneous packages into logistics units simplifies the identification of unlabelled goods. This is possible, as shown in the case of roll-racks containing TINE Lettmelk, when the volume of goods to be delivered to individual retailers is sufficiently large. Considering goods as interchangeable reduces the need to identify them accurately. This manner of handling is, as shown in the cases, more an exception than a rule, however, for how goods are handled, such as when large volumes of TINE Lettmelk or Corona strawberries have to be handled in a short amount of time. The overall use of labels to identify and discern different logistics units from one another is shown in fig. 6.4 below:

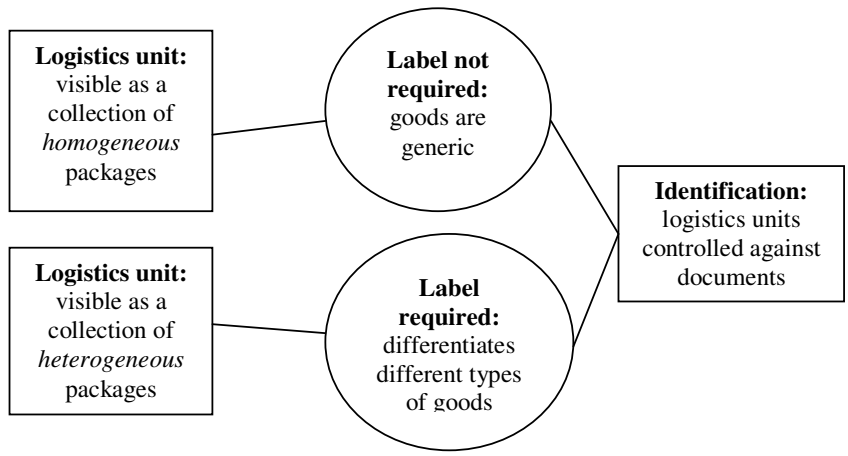

Fig. 6.4 Identification of goods and the use of labels

6.2.4 Information Systems

The information system is the overall setting of the interplay between the three different informational elements (information contents, information carriers, and documents and labels) previously considered in this section. TINE and BAMA have information systems that are vital to the distribution of the four studied products. Information systems used within Nor-Cargo Thermo, Dole, Fjordland, and Aker Seafoods are to a lesser degree accounted for in detail within the case narrative. How goods are distributed is supported by information exchanged in the supply chain where several information systems distinguishable from each other are used.

Within these systems, information about goods is registered, transformed, and provided to information users. Packaged goods are registered in the information system as information contents of goods. Goods are identified as a logistics unit, and this entity is registered into the information system as a combinination of a 1) product name, 2) shape, volume and weight features of packed goods, and 3) time and place descriptions. These elements of information about goods may be electronically registered using GS1 codes. GTIN codes inform about the goods, SSCC about the logistics unit, and GLN about the place features. All these codes may be combined with information relating to time, such as time of past and future identifications and best-before dates of perishable foods.

Corona strawberries and Dole bananas are distributed using BAMA's information system; TINE Lettmelk and Marian fish filet are distributed using TINE's information system. The cases show that the information systems are most integrated between actors operating within a common corporate boundary such as within either TINE or BAMA. TINE uses its relatively advanced MOVEX ERP system, while BAMA uses a combination of OLFI and LORRY EDI systems within its network of actors, including its distribution centres. In the Corona Strawberry case, different modes of information exchange between actors are used to distribute the product, based on the established LORRY and OLFI systems. Other actors that TINE and BAMA maintain business relationships with also have relatively automated systems within their corporate boundaries. This is the case of e.g. retailer groups and individual retailers like Norway Seafoods, Dole and Nor-Cargo Thermo, which have all developed systems for information exchange within the boundaries of these firms.

The degree of automation of information exchange varies within these intra-company networks of actors. While TINE and retailers use a highly

automated ERP system, BAMA uses an older, internally developed EDI-based system, and Dole uses a combination of various rather manual technologies to exchange information between actors in different countries. Information exchange within the supply chain that is seemingly controlled by a "focal" actor such as TINE or BAMA, is relatively more integrated than information exchange between more independent actors. Dole is an exception to this rule since it uses a high degree of manual information exchange between different actors within its information system, for instance when e-mail is used to communicate between Dole in Hamburg and DFFI (Dole Fresh Fruits International) in San Jose, Costa Rica.

The cases show how information in many cases is exchanged using less automated media such as telefax, telephone and e-mail. The use of manual technologies is developed into manual routines with a limited degree of electronic (automated) information processing, as when ordering Marian fish filet from distribution centres to Aker Seafoods, and communicating between DOLE Fresh Fruits Europe in Hamburg with DFFI in Costa Rica and BAMA Trading in Oslo. When the TINE distribution centres send order information by e-mail to Aker Seafoods, this information is electronically stored in Aker Seafoods' computers and has to be retrieved from the computer files.

The Strawberry Team uses a manual information exchange system with a range of different media when coordinating supplies of Corona strawberries with its demand and transport of these products. Within the supply chain, there are "islands" of information systems with relatively integrated ways to exchange information within an "island". Between these "islands" of electronic communication, actors use less automated forms of ICT to exchange information about goods. Therefore, the technologies used to exchange information within the network of actors in the supply chain also seem to some degree influenced by the level of integration between supply chain actors. This is because the highest degree of automation in information exchange is found within BAMA and TINE representing relatively highly integrated corporations of different subsidiary actors.

To be able to automate information exchange between actors in a supply chain actors depend on the use of a common information carrier or "language", e.g. a GS1 code. At BAMA, the product codes are registered within the OLFI and LORRY EDI systems, and in the MOVEX ERP system used by TINE. These information systems combine various types of information, including information about the goods, in order to assign the goods to activities that transform their condition in time, place and form. The extensive use of standardised codes as information carriers helps facilitate

the use of more automatic communication of information. In addition, product names, the form of goods, and the type of package in use are well known to the different supply chain actors. The supply chain actors know how different types of goods are packed using specific types of packages. Accordingly, knowing what type of packages are used to contain goods influences how goods are described; hence, packages also represent a standard with regard to the exchange of information contents. When informing about packed goods, describing the packages used simplifies characterising the volume, weight, and shape of goods.

The automation of information exchange may represent an indicator of the level of supply chain integration. This is because the automatic exchange of information involves sharing information without first controlling or transforming the information contents manually. Electronic exchange of information regarding goods depends on routines having been developed within and between actors for this purpose. Supply chain integration may be also be described by the degree of electronic data interchange between information systems operated by different actors. Packages facilitate the characterisation of goods by facilitating how information contents about goods are created and exchanged, thus supporting both electronic and manual information exchange.

The information system is a facility or tool that registers, transforms, and coordinates various types of information to support the provision of information contents to actors at sorts. The package contributes within an information system by characterising more precisely the time, place, and description of goods. The information system is used to combine different types of information contents using information carriers and provides data to create labels and documents used by actors. Within a specific information system, information about goods is used in combination with information concerning plans and forecasts, the logistics facility and human resource capacities, inventories of goods, and orders. Information about goods is one of many elements in this system.

The communicative function of the package as an information source involves how the package contributes to characterising goods. This aspect of informing about goods is shown in fig. 6.5 below:

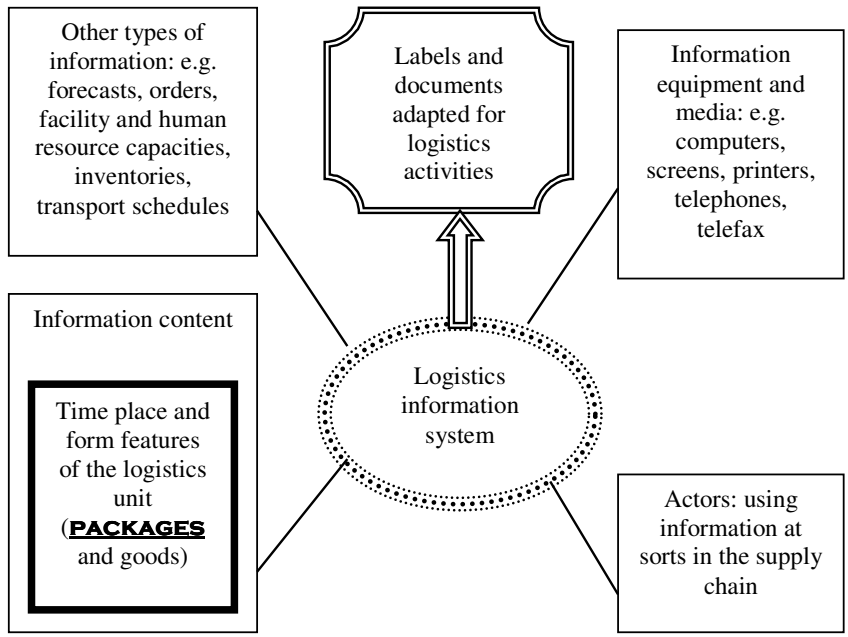

Fig. 6.5 The package as an element of information content in the logistics information system

When goods are packed, packages simplify information about them. The package is an auxiliary information resource that is combined with other data in an information system used by actors in the supply chain. Information and packages are heterogeneous resources that interplay in the setting of an information system, together facilitating how to inform about goods.

The information system may be designed in different ways to facilitate varying degrees of electronic information exchange within a firm facilitated by the application of ICT. In addition, when information is exchanged between actors in different firms, it involves linking different information systems with each other. Here, the package represents a standard form that makes this type of communication possible.

6.3 Using the Package to Identify and Characterise Goods

An important purpose of the interplay between goods, packages, and information was described, in accordance with fig. 6.1, to be able to characterise goods based on interplay between goods and packages. This description regarding the time, place and form features of goods provided through documents is the basis for being able to identify goods through an interplay between packages, represented by a logistics unit, and information. Accordingly, packages contribute to providing information contents about goods and to linking goods with the information system.

The logistics unit is the entity that is identified and therefore also primarily informed about in a supply chain. The logistics unit is always identified as a package. Packages play an important role in giving information contents, together with descriptions of goods, through identifying a logistics unit. Through a description of goods and packages, information contents are created and may be communicated using documents and labels as the basis for being able to exchange the information needed to carry out logistics activities and to use for other business and societal purposes. Packages play a role as part of the information contents used to describe goods. Here, the logistics unit is the type of package that is being informed about, together with the other packages and goods contained in a logistics unit.

Correct identification of goods is based on the roles of the package as an information source and as an information carrier being closely intertwined. A correct identification of goods depends on both the information about goods having been correctly exchanged and therefore accurately documented through an information system, as well as the goods actually having been delivered in a manner that allows their control against documents. Information and flow of goods are intertwined and the package is a vital element in describing how goods and information interplay. Providing information about goods is therefore dependent on interplay between the communicative function of the package as an information carrier and its function as an information source.

7 Transformation of Goods and Information

While the previous Chapter 6 focused on the relatively *static* features of how packages, goods, and information interplay, this chapter takes the analysis further by examining how goods are transformed through logistics activities and how information concerning goods, therefore, also must be transformed.

This chapter consists of four sections. In Section 7.1, focus is placed on the interplay between logistics activities and goods in order to transform goods with regard to provision of time, place, and utility. This is followed by Section 7.2 concerning how the flow of goods regarding time, variation, and frequency influences the transformation of goods. Section 7.3 covers how transformed information is provided and used at sorts in order to manage and operate a flow of goods. In 7.4, the chapter concludes by discussing how information about goods is transformed and also exhibiting how this transformation is both distinct and different from the transformation of goods.

7.1 The Transformation of Goods

From each of the four cases, a distinguishing feature regarding distribution is chosen to briefly analyse aspects of how goods are transformed. Regarding Corona strawberries, the impact of *perishability* is chosen since the durability in their flow of goods is extremely short. As regards TINE Lettmelk, *combination with other goods* is chosen, since before and after production, this product is combined with different types of goods which makes it possible to divide the flow of this product into two separate and distinguishable parts. *Technicality* is chosen as the distinguishing feature of Dole bananas since they are a climatic fruit transformed in appearance while contained in distribution packages, and a product that is retailed without consumer packages. This involves covering the technicality of packages relative to the technicality of the banana. *Bulk* is discussed with regard to Marian fish filet since this is a relatively expensive food item, produced and distributed in small quantities in combination with many different goods. These discussions all include the impact of packages on the transformation of goods.

7.1.1 Perishability and the Transformation of Corona Strawberries

The feature focused upon here is the degree of perishability influencing how limited time has an impact on production and distribution of this product.

Time is judged as an important feature in the transformation of Corona strawberries, mainly due to the fact that it is a seasonal product. In season, Corona strawberries are produced in relatively large volumes compared with other BAMA products. This means that additional organisational resources need to be made available to facilitate the distribution of Corona strawberries, together with the other products that BAMA distributes, on a more even basis through the year. BAMA is organised to manage relatively stable flows of its other fresh fruit and vegetable products. The distribution of Corona strawberries, involving a high degree of variation in its short and hectic early-summer season, conflicts with this characteristic of the BAMA organisational structure, including the configuration of its information system. This problem is solved within BAMA by using an auxiliary resource, the Strawberry Team.

Another important feature of Corona strawberries regarding time is that this product has a very short shelf life. In addition, a variable amount of strawberries are supplied every day of the season at the same time. After delivery from the producer, BAMA's aim is to limit the time spent carrying out logistics activities, thereby delivering the goods in the freshest possible state. Time provides an absolute limit in the durability of the product, thus providing a measure of how many Corona strawberries that need to be sold. Time shortage may therefore add to the complexity of distributing goods when a larger number of different logistics activities needed to transform goods must be combined within the limited time frame of the flow of perishable goods.

The most distinguishing feature regarding the use of packaging to carry Corona strawberries, is the logistics unit remains unbroken through its entire flow from farm to distribution centre, and in many cases, also to the store. Breaking logistics units is time consuming since this involves materials handling. Therefore retaining a logistics unit in its original form helps economise the use of time in this flow of goods.

7.1.2 Combination with Other Goods and the Transformation of TINE Lettmelk

TINE Lettmelk consists of two different parts that are distinct from each other when considering the description of goods. In each of these parts the feature of combining with other goods differs. In the first part, raw-milk is produced at the farm and transported to the dairy for storage in silo tanks. The second part of the flow is when the packed 1-litre Lettmelk product is distributed from the dairy to the retailers. In the first part of the flow, goods are unpacked and contained in various forms of storage tanks, while in the

second part, the goods consist of the finished Lettmelk product packed in PURE-PAK cartons. Since the raw-milk is not packed, while the finished Lettmelk is, this influences how goods are contained and handled at logistics facilities.

In the upstream flow of goods, raw-milk is mixed in tanks with deliveries from other dairy farms. Different types of facilities are needed to store and transport milk before and after production. Each dairy has, accordingly, two sets of vehicles to transport and two distinct modes of storage of goods. Materials handling activities are also influenced by whether the goods are raw-milk or finished products such as TINE Lettmelk. Raw-milk is pumped through tubes while packed goods are handled using equipment adapted to handling packages.

Raw-milk is not handled, stored or transported together with other types of goods. This product is contained in tanks and mixed with deliveries from different dairy farm suppliers. Raw milk is contained in milk tanks rather than packaging. The milk tanks used to carry raw-milk, accordingly, influence in a distinct manner how logistics activities are carried out to handle only one type of goods in this part of the flow. Prior to production, milk tanks primarily function to carry goods rather than identify goods.

Raw-milk is the single raw materials source supplied by dairy farmers. This form of goods is transformed through production activities into a range of different products that are distributed by TINE. The different raw-milk based products are then, in turn, combined with various other products supplied from TINE, TINE's subsidiaries including Fjordland, Prior, and Gilde, demanding a refrigerated environment and delivered through LFD to retailers. This range of goods is packed helping to facilitate discerning goods from each other when delivered to the retailer. The use of containment facilities is changed from before and after production and is a key feature in characterising how goods are transformed through production. After production, packaging plays a key role in discerning different types of goods from each other.

7.1.3 Technicality and the Transformation of Dole Bananas

An important distinguishing feature of Dole bananas is that these goods undergo production both in a banana ripening facility and during transport. Another distinguishing feature is that it is distributed in the same banana box and is first unpacked by the retailer. These are aspects of the technicality of this product influencing its transformation, and the package, together with the technicality of the goods, therefore, influence how these types of goods

are distributed. This is exemplified by how a banana as a climatic fruit undergoes ripening also after harvesting; this process takes place without opening the banana box. Since this ripening process happens within a specific time frame after harvesting, the ripening of the banana needs to be planned vis-à-vis logistics activities, most importantly transport and production at the ripening facility. Therefore, as in the case of Corona strawberries, time is likewise an important variable when distributing bananas. However, since the banana is a fruit that both ripens and decays after harvesting, this process of transforming the goods may be manipulated when the banana is in the ripening facility. In the case of Dole bananas, the transformation may be planned, while in the case of Corona strawberries, where volume and quality are prone to variations, control activities are of greater importance than planning the flow of goods.

The time frame of the flow of bananas is limited, spanning a few weeks from harvest to delivery to the retailer. A substantial proportion of this time is, however, constrained by the goods' need to be transported from Latin America to Europe. The ship's goods containment facilities are designed to slow down the ripening of bananas and transport them as fast as possible, thus also influencing their transformation. The possibility of manipulating the production process at the banana ripening facility also gives BAMA Trading the opportunity to allow a weekly supply of bananas from Dole's Hamburg terminal to be split up in daily deliveries to distribution centres, thus letting the distribution centres supply their retail customers with fresh Dole bananas daily. Packages are, together with other facilities, used to control the technical features of bananas. The transformation of Dole bananas is therefore influenced by a combination of technical features of this product's materials in combination with the technicality of the package and facility features used.

7.1.4 Bulk and the Transformation of Marian Fish Filet

An important feature regarding the distribution of Marian fish filet is that a low volume of products is transformed using facilities provided by several different companies. Additionally, this is a relatively expensive food product. These are two aspects of the bulk of this product. Fjordland, Aker Seafoods Hammerfest and its trawlers, GILDE, Nor-Cargo Thermo, and the TINE distribution centres are actively involved in supplying these products to retailers. Each of these represents actors who, in different ways, are responsible for transforming Marian fish filet from various raw materials to the finished products. The distribution of this product resembles that of Dole bananas since Aker Seafoods, like Dole, only sells a portion of its production for distribution through TINE's network. In the case of Dole, however, the

flow of bananas is operated as interchangeable goods that also may be sold as a commodity on a world market. Marian fish filet are, when packed, a branded product marketed only by Fjordland in Norway. Since the produced volume is low, Aker Seafoods has a problem using the production equipment, which is specialised for the production of fresh packed fish products.

The low volume distributed also influences what logistics activities must be carried out together with logistics units containing other types of goods. The use of GILDE backs as distribution packages, and these packages may later be used to carry other products within the LFD agreement. In the transport and handling from Hammerfest to Oslo through the TINE distribution centres, Marian fish filet also must be combined with other goods in order to economise on activities. The goods Marian fish filet are combined with vary at different locations. Therefore, a vital aspect of transforming goods also includes how the transformation of a specific type of goods is carried out as related to flows of other goods.

7.2 Features of the Flow of Goods

This section discusses how the features of the flow of goods regarding time, variation, and frequency influence the transformation of goods. This involves explaining how logistics activities are coordinated within the scope of the flow of goods to achieve the provision of time, place and form utility of goods.

7.2.1 Time and the Transformation of Goods

Time is used to describe how goods are sequentially transformed through logistics activities and therefore allows that the description of goods in different states be compared with each other. At intermediate sorts goods have a past, present, and future state that must be accounted for in order to assign the goods. At the initial sort the past state is less evident, while the end-user may, to some degree, be concerned about the future state of the purchased product . Figure 6.5 shows how activities and transformed states of a product are sequentially related to each other:

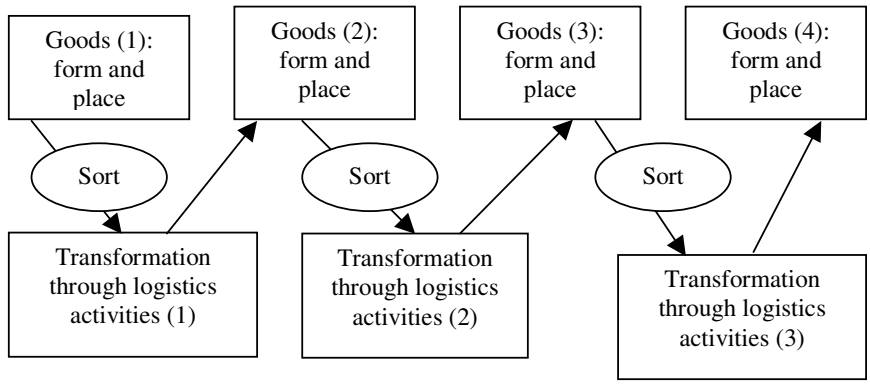

Fig. 7.1 Transformation of goods

Logistics activities regarding transport, storage, production, and materials handling are carried out sequentially. When the material features of goods are transformed through production, packages usually must be unpacked. The ripening of the Dole banana is an exception to this rule. Logistics activities are carried out when Corona strawberries are handled at the farm, moved from the fields to the cold storage room at the farm, and then later loaded onto the truck and transported to the distribution centre terminals. The harvesting of strawberries is a form of "production" since this activity detaches the strawberry from the plant where it grows, transforming its form features. Milk is produced when the cow is milked and TINE Lettmelk is transformed into 1-litre cartons at the dairy. However, to be able to produce TINE Lettmelk at the dairy depends on preceding production and logistics activities and following logistics activities, including retailing the goods. Production represents a planned transformation of the form features of goods coordinated with other logistics activities. Logistics activities follow each other; hence they must be sequentially related to each other.

Fresh foods are perishable products, and their features, combined with time, primarily influence the rate of decay. How the individual logistics activities are carried out, as well as the packages used and the facilities containing the goods, influence this rate of decay. While production aims to increase the value of the product, time is usually considered to reduce the quality of the product through deterioration of the goods. However, the rate of decay may be influenced by how the goods are produced, including how they are packed, and how logistics activities are carried out time-wise.

7.2.2 Variation and the Transformation of Goods

Variation concerns changes in the initial supply and demand of products due to both planned and unexpected events. Variation, therefore, influences how different logistics activities are coordinated; especially storage has been used to buffer discrepancies in the supplied volume of goods with demand for products. Variations in volume of supply and demand of goods measured over an annual period are caused by either unexpected occurrences or more expected seasonal variations. Corona strawberries are a product with large seasonal variations. Seasonal variations mean that the actors in the logistics network must ensure sufficient resources to manage and operate the materials flow of the additional goods during the season. In the case of Corona strawberries, the distribution of this product is managed by supplementing additional, organisational resources. At the same time, existing resources are used to operate the flow since facilities have available capacities due to a lower volume of other goods in the summer season. Since Corona strawberries are extremely perishable, storage may not be used to buffer unexpected variations and coordinate the transformation of these goods with logistics facility and human resource capacities when it comes to logistics activities.

A common characteristic of all the studied cases is that the initial supply volume of goods varies. Harvesting, fishing, or milking are activities linked with uncertainty regarding supply volume, a common characteristic of many foods products. The supply of raw materials varies and in these cases, Aker Seafoods, Dole, and TINE use plans to limit the consequences of variations in supply. Dole may find alternative supplies of bananas from other sources if one region for instance is hit by hurricanes. Marian fish filet is a premium quality product with a relatively high price whose first priority is securing delivery even though fish catches may be low. Dairy farmers strive through long-term production planning to supply an even amount of milk. Should there still be a raw-milk supply problem, dairies have a small excess amount of raw-milk in store every day. Raw-milk may also be delivered from other regional dairies to provide sufficient supplies. Actors managing the flow of goods do their utmost to even out unexpected and seasonal variations in supply through planning and keeping up the flow of goods to some degree by compensating with alternative supplies of goods or adapting facilities to variations in the volume of goods.

7.2.3 Frequency and the Transformation of Goods

The level of frequency impacts on how often shipments of goods are identified at a logistics facility. The volume of goods is not measured

regarding frequency, however, frequency may impact on the volume of goods contained in a logistic unit. Accordingly, when the same amount of goods is transported more often, it increases frequency. Materials handling, together with transport, are the logistics activities most evidently related to frequency and involve variations in handling goods arriving from transport and loading goods onto transport vehicles. Landing Dole bananas at the Hamburg port and handling Corona Strawberries at the BAMA Trading terminal may be regarded as forms of cross docking. In some cases, cross docking is carried out when the time frame between the arrival of goods, the handling of these goods, and loading onto a new vehicle for transport is limited. In cases of cross docking, different frequencies of handling goods need to be closely coordinated. Or, goods are divided into new units of for either storage or later transport from a warehouse or shipment to production. In these cases, frequency between incoming and outgoing goods at a warehouse is not closely linked since storage is used to buffer the flow of goods. This is then case when distributing Dole bananas, e.g. regarding the use of the banana ripening facility.

When cross docking is carried out there is no storage buffering in the flow of goods. Changing the frequency of the arrivals and shipments of goods is a tool that may be used to plan the coordination of logistics activities carried out by different supply chain actors.

Frequency is important with regard to intermediaries in the supply chain since it influences how incoming goods are transformed into new logistics units, such as a distribution centre. This is because frequency is related to both incoming and outbound goods, and a distribution centre needs to coordinate its internal activities in relation to how often goods are received and dispatched. At a distribution centre, materials handling, together with storage, represent the key activities regarding receiving and transforming goods. This involves changing logistics units by combining different forms of packages. In the case of Marian fish filet, the consumer level package is the level used to assort these goods. At a distribution centre, the transformation of goods, therefore, consists of constructing new logistics units adapted to the requirements of the recipient of the goods. Here, logistics units containing the distribution level packages of mainly the same or similar types of goods are received from various suppliers.

Goods sent from the distribution centres are combined with a number of different goods, thus reducing frequency, and a retailer receives the assortment of goods that have been ordered in one delivery instead of multiple, smaller deliveries, to the same destination. When bananas arrive at the Hamburg terminal, their transport must be handled weekly from

Hamburg to Oslo. When distributing them from the banana ripening facility frequencies are higher since goods have to be shipped to the over 50 different BAMA distribution centres in accordance with orders from these. In the case of Corona strawberries, all handling is done on a daily basis during the season. Larger retailers in Oslo receive pallets of these goods by a special truck, increasing the frequencies of transporting goods from BAMA distribution centres, while the smaller retailers receive a number of IFCO crates of Corona, together with the other BAMA goods; this does not influence frequency. The facilities that handle goods have limited capacity. Therefore, the volume of goods coming from different suppliers and going to various customers have to be coordinated with different, individual facility capacities in the scope of the supply chain.

Production, storage, and time in transport are activities that help coordinate deliveries by being buffers in the flow of goods. In the case of bananas, transport time, together with time spent in the ripening facilities, may be manipulated in order to influence frequencies of delivered goods. Bananas are ripened to such a degree that the truck compartment is filled when transporting them from the banana ripening facility to the distribution centres. With regard to Marian fish filet, this limited amount of production varies according to orders. However, this variable volume is normally delivered twice a week, independent of the volume produced, in accordance with a delivery schedule.

Frequency influences the volume of goods regarding the logistics unit. Reducing frequencies makes it possible to create logistics units containing only one type of product, while increasing frequencies means that a logistics unit to a greater degree must consist of different types of goods. In practice, the frequency of deliveries is negotiated through agreements as in the case of Marian fish filet. Also, in the cases of distributing goods from the distribution centres, transport is carried out in accordance with routing plans, and logistics units, therefore, are adapted to these.

Routing plans are created based on information concerning the expected demand for different goods by retailers, the capacities of the trucks, and the space demanded by the different packaged goods combined into logistics units (pallets of distribution-level packages) on the truck. Frequency influences the size of logistics units and how many of these are handled. Frequency, therefore, also influences the volume of goods being handled through logistics activities. However, increased or reduced amounts of goods being fitted into the same number of logistics units do not influence the number of goods that need to be identified.

The frequency measured in the number of logistics units handled at facilities increases as the product moves downstream in the flow. As for agricultural products, increased variation is detected further upstream in the supply chain. This is especially the case with Corona strawberries where supplies may change from day to day due to growing and harvesting conditions, and shift from region to region during the season. The relatively high frequency also secures the capacity of the technical resources within the materials flow at regular and planned intervals. Facilities are dependent on a planned volume of goods arriving at these intervals, otherwise the capacity is not efficiently used since logistics equipment and human resources otherwise may be idle during limited periods. Facility capacity limitations are not regarded as a challenge in my studied cases due to the fact that excess capacity is secured. Dole has a larger banana vessel than necessary and rents out the excess space; independent transporters who have a number of extra trucks constantly available, are used for much of the transport, and capacity within logistics networks may be coordinated by rerouting supplies, such as in the case of providing raw-milk to production at the dairies. The transformation of goods are characterised in part by the frequency in which goods are handled: the higher the frequency, the more units that need to be handled and informed about in order to assign goods to transforming activities.

Frequency influences the efficiency of using logistics facilities since frequency also impacts on how logistics facilities are used. This concerns whether logistics facilities are used to handle one large or several small shipments of a same type of goods. This involves how ands when logistics facilities lay idle at a warehouse or terminal location. If a pallet can be stacked with other adapted distribution packages, this represents a potential for using transport and materials handling capacities more efficiently. On the other hand, the use of logistics units may also be adapted to user needs related to product quality regarding freshness, by increasing the frequencies of deliveries. Frequency also influences the complexity of the flow of goods, as increasing frequencies may lead to an increased need for more detailed operations planning and a greater need for coordinating logistics activities.

7.2.4 The Interplay between the Different Features of the Flow of Goods

Variation in supply and demand is the basic challenge to coordinating different logistics activities and carrying out the individual logistics activities within a supply chain. The features of the flow of goods, time, frequency, and variation are interrelated, and together they may be used to coordinate how goods are transformed in a supply chain. Variations in the supply are

related to the time and volume of supplies and demand for goods and may influence transport frequencies and the time spent to carry out materials handling since more goods may need more time for handling.

Variation has varying impacts on the flow of goods depending on the applied management principles of distribution. The use of postponement or speculation principles is not evident as an explicit distribution strategy in any of the studied cases. However, these principles may be used to account for ways of how information is used to direct the different flows of goods. In accordance with principles of postponement, agility is of great importance in order to be able to rapidly coordinate orders with supplies and attain an even flow of goods. This is, for example, the case when distributing Corona strawberries where the logistics resources must be capable of adapting to the unexpected daily fluctuations in both supply and demand. In the case of TINE Lettmelk, production is always initiated according to a plan. When using principles of speculation, as in the case of the distribution of TINE Lettmelk, storage tanks are used as buffers to coordinate the small fluctuation in supply of raw-milk with larger fluctuations in demand for different dairy products. Here, TINE Lettmelk represents one of the most perishable products, while other dairy products, such as cheese, need to be stored to be prepared for consumption.

Frequencies are used together with capacity features (human resources and facilities) of the supply chain play a role as tool to contribute to coordinating this flow. Time represents a feature of the flow that also may be used to plan when logistics activities are carried out and how much time is used. In the distribution of fresh foods, time is usually limited. Frequency influences the volume of goods are contained in an individual transport facility, while storage involves the use of location-specific warehouses to contain goods. Therefore, frequencies together with storage may be used as tools to buffer in relation to variations in the flow of goods. In the case of Corona strawberries, agility is needed regarding transport capacities and administrative resources to handle variations in daily supplies.

Packages are used, together with logistics facilities, to influence the perishability of fresh foods. Packages, therefore, to some degree influence the need for agility in the supply chain, since perishable goods demand that facilities and human resources be flexible to accommodate for variations in supply and demand in a limited time frame. Hence, packages reduce the need for agility in a fresh foods supply chain. To be able to coordinate logistics activities in an environment featured by variations that influence the timing and frequencies of goods, information about goods is needed that is applied to carry out different sequentially organised logistics activities.

7.3 Information and the Transformation of Goods

The preceding sections in this chapter have discussed how goods are transformed. This section moves the focus to how information in a supply chain interplays with the transformation of goods. The role of information in transforming Corona strawberries, TINE Lettmelk, Dole bananas, and Marian fish filet is covered individually.

7.3.1 Corona Strawberries and Information

The Strawberry Team may be regarded as a central node in the network of distributing Corona strawberries. The activities of the BAMA Strawberry Team are part of an information sub-system within BAMA's ordinary system. The Strawberry Team uses the existing EDI systems within BAMA only to a limited degree, and mainly to facilitate transport and inform distribution centres of confirmed deliveries of Corona strawberries. To enable the coordination of supply with demand information from producers using SMS and fax, the daily harvest must be coordinated with orders received from the distribution centres. The harvested volume representing the daily supply of goods is determined gradually throughout the day and varies from day to day. On the other hand, the volume of orders fluctuates based on the day of the week and weather conditions and therefore needs to be communicated to in a rapid manner provide accurate, updated information about these goods. When supply and demand, measured in pallets divisible into crates of Corona strawberries, have been fixed using price as the main coordinating tool, delivery from farms to the distribution centres must be coordinated with transport capacity. In addition, the distribution centres must take into account that they may have a limited storage capacity.

The Strawberry Team handles most of the information regarding the daily supply, demand, and transport of Corona strawberries. The supply information is different from the demand information in volume, and has to be transformed into actual deliveries; this is communicated to the logistics department who coordinates the provision of transport facilities. This example also shows how, within the limited time frame, a complex exchange of information takes place. Incoming strawberries are regarded as interchangeable goods and not predetermined for delivery to a specific distribution centre. Continuously incoming orders are matched with shipments of outbound products based on these orders. Since the goods are not identified with a unique identification code or other forms of marking linking different types of sequentially transformed information about a specific unit of distributed Corona strawberries is a problem. As supply information is provided to the Strawberry Team at about 16:00 the day

before, it is noted on the Strawberry Team's EXCEL spreadsheet, and used to help split up the accumulated supply of goods into individual deliveries from the farms to the different distribution centres.

Information about the form and location features of Corona strawberries characterises how these goods are transformed in a limited time frame. This information, based on a preceding identification and registration of goods, may be regarded as the focal unit of information related to physical distribution. This information plays a role as a point of reference to other types of information used to distribute Corona strawberries, including order information and logistics resource capacities.

7.3.2 TINE Lettmelk and Information

TINE Lettmelk is a product that demands rigorous control due to the fact that this product is highly vulnerable to quality discrepancies. Therefore, information regarding the quality of the raw-milk must be continuously registered by taking samples. This represents an additional activity to that of transforming the goods that is carried out exclusively to create information to secure the quality of the goods. Raw-milk and finished milk products undergoing production are controlled to hinder product discrepancies and provide the highest grade raw-milk for the production of different vulnerable, finished milk products. The dairy farmer aims to have cows at the farm produce milk within predetermined quotas. After the milking process, trucks routinely collect milk at farms at fixed intervals. The total production of raw-milk is planned slightly above the forecast demand so that the dairy does not run out of raw materials. Should this be the case, however, cooperating TINE dairies may be requested to provide additional raw-milk.

The daily provision of raw-milk to the dairy is therefore based on information set on a long-term basis and includes which farms deliver to the specific TINE dairy, as well as the annual production quota of each farm. The production at the dairy is transformed into a packed entity. The consumer packed goods are then informed about and measured using package form features. TINE Lettmelk is a well-established product whose daily ordered volume varies very little from day to day, or from week to week. Order information received in the morning is coordinated with production information. Production is then adjusted to meet the registered, daily orders from retailers and other customers. This exchange of information with retailers provides the destination for the goods, and this earmarking transforms the information by combining information about the supplied volume of TINE Lettmelk with the name of an intended destination.

The example of TINE Lettmelk exemplifies how an abundance of information is registered for the daily assignment of transporting goods further. This excess of information is used to secure product quality and also secures an even flow of goods since quality discrepancies often lead to the need for tracking and rerouting goods. Production at the dairy transforms information about milk more directly. After production, information concerning the TINE Lettmelk flow of goods must be changed from reporting about unpacked raw-milk, to informing about the consumer-level packed Lettmelk product. While raw-milk is registered as the fluid contents in tanks, TINE Lettmelk is reported in units of packages, mainly as a standard number of milk cartons in either trays or roll-rack containers. This case, therefore, shows that when a raw material undergoes production and is packed, the way the product is informed about changes.

7.3.3 Dole Bananas and Information

Both supply and demand of Dole bananas are relatively stable throughout the year. The time frame from harvest to delivery is longer than for Corona strawberries. The communication's main role is therefore to verify an anticipated volume of bananas to be ordered and later provided through BAMA's supply chain. Since the time frame is relatively longer than for the other studied products, information about anticipated orders and adjustments of these is first exchanged, and then a final order is worked out a few days in advance of delivery.

Orders are therefore variable contents of information that are gradually adjusted as bananas are shipped to their destination in Norway. This may be compared with how strawberry farmers in the course of the morning several times inform the Strawberry Team about that certain day's supply of Corona strawberries. Information may, accordingly, be transformed regarding the volume of goods that are to be either delivered or ordered. Information that leads to orders of Dole bananas is transformed sequentially through the retailer to BAMA Trading. This order is then used together with other types of information within Dole's information system to carry out an actual supply of goods. Through this process, either standard shaped boxes or pallets containing a standard amount of these boxes are informed about. The package, therefore, in this case functions as a standardised form of information contents used to describe goods.

Bananas remain in the same packages and since BAMA only uses one type of banana box from the packing station in Costa Rica to the store, the volume of bananas is, throughout the flow of goods, measured in a standard form of pallets or boxes of bananas, and the pallets always consist of a fixed

amount of banana boxes. Hence, bananas are transformed without transforming the form features of the package. “Time” must be registered together with “location” to provide an exact assessment of the type of materials contained in the banana box. In this manner, information about the goods must be transformed in order to control the ripening process of the banana. At the banana ripening facility, the location is given, but time is manipulated in order to provide a daily supply to BAMA Trading’s distribution centre customers.

The transformation of the form features of Dole bananas is not obvious since the bananas remain in the same package after being in the ripening facility. It is only through providing information about where the goods have been previously and for how long, that actors may be provided with detailed information concerning the state of the distributed bananas. Information about the banana box must be combined with time and location features in order to give complete information about the goods. This is necessary since the package quite literally hides the state of the goods unless the goods are unpacked. Therefore, an unopened banana box contains a form of goods that may be accounted for only as far as information concerning time and place-related features of these goods. This is possible because this type of information may be related to goods being registered in the system in connection with the transformation process of the goods in specific containment facilities.

By controlling the environment of the bananas at the ripening facility the delivery of bananas to retailers through distribution centres may be altered when customer orders fluctuate. Information concerning the timing of goods with regard to location is used to influence how goods are transformed through logistics activities. If Dole Hamburg reports that the ship carrying bananas is delayed two days due to poor weather, this information indicates that the goods may be damaged. Also, it indicates that the ripening process has been going on for two extra days influencing product quality at a rate normal for the storage facilities on the ship, and it points out a need to coordinate the state of the bananas with their forthcoming processing at the ripening facility. It is also possible to estimate the quality of bananas through a visual control, as the state of decay is observable. Since bananas are not packed in consumer packages, the only way to be informed in a precise manner regarding their decay is by registering this information in an information system and later identify the goods at the store. Time features of goods are, accordingly, informed about with regard to registering and assigning goods to logistics activities.

7.3.4 Marian Fish Filet and Information

Information about Marian fish filet is exchanged between different actors in order to operate the flow of these goods. The type of information exchanged between supply chains of actors, however, differs. Aker Seafoods in Oslo provides forecasts for the overall production of all fish products at Aker Seafoods Hammerfest. Information is exchanged between Fjordland and Aker Seafoods Hammerfest providing forecasts for deliveries of the Marian products and for more long-term product specifications. Trawlers communicate to Aker Seafoods Hammerfest the volume of their catch and arrival time at the port. The TINE distribution centres inform Aker Seafoods Hammerfest about their orders twice a week. TINE communicates with Nor-Cargo Thermo regarding the volume and destinations of each transport of Marian goods from Hammerfest to the distribution centres. Aker Seafoods then needs to confirm the actual loading time of the goods in Hammerfest with Nor-Cargo Thermo's office there. These various forms of information contents are combined and thus transform information about these goods.

The information used is a combination of long-term plans and more operational information. The long-term information gives the basis for planning logistics and production activities. The short-term operational information has to be combined with other information at sorts. Raw-material supply is combined with Marian fish filet's production plans that are based on orders, and this must be coordinated with forecasts for Aker Seafoods Hammerfest's other production. Information about the volume of goods that needs to be transported after a day's production is communicated to Nor-Cargo Thermo, which must coordinate this with information received from its other customers regarding required transport services. Information exchanged between supply chain actors provides data that are combined with additional information sources from other business relationships to resolve how to carry out activities. Therefore, information exchange between supply chain actors, as it is shown in the example of Marian fish filet, provides a vital part of the information necessary to carry out logistics activities. Even though information systems between the different actors are not well integrated, information concerning goods has to be communicated in order to coordinate supply with demand, as well as coordinate logistics activities with capacities within the supply chain.

Marian fish filet represents a low volume product. Therefore, informing about this product in many cases involves combining information about this type of goods with that of other types of goods. On the trawler, the raw materials used to produce Marian fish filet are part of the total catch of fish. At Aker Seafoods Hammerfest, the production of Marian fish filet must also

be coordinated with its other products. These different materials are distinguishable by their product names. A product is registered by using the name of a fish species, or it may be the name of a branded product. Marian fish filet is given priority due to its quality requirements regarding freshness and use of raw materials. The quality selection at Aker Seafoods production facility is determined by labelling the goods in the fish tubs and using this labelling also to register the goods in the Maritech information system, thereby allocating different quality levels of goods to different production transforming these into different types of products. At Fjordland, the management of the Marian products is carried out together with other products. At Nor-Cargo Thermo facilities, Marian goods are handled and transported together with many other types of goods, and the activities must be coordinated with the requirements of these other goods. At the TINE distribution centres, the handling and delivery of Marian products must, in the same manner, be coordinated with the requirements of these products. When retailers order Marian fish filet they use an order list containing TINE's full product range.

When informing about the low-volume Marian fish filet in the entire supply chain, a feature that stands out is that information about this product must be combined with information regarding other goods. Therefore, it is important that goods consisting of Marian fish filet be easily identified in relation to other goods. In this case, this is primarily secured by various forms of labelling, including accurate coding of distribution packages, and the use of information systems to verify the state of the goods, and, most importantly, the location of this type of goods.

7.4 The Transformation of Information about Goods

The preceding analysis shows examples of how information is provided to transform goods, and that information also needs to be transformed and adapted to different uses. Therefore, information about goods also needs to be transformed. The transformation of goods is different from how information about goods is transformed. As regards packaging, informing about goods involves the function of the package as an information source. How this information about goods is transformed, is based on the flow of goods and is shown in fig. 7.2 below:

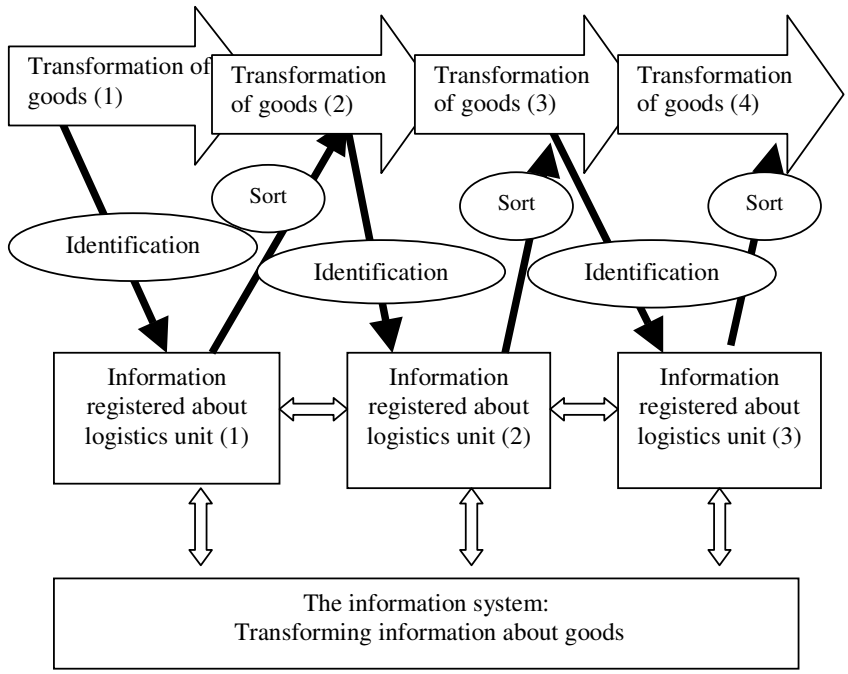

Fig. 7.2 The transformation of information about goods (One-headed black arrows indicate the direction of communication involving using packages as an information carrier and source. Arrows indicate the transformation of goods, while double-headed arrows show information exchange)

The transformation of goods is interrelated with the transformation of information. When goods are identified at sorts, this information is registered into an information system. The information has thus been updated and, therefore, information contents concerning goods are transformed through identification. Identifications of logistics units are carried out sequentially regarding logistics activities and provide a sequential transformation of information about the present state of the goods. These registrations, when they are accumulated in data records within an information system, represent the basis for being able to inform about the past state of goods.

Goods are identified prior to a sort in order to update information, and after a sort in order to carry out logistics activities. When identifying goods prior to a sort, the present features of the goods are registered and this, combined with other information, is provided to actors using it to assign goods. Accordingly, information about goods is transformed in a sequential manner

the same way goods are transformed, however, the contents of this information are provided from a wide range of actors within the supply chain. Other information is primarily characterised as information about the past and future states of the goods. In addition, transformed information about goods that is adapted to being used at sorts must be combined with other information such as transport schedules, personnel plans, and storage capacity at facilities necessary to assign goods. The information system plays an important role in transforming information about goods. This is where information about the different states of the goods is received, processed, and communicated. In an information system, information based on identified logistics units is combined with other types of information regarding the temporal features of goods.

While the transformation of goods takes place in the flow of goods through activities, the transformation of information takes place in the wider realm of actors in the supply chain through information exchange between these actors. Information about goods may be transformed and provided by combining different informational elements concerning the 1) past state, 2) present state, and 3) future state of goods. The transformation of information is closely related to describing the temporal states of goods, but this is only one aspect of information transformation. Information about the registered, and therefore also identified, goods must be combined with destination information and how the goods are to reach their destination, to be meaningful regarding an assignment at a sort. This represents the aspect of the future state of goods. Therefore, information about goods not only consists of identified and registered goods, providing information about the past and present states of goods, but also information concerning plans provided by forecasts or orders, concerning the future state of goods. The temporal state of goods represents variable information contents. This information is an important part of describing “the core features” of the flow of goods. Information concerning product name, time and location features of goods is combined to create accurate information content about goods.

The package facilitates part of the information contents characterising the form features of packed goods. This information is combined with information elements concerning the product and time and location features and is a transformed resource. These elements, therefore, usually have different form and place properties when it comes to time. Finally, these information contents are then adapted to different actors’ needs, securing the efficiency of carrying out logistics activities mainly, but also other types of activities. The issue regarding how the package facilitates the use of information in a supply chain is covered in the following chapter.

8 Using Information about Goods

While the previous chapter was concerned with how packages and goods are transformed and how information about goods is influenced by this transformation, this chapter moves the focus to the role of the package to inform about goods. How registered information, based on the transformation of goods, also may be used to track goods and trace products is discussed in Section 8.1. Section 8.2 takes the discussion regarding the use of information about goods, including the role of the package, one step further by analysing the roles of communication to coordinate, influence, and learn. Section 8.3 focuses on the role of the package with regard to information exchange concerning 1) the communicative function related to the physical functions of packaging, 2) the role of packages in mediating between actors and activities and 3) how packages facilitate adapting information about goods to different user needs.

8.1 Using Information to Track Goods and Trace Products

Tracking goods and tracing products are closely interrelated with logistics activities. These are activities that do not in a direct manner transform goods. Instead, tracking and tracing are information-gathering activities that involve collecting information about previously transformed goods. Tracking and tracing aim to provide information about goods that have been registered when logistics activities have been carried out previously. First in this section, the activity of tracking goods is discussed, followed by an analysis of how products are traced.

8.1.1 The Role of Packages in Tracking Goods

Tracking goods is an activity that involves communication between actors to find information records about the latest identification of a specific shipment of goods. This activity is normally initiated by an actor's query concerned with locating one or more specific logistics units or unpacked goods. When goods are transformed, they are registered and thus identified in a sequential manner, or continuously if electronic tracking devices are used. Accordingly, the most recent identification of the goods is sought when tracking goods.

If goods are automatically tracked, the present location is reported instantly through an information system. This is the case when Nor-Cargo Thermo tracks its vehicles using a GPS system. The location of a transport vehicle is compared with the transport documents following the vehicle, providing an exact identification of the goods on that vehicle. In the cases involving a

higher degree of manual tracking, a search process is initiated involving different forms of media, such as ERP systems, e-mail, telephone, and fax between various actors in the supply chain. When tracking is aimed at locating goods that have not been received, this activity is directed upstream by literally following the flow of goods. On the other hand, when following the flow of goods downstream, tracking concerns identifying goods in the opposite direction of the flow of goods.

The four product cases show how tracking goods is carried out in different ways. In the case of long distance transport, such as when Dole bananas are transported by ship and Marian fish filet are transported by Nor-Cargo Thermo from Hammerfest, a GPS system is used to track the exact location of the vehicle or vessel. This information is directly accessible on a data screen operated by the transport company. In the case of Marian fish filet, Fjordland normally will inquire about the current position of goods, and Nor-Cargo Thermo then usually communicates this location information by telephone or Internet to Fjordland. In the case of tracking goods upon delivery from the distribution centre terminals, delivery vehicles are usually linked with the distribution centres through mobile phones carried by the drivers.

Goods being delivered consist of a mixture of packages containing different products combined into units of goods addressed to different destinations. In these cases, the logistics units being tracked are distribution-level packages combined into transport-level roll-racks or pallets. These transport-level packages are logistics units that are manually registered when they leave the terminal and arrive at a retail location. Therefore, when the distribution centre knows that a package or combination of packages are on a certain truck delivering goods in accordance with a pre-determined route, the distribution centre must contact the driver to find out the truck's exact location.

Corona strawberries do not carry a SSCC identification code. Based on the label on the IFCO crate that provides hand-written information in text and numbers, it is only possible to track Corona strawberries down to a group of usually palletized crates that were delivered from a certain producer at a certain date. These goods are registered in quantities measured upon arrival at distribution centre terminals in numbers of pallets containing a standard number of IFCO crates, in numbers of IFCO crates at retailers, and when loading and unloading trucks. Therefore, locating Corona strawberries supplied by a specific producer on a specific date involves a more complex search process where all the Corona strawberries being delivered must be checked. This is a time-consuming, manual process since around 60 different

suppliers provide Corona strawberries. Usually, the actors have some idea about the route of the Corona strawberries, based on the registration of the goods when they arrived and were they were placed sequentially along the BAMA Trading or distribution centre terminal walls. In the same manner, goods are loaded sequentially. Actors seek information by following the flow of goods almost literally upstream and locating the actor currently responsible for transforming them. Tracking goods does not always involve their physical identification and may be the case when informing about the availability of goods in negotiations during a purchasing process. This involves acquiring information concerning the latest location of goods through data records from an information system.

The use of GPS technology, GS1 codes, and the levels of detail in information contents on labels are examples of how tracking can be facilitated in different manners. When labels carry an identification code, such as a SSCC code, this may be used to simplify locating goods in a logistics network by allowing for more automated registration and later identification of goods. Tracking goods is an activity that is carried out upon demand, generally based on a query and, therefore, on an irregular basis. Tracking is not a planned activity since it is usually done based on an unexpected need to locate goods. The capability to track goods, therefore, represents an organisational resource that is utilized upon demand and is, accordingly, a latent organisational resource. The communicative function of the package as an information source is used, together with the package as information carrier, to identify the location of the goods. Tracking goods is an activity that involves communicating and using information, and does not directly involve the physical features of the flow of goods. Location information may, however, later be used at sorts to carry out logistics activities. Hence, information that is registered using packages when carrying out logistics activities influences how goods are tracked. In addition, the technology of the different information systems used and how these systems are integrated to enable information exchange involving monitoring of the flow of goods, influence how goods are tracked.

8.1.2 The Role of Packages in Tracing Products

Tracing products is concerned with supplying detailed product history information that may provide an accurate reason for the occurrence of product discrepancies. First, this involves communicating to seek the source of this information, then relaying the registered data to the actor needing detailed product information. This detailed information is more or less latent and is generally only required when product discrepancies are detected. End-users may also require detailed information for their own sake. Food

products must comply with strict quality standards, and due to these, product quality is controlled and registered during production, transport, storage and handling. Moreover, product information regarding best-before date, product contents, and location origin is provided on the package label. In most cases, this information is sufficient for consumer needs, making it unnecessary to actually trace a product to seek additional information. Product tracing, therefore, is an activity providing information in addition to that provided through package labels or documents following goods.

The capacity to track, may therefore be regarded as a form of "traceability", since this involves seeking the "history of the goods" on its way towards the end-user. "History" is here regarded from the perspective, not of the end-user (as commonly viewed when regarding "product traceability"), but from the perspective of the actor that has sent goods downstream in the supply chain. This form of traceability involves using information registers in the supply chain in order to locate goods. This is one example of how product tracking and tracing goods are information-gathering activities that may be difficult to distinguish form one another.

The cases show how the information contents provided when tracing a product start by identifying the logistics unit. Typically, the label carried by the logistics unit or lower-level packages combined into the logistics unit provide the initial product information. In many cases, this information is sufficient for the actor's needs. Sometimes, the materials themselves are clearly readable and labelling of consumer packages is unnecessary, such as in the case of Corona strawberries. Informational text on packages or supplied through packages, labels, or tags help accurately identify goods and provide the means to be able to trace identified goods upstream. When additional product information is needed, the identified goods to be traced must be linked with production records, which records in reality involve identifying logistics units that have previously been registered. This involves the aspect of internal traceability. When tracing the product, the package's role as an information source is applied. Information is sought in data records where information about the transformed goods is stored. This type of product information is stored within information systems of different actors in the supply chain. This involves chain traceability (see Dreyer at *al.* 2004). This shows that product traceability involves a close interdependence of internal and chain traceability.

At times, actors do not possess the goods and merely wish to complement their existing knowledge of the product with more information. In these cases, such as when retailers make queries about products to distribution centres when ordering, the sales personnel must interpret the query in such a

way that the information may be communicated from actors upstream in the flow of goods. A communication process is initiated once a product query has been registered. This process starts by seeking information upstream following the trail of the flow of goods. When the necessary product information records are located, the actor in possession of this information communicates it to the downstream actor who made the initial query. This communication process may be between actors directly, or the information may be channelled through intermediate actors. When tracing a product, information exchange, as described in the cases, usually involves manual types of exchange. However, product traceability may be enabled through an automated system, potentially increasing the efficiency of this activity.

The information contents communicated when tracing a product consist of, as discussed in Chapter 6, characterising goods at the core with its layers of packaging, and this information is linked with the facility where goods are contained. The logistics unit, the outer layer package form consisting of, for example, consumer packages, distribution boxes, containers, or pallets containing distribution packages, is observed. Additionally, the actual identification of the goods regarding logistics activities may be linked with other data records used to describe how these activities were performed. In the case of TINE Lettmelk, this product is meticulously registered through its various logistics activities with the aim of securing product quality by detecting quality faults at an early stage. These registrations may, however, also be used to trace the product in a detailed manner. As regards unpacked materials, such as raw-milk, the tanks play the role of packages and also need to be identified as location information. This information about the goods containment facilities must be supplied with volume information since these facilities contain a variable amount of goods.

When tracing a product the role of the package as an information source is most evident since this activity mainly involves seeking information about the product through their previous forms of registrations at different locations within the supply chain. This is information about where and when goods are packed and includes descriptions of goods and packages. Packages are, in addition, the basis for identifying goods that need to be traced.

8.1.3 The Interrelationship between Tracking Goods and Tracing Products

It is important that actors in a supply chain have the capability to trace products upon demand. This requires that communication links have been established both within firms and in business relationships. In the event of a

need to ensure product safety and quality, this capability to trace products is imperative. The need to carry out product tracing depends on product characteristics, such as how prone they are to damage during physical distribution. Of the four studied products, the most vulnerable ones, Corona strawberries and low-fat milk, are traced most often. Control activities are mainly carried out to deter the occurrence of product discrepancies. Even though this activity is seldom performed, actors must have the capability to do so because of government demands and to ensure the long-term quality of the provision of goods.

When tracing a product, a combination of time, place, and form variables of goods are sought upstream, almost literally following the flow of goods. This information is denoted as "upstream", since it is the data records of the supply chain product's history that are sought, "upstream" depicting the previous times and places where the goods have been transformed. However, "traceability" must according to government regulations be supported in a downstream direction. This activity is however regarded here as a form of tracking, since this involves informing about the present location of goods. The goods have been dispatched, and a downstream search for information about goods will normally also involve locating goods. Tracing a product may therefore lead to a need to track goods. In these cases, a logistics unit will first be "traced" through the information systems of the supply chain, and then tracked using the information flow to locate a specific shipment of goods.

8.2 The Roles of Communication

This section is based on the roles of the communication model (Gadde and Håkansson 2001) shown in Section 2.2.3 to discuss how various types of information provided through a package may be used for different purposes, including how packages facilitate communication related to coordinating, influencing, and learning.

8.2.1 Using Packages to Coordinate

Coordinating involves organising activities dependent on information exchange between different supply chain actors. Coordination is viewed here as mainly concerned with how information about goods is used for different logistics activities and includes reporting capacities in the supply chain. Information about goods must be combined with information about human resource and facility capacities.

The previous parts have shown that the package plays an important role in the identification of goods. A fundamental problem in a supply chain, as discussed in Section 2.1, is how to coordinate variations in supply and demand through the use of capacities with regard to different logistics activities. Information about goods used to plan logistics activities in the supply chain represents a form of administrative data that is used together with orders to direct the flow of goods. The actual operations involved in logistics activities rely, to a high degree, on technical information to specify more precisely how to carry out these activities based on documents adapted for these purposes. This involves coordinating activities that transform the goods; the activities of tracking goods and tracing products provide technical information based on previously registered goods that may be used to secure the flow of goods.

Technical information regarding the present and future state of goods, especially, is used to coordinate these activities. By informing actors of where the goods are located and their intended time, place, and form features, goods may be assigned to the appropriate logistics activities. Actors managing physical distribution assign goods to activities transforming the them in a logistics unit and its location by providing different and individual instructions for how to carry out the needed activities. Some of these instructions are provided through documents when activities are carried out manually, while others call for more automatic activities. These instructions are created so that one activity may follow the other, such as when milk is first produced at a dairy, then loaded into roll-racks, picked up by terminal workers, and finally loaded onto the delivery vehicle. Therefore, information about goods and how these are to be transformed through activities must be provided to a specific actor so that logistics activities may be carried out in a sequential manner.

Tracking goods and tracing products also provide information that may be used to coordinate activities. Identifying the location of the banana ship carrying Dole Bananas is a form of tracking and is done through automated GPS systems and manual procedures using radio contact with the ship's crew. Tracking a cargo of bananas on a ship bound for Europe, for example, helps to coordinate Dole's own terminal activities in Hamburg. If, for instance, arrival is delayed for a few hours, notice may be given to terminal workers to come to work at a different time than planned. Information regarding a delayed shipment of bananas is also communicated to BAMA Trading so they may notify Color Line and Nor-Cargo Thermo, giving them an opportunity to coordinate their vehicles and personnel operating the transport from Hamburg to Oslo. Tracking goods, therefore, provides

technical information that is used to secure correct delivery of goods in accordance with administrative plans.

Tracing products provides technical information that helps coordinate logistics, production resources, and activities in a long-term perspective. When samples of raw-milk showing an inferior quality are detected, the dairy needs to communicate with the farmer in order to improve how activities are carried out. This helps improve the coordination of logistics activities in the long run, since a satisfactory quality provides a smoother flow of goods devoid of interruptions caused by detected product quality discrepancies.

The package, in its role as an information resource, is a facilitator of mainly technical and administrative information used to coordinate supply and demand. Packages are also used to coordinate variations in the volume of goods with the frequencies with which the goods are at different logistics facilities, thus influencing how logistics activities are carried out. This information about goods is therefore applied more precisely to coordinate the sequentially organised logistics activities and different operations within these activities that transform goods.

8.2.2 Using Packages to Influence

One of the most obvious communicative roles of a consumer package is that its form features, together with labelling on the package, aim to promote products by influencing consumers in a retail environment. In the case of Marian fish filet, a great deal of effort has been put into creating a consumer package that not only contains the product, but also may influence the consumer at the store by providing a commercial text on the package, and using a design that underlines the quality of the product.

In the case of Corona strawberries, the influencing role of the plastic basket is more sublime. The basket is not labelled, but the form of the 500-gram berry basket allows easy inspection of the contained goods. Also, the basket is a common consumer type of package used for different berries, and therefore should convey a perception of freshness and quality to the consumer. Furthermore, when goods are identified, this information may be used to influence customers in their purchase negotiations. A customer may, for instance, perceive location information of the goods as an additional value.

Providing location information through tracking goods helps increase efficiency in planning the use of customer resources and activities by finding

out when goods will arrive and prepare its resources better for their arrival at terminal facilities as a result. Such information is administrative and may in a purchase situation be communicated to a customer to verify when and how goods may be delivered. The customer may value information regarding precise location and other features of the goods that may influence them during a purchasing process. Tracking goods is an activity that influences the customer as it shows more precisely how and when the goods may be delivered. Nor-Cargo Thermo uses trucks with a GPS system that helps inform about the location of goods during transport. The ability to track goods in this precise manner may influence customers seeking transport services to select a logistics service provider, since tracking and monitoring goods during transport secure the timely delivery of goods, thus improving the ability to control the delivery of perishable goods.

Product information provided by tracing a product may also be used to influence a purchase. A consumer and a professional user may appreciate technical information regarding product history. This information may be used to influence a professional supply chain actor in a long term perspective since it enhances the professional customer's perception of the quality of a product knowing that these features also are of importance to consumers' perceptions of product quality and safety. In the case of fish products, over-fishing and the region where the fish is caught are concerns that may be reduced through documenting precise product information. In the case of Corona strawberries, knowing the producer may influence the sales if the purchaser has previous experience with the quality delivered from a particular farm.

The informational role of the package concerning coordination is mainly related to the technical activities providing goods to an end-user. Influencing is related to actors concerned with not only carrying out a logistics activity, but also influencing the development of logistics activities in a long-term perspective. This involves marketing through providing orders and sales by the retailer, as well as wider societal aims such as securing product quality and safety. As far as influencing, the identification of goods plays a more sublime role. The information, either on the package or in documents, communicates to actors more directly, and may thus also influence them. In the case of influencing, the two communicative functions of the package as an information source and an information carrier represent separate uses. Packages are, accordingly, used to influence, either by communicating information directly from the package, or by informing about goods based on information provided from a data system. When influencing actors the information is mainly commercial and is of importance in marketing products as well. The marketing of products is also important for creating

orders that, together with forecasts, lay the ground for carrying out activities that transform goods. It is, therefore, mainly with regard to influencing actors that the marketing role of packaging, as indicated by Lambert et al. (1998), is evident.

8.2.3 Using Packages to Learn

Learning about goods is important both to logistics professionals and consumers and concerns how information is used to improve the capabilities of supply chain actors. Tracing a product is carried out in a basic manner mainly to learn about a product in a way that influences the future behaviour of supply chain actors. The label is an important device in learning about the product since it not only helps identify where the goods currently are, but also helps to inform about the history of the product. When tracing Corona strawberries, the label is the basic source of technical information. The farmer places this label in the slot on the IFCO crate after harvesting. The use of the label is limited to logistics professionals when distribution centres or retailers receive goods. Then the information on the label is used to identify the farm where the products were produced, and it also identifies the picker. If a farm delivers strawberries of poor quality time after time, BAMA usually attempts to help this producer improve production on a more long-term scale. Incidences of damaged Corona strawberries due to transport shock and vibration were previously abundant. This was commonplace when cardboard crates were the most common mode of carrying strawberries at the distribution-level and is the reason why BAMA decided to change its distribution-level package to IFCO crates that protect strawberries far better.

In the supply chain, identifying quality discrepancies of goods leading to tracing this product, usually initiates a learning process to develop activities to improve product quality. Learning about goods is based on informing about them in the supply chain and has a more long-term scope than coordinating and influencing. This is because it may involve improving the ability of the human resources to carry out activities and changing the products and facilities used in these activities. It is mainly through tracing products that information about goods is used to help improve how to carry out logistics activities that provide the basis for reducing distribution problems, thus enhancing product quality.

Consumers may also study detailed labels containing technical information, as in the case of TINE Lettmelk cartons, to learn about vital characteristics of the product. This helps consumers choose products that are best suited to their needs. The information stamped on the arch of the PURE-PAK carton provides the best-before date, letting consumers learn about the degree of

freshness of the product and at which production line at a specified dairy it was produced. This basic product information may stimulate the consumer to learn more about this product, especially regarding its different quality and safety issues. The same information may be used by TINE to learn exactly when and where a production failure took place, thus providing an improved capability to develop its activities and resources in this production process. The carton also provides printed technical information that lets the consumer know the ingredients of the product and how it was produced, as well as commercial information regarding recipes. The consumers may use this information on the milk carton to learn better how to use the product in their household. This type of product information may also influence consumers in a purchasing situation and, with regard to professional customers, enhance the value of a product on a long-term scale including potential repurchases of the product.

This aspect of informing about goods is also important when it comes to marketing the product. It is mainly from documents provided through tracing products and from labels containing detailed product information that actors learn about the goods. This basically concerns providing information about the more precise aspects of the goods for professional actors in the supply chain and as products for end-users. As in the case of influencing, learning is also, in part, facilitated by a package. Information used to learn about goods is provided through using the package as an information resource to identify and characterise the goods accurately, and involves providing information about how goods have been transformed through the scope of the entire supply chain.

8.3 The Package as a Facilitator of Information Exchange

The previous sections of this chapter are concerned with using information about goods in a supply chain context. This involves the activities of tracking goods and tracing products for user needs regarding coordinating, influencing, and learning. In this section, focus is directed towards the role of the package to communicate about goods through information exchange in a network of various supply chain actors. The first part of this section provides an analysis of how the communicative functions of the packaging are influenced by its physical functions. This is followed by an overview of the discussion in Chapter 7, and Sections 8.1 and 8.2 regarding how the package is a resource that links actor needs with activities, thereby facilitating information exchange. This involves analysing how the package plays a mediating role between the flow of information and the flow of goods by linking actors with logistics activities through contributing to the information exchange. The last part of this section is concerned with how

packages contribute to the adaptation of information that is exchanged to meet user needs.

8.3.1 Communication and the Physical Functions of the Package

The functions of the package include 1) being a goods protection facility through containing goods, 2) the provision of utility with regard to logistics activities, and 3) communicating within and between information systems. Accordingly, this section focuses on how the two physical functions of the package, as a goods protection facility and a provider of utility regarding logistics activities, influence the communicative function of the package. This communicative function is primarily related to information exchange.

The packaging that facilitates the protection of goods may be regarded as the most fundamental function of the package. When goods are contained in packages they are identifiable logistics units allowing a linkage to an information system through comparing labels with documents. Unlabelled goods may also be identified against documents by counting the standard types of packages. When goods are packed they also may become measured as standardised volume contents of goods, which also contributes to how the volume information is communicated through documents. The use of a package designed to contain a specific volume of goods facilitates how the volume, weight, and size of goods are reported on. This is important since, when packed, goods are usually concealed from direct visual control and documents and labels provide the only access to revealing the contents of the package.

When, for instance, BAMA Trading receives all its bananas in one size of banana boxes grouped onto pallets, this is a result of an itemization policy that influences how bananas are measured when purchased from Dole and later sold to BAMA Trading's distribution centre customers. Unitisation of goods provides goods with size and shape. While unitisation? is a feature of packaged goods related to logistics activities, apportionment is mainly pertinent to retailing products and is primarily used to characterise how consumer packages are used to create a product size and shape. Among the product cases only bananas are not consumer-packed; consumers must therefore themselves choose the volume they wish to purchase by picking the desired number of banana fingers. Apportionment and unitisation are facilitated through the use of packages, and package form features, thereby, influence how goods are characterised in documents provided through an information system. Therefore, apportionment and unitisation of goods through packaging not only influence the volume features of goods but also how the volume of packed goods is reported.

The utility function is concerned with how packages influence the efficiency of logistics activities. Packages may be more or less well adapted to different logistics facilities (e.g. forklift equipment, storage compartments, conveyer belts, ramps) and manual handling. Package utility is influenced by how well different levels of packaging fit together when combined into a logistics unit, and how well the logistics unit is adapted to logistics facilities. This is obvious in the case of Corona strawberries where different packaging levels are well adapted to each other because of their standard shape and size characteristics. A truck storage compartment is also designed to carry a specific number of EURO pallets. Packaging standards influence the physical characteristics of packages and are therefore of importance when different types of goods are handled using containment and goods handling facilities.

Additionally, packaging standards influence information exchange concerning goods. When the same type of goods packed in standard sized packages are combined, a fixed number of distribution packages represents one pallet of these goods. Therefore, it is possible to talk about goods as "pallets" without also having to go into informational detail regarding the contents of this pallet.

Since the information about goods should reflect physical features of the packed goods, the typically standard characteristics of packages also facilitate the standardisation of information about goods. Describing a logistics unit involves explaining the different standard package forms used. A pallet of Dole bananas, Corona strawberries or a roll-rack of TINE Lettmelk all contain standardised numbers of distribution packages that may be used to calculate an approximate volume of goods. Describing the contents of the logistics unit involves characterising goods contained in standard size packages and how these packages are combined with others containing other types or the same type of goods. How goods are identified and characterised is, accordingly, dependent on shape and size features of the package. The physical features of packages thus influence how goods are identified and how information is exchanged. Consequently, using standardised packages to characterise goods facilitates the creation of standardised information contents in documents, influencing how information is exchanged. Figure 8.1 below shows how different functions of packaging (shown in shadowed boxes) are related to the interplay between the package, or labels carried on the package, and different uses for the package (e.g. in an information system, for logistics activities, or in protecting goods):

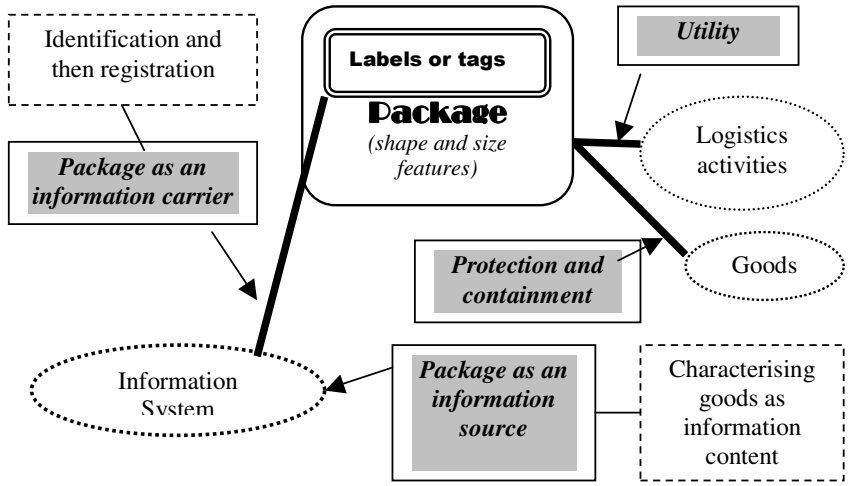

Fig.8.1 Interplay between different packaging functions. (Shadowed boxes indicate the different functions of packaging)

Figure 8.1 illustrates how the communicative function of the package as an information carrier links packed goods with an information system. Since packages carry labels, this element of information carried on packages using labels facilitates accurate identification of goods when controlling them against documents. The information contents carried on labels should correspond with information contents listed in documents provided by an information system. Hence, packages influence the accuracy of goods identification.

The function of a package as an information source includes how packages are used as information contents in information systems and to exchange information between supply chain actors employing different information systems. The standard features of the package influence the use of ICT in the supply chain to automate information exchange. This view assumes that standardised packaging carries labels with bar codes (or the potential use of RFID tags) based on GS1 standards, which facilitates automated identification of goods by linking the coded information on the label directly with the information system through scanning these bar codes. Therefore, communicative functions of the package, both as an information source and as an information carrier in interplay, facilitate automated information exchange through the use of ICT. Hence, the package influences not only how goods are identified and characterised, but also the efficiency of

information exchange through facilitating electronic data interchange within and between information systems.

8.3.2 The Package as a Mediating Resource between Actors and Activities

This section focuses on how the package mediates between, or links the flow of goods with the flow of information by facilitating communication between supply chain actors and logistics activities and other user needs. The transformation of information about goods is complex. At a sort, information about identified goods may concern its past, present, or future state. Information concerning the different states of goods is used for different purposes. Features of different logistics activities and a wide range of other activities transcending the borders of a supply chain are examples of the many different purposes of using information about goods. This information may for instance be used to pick up goods at a distribution centre for outbound transport, to facilitate the cultivation of an agricultural product, to satisfy government requirements, and to influence consumers in a retail setting. Information about goods is, accordingly, exchanged in a wide range of activities. Within the supply chain boundaries, logistics activities, tracking goods, and tracing products are regarded as the most prominent uses of information. Actors have different needs to coordinate, influence, and learn, which may be described relative to different types of activities regarding tracing products, tracking goods, and logistics. The relationship between 1) information exchange concerning goods, 2) different activities, and 3) user needs is based on the discussion in Section 8.2 and shown in fig. 8.2 below:

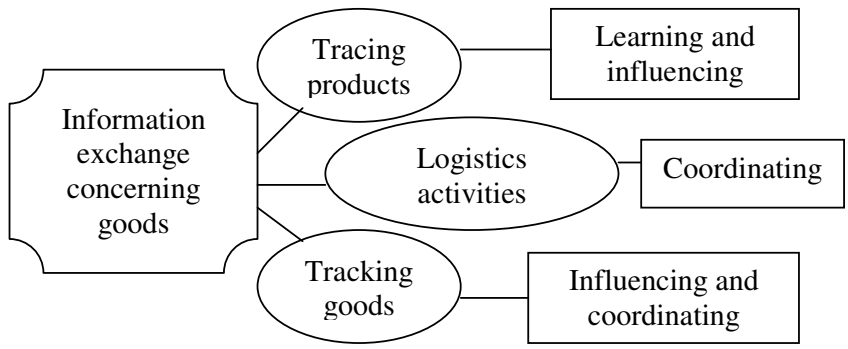

Fig. 8.2 The communicative roles of packaging and logistics activities, tracking goods, and tracing products

Information exchange concerning goods is primarily used to carry out logistics activities and aimed at coordinating supply chain resource capacities with variations in the flow of goods (see e.g. Heskett et *al.* 1973). Tracing products provides information about goods that is used to learn about them and influences both customers and suppliers by providing detailed historical information in the supply chain. Information obtained through tracking goods is mainly used to influence customers and coordinate logistics resources and activities. Different activities are, accordingly, related to different actor needs and represent the fundamental requirement for adapting information to user needs.

In Section 8.1, it was discussed how tracking goods and tracing products are dependent on information having been registered through logistics activities previously. The package plays a vital role in facilitating goods' identification, both by carrying labels and through simply counting the number of packages containing goods. If these packages are of the same type, the standard features of packages thereby simplify calculating the identified volume. Identification of goods is vital preceding the sort, as when receiving incoming goods from transport and when assigning goods to logistics activities such as collecting them for outbound transport. In addition, the role of an individual sort differs from previous and future sorts regarding the types and features of logistics activities.

At sorts, information contents concerning goods are adapted to activities when creating documents. Information provided through tracking goods and tracing products has different features than information provided from logistics activities. While the function of sorts primarily is to support the transformation of goods through logistics activities, tracking goods and tracing products are indirectly related to the transformation of goods. These are types of "information providing" activities that are dependent on the previous registration of information about goods. Tracking goods, tracing products, and logistics activities are interrelated since they all are dependent on the previous identification of goods and registration of information about them in an information system.

As discussed in Section 8.1, tracking goods is concerned primarily with informing about the present state of goods and tracing products to inform about the past state of goods. Logistics activities are, as discussed in Chapter 7, dependent on identifying the present state of goods in combination with information concerning their future state. Characterising the different states of goods in relation to each other involves accounting for differences in time, place, and form features. The form features involve characterising goods and the use of different types of packages to contain them and how goods are

identified as logistics units. Since it is the logistics unit that is identified at a sort, how goods and packages are combined into logistics units, therefore, influences the information contents that are exchanged.

The information role of the package is important in the provision of information to different types of activities. When goods are packed, the logistics unit is identified and registered at a sort. Since goods' identification is indirectly related to tracking goods and tracing products, the communicative function of the package as an information carrier is also indirectly related to these activities. However, the communicative function of the package as an information source, involving the role of the package as part of the information contents exchanged, is vital to logistics activities, tracking goods, and tracing products.

Logistics activities primarily involve identification and handling of logistics units. Goods handling is influenced by specific needs related to features of the goods, such as perishability and risk of damage through vibrations and shock. Tracking goods is primarily about locating a logistics unit and potentially also smaller packages or goods contained within a logistics unit, while tracing products concerns seeking information about products, including complete information about logistics units and the packages and goods contained in these units. Furthermore, tracing products also involves seeking information about how production has transformed the form features of goods, for instance how goods are packed. When tracing products, the logistics unit is one element of information contents that is combined with other types of information about goods and packages.

The logistics unit also plays a vital role in marketing. When purchasing goods, customers need to be informed about availability and the packages the goods are supplied in. The packages unify goods providing more effective logistics activities, and apportion products to retailer and consumer needs. This information is dependent on updated information provided through identification and registration of logistics units. Customers may order goods in quantities measured at the transport packaging level, such as roll-racks of milk or pallets of Corona strawberries. In the case of Marian fish filet, a low-volume product type, the consumer level packaging is used to negotiate volume measurements of goods. Here, distribution-level Gilde meat boxes function primarily as logistics units. In most cases, however, the logistics unit is represented by a transport level package. The logistics unit, which in principle may be a type of package at any level, is the entity employed to influence customers during purchasing negotiations. This concerns a marketing function of the package used to exchange information and influence in business-to-business relationships.

Moreover, marketing involves information exchange in business-to-consumer relationships. In a retail environment, the discussion in Section 2.3 showed that especially the consumer level package is of importance since this type of packaging assigns goods and thus adapts them to consumer needs through apportionment. In addition, consumer packages influence consumers by their design and the promotional information printed on them. Tracking goods is an activity carried out by professional supply chain actors and involves mainly searching for a logistics unit and potentially lower-level packages contained in this unit. A consumer may visually observe consumer packaging in a retail setting and use this level of packaging to find product information. Consumer packaging is also utilized by the end-user to initiate a tracing process to find additional information about the product. However, once professional actors in the supply chain become involved in tracing a product, it becomes evident that the logistics unit plays the most prominent role since this is the entity that is identified and registered in the information systems of the supply chain actors.

Consumer packages function closely intertwined with what is perceived by supply chain actors as products. Features of products are characterised regarding logistics units. This is because it is logistics units are identified and controlled against documents and are, accordingly, the object that is registered in the information system. Characterising goods involves accounting for the level and type of package that a logistics unit at the outer level is distinguished by. This may be regarded as the core information contents about goods that are exchanged. Therefore, in practice, informing about goods starts by describing the type of package functioning as the logistics unit, and then accounting for its contents of various forms of packages and goods. Information about features of goods is thus a combination of different information contents concerning packages and goods.

Information contents about goods are exchanged for different purposes. This is primarily reflected in that various levels of packaging are used for different purposes. Consumer packaging is used mainly by retailers to promote products, distribution level packages are used to unify goods into sizes that may be handled manually in logistics activities and contain a convenient number of consumer packages for the retailer, while transport level packages are most commonly used to facilitate handling during logistics activities. Different types of logistics activities, consequently, depend on information concerning specific levels of packaging. Package characteristics, including the classification of packages into different levels, represent a tool for how information about goods may be created in documents and thereby exchanged. Packages facilitate identifying goods and

thus influence how goods are characterised, since it is the type of package, the logistics unit, which is physically identified at a sort, not the goods contained in packaging. At a sort, goods are a relatively idle resource concealed within the package. Packages are therefore viewed as a mediating resource between activities and actors. This view is based on the fact that packages facilitate both identifying and characterising goods and then linking this information needed by actors to carry out activities.

8.3.3 The Adaptation of Information about Goods

Information about goods has to be adapted since the various supply chain actors have different requirements regarding the activities they are responsible for. In Chapter 7, it was discussed how individual supply chain actors carry out different logistics activities sequentially related to each other. In addition, informing about goods in a supply chain also involves tracking goods and tracing products. Another aspect of using information is, as discussed in Section 8.2, that actors may in principle use the same information contents about goods for different purposes regarding coordinating, influencing, or learning. Information about goods is a transformed resource. Information contents are transformed at a sort when goods are 1) identified and registered when it comes to *providing* information, 2) when the information is *adapted* using an information system, and 3) when actors *use* documents for different purposes. Adaptation of information is, accordingly, an activity that takes place between the identification of goods and the use of information about them. This is shown in fig. 8.3 below:

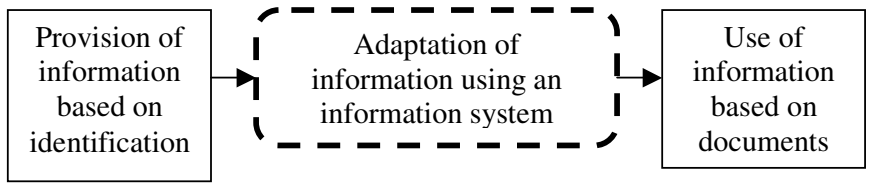

Fig. 8.3 The transformation of information about goods

The adaptation of information is an activity that links different types of information contents stored in an information system with actor needs. The transformation of information means that information about the same goods may be described regarding past, present, and future features. Additionally, information about goods may be combined with information concerning goods handling, product values, destinations, time schedules, and a vast amount of other types of information needed by the actor to carry out a

specific activity. Information exchange is related to the provision, adaptation, and use aspects shown in fig. 8.4. Information must, consequently, be exchanged to provide information, process and combine different types of information contents within an information system, and to communicate information to the actors through documents.

Packages are used to provide utility to users, both in the flow of goods and for information, through the use of the information system. While utility previously has focused on features of goods, it may also be described in relation to information contents as discussed in sections 6.1 and 6.2. The provision of information as far as activities may be regarded as more or less well adapted to user needs and represents a quality aspect of information contents that influences the ensuing activities that the information is used to support.

In these cases, the provision of information about goods is related to logistics activities by registering the transformation of goods through previous logistics activities, and is not used to carry out future logistics activities. Furthermore, this provision of information may, in some cases, represent the final objective of some actors, such as government agencies demanding product traceability and customers seeking to analyse product offerings from a supplier concerning their inventory requirements. Therefore, information about goods needs to be adapted to a wide range of purposes.

A central feature of adapting information about goods is that it represents combining different types of information about goods with information about facility and human resource capacities in the supply chain. This is the essence of coordination in a supply chain and is discussed in Section 2.1. The communicative function of the package as an information source is prominent when adapting data through information processing in an information system. The communicative function as an information carrier represents the basis for the capability to accurately adapt information about goods. Information about the time, place, and form features of packages is combined with the product name and information concerning other logistics resources, and used to create documents that may be used to satisfy user requirements.

A range of different documents contains adapted information about goods. These include product lists used for ordering goods, order forecasts, order forms, inventory lists, transport documents, invoices, picking lists, and customs declaration forms. Packages are apparent as part of the information contents in all these types of documents. However, the way goods are described is adapted to the use of the document, influencing how packages

are used to characterise goods. By combining different types of information contents related to goods, documents may be produced that are adapted to logistics activities, as well as for other purposes.

The logistics unit is of importance when it comes to the adaptation of information since, as previously discussed, this is the physical entity that links the information system with the flow of goods. Therefore, features of the logistics unit will also be reflected in the information contents. Characterising the logistics unit, accordingly, influences how information is adapted to different user needs. When goods are packed the form features of goods are characterised by standard packaging shapes and sizes, and the package and the labels it carries are then identified. Hence, information contents adapted in an information system primarily reflect the identified logistics unit, thereby also facilitating goods' characterisation. Figure 8.4 illustrates how goods, logistics units, information systems, and documents are related regarding the provision and use of information in a supply chain:

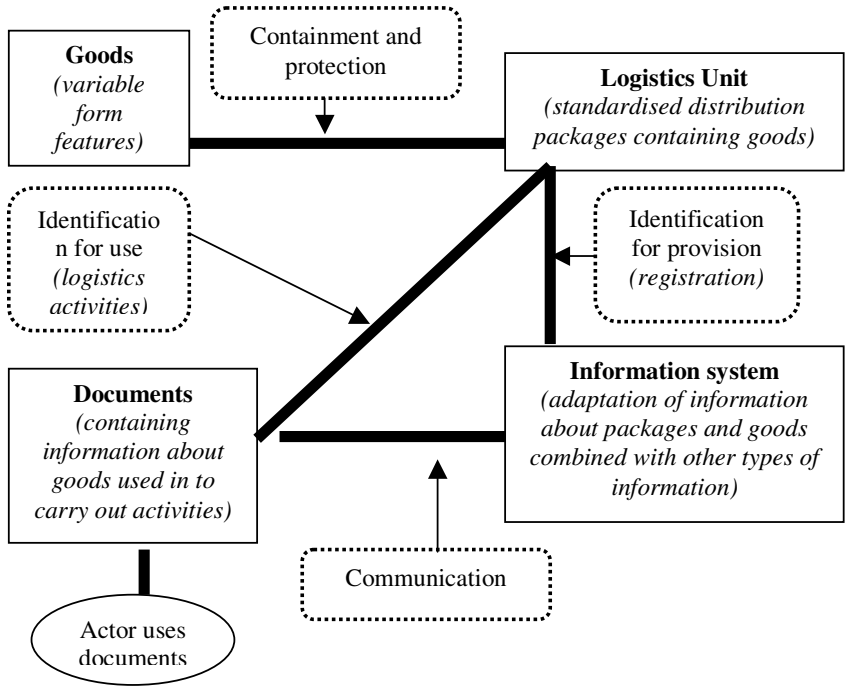

Fig. 8.4 The relationship between goods, logistics units, information systems, documents and actors in a supply chain

Figure 8.4 illustrates how goods are linked with an information system through the logistics unit. In addition, this figure shows how documents are interlinked with the information system through communication involving information exchange between actors. It also shows a link between the logistics unit and documents when identifying goods. Accurate information exchange is facilitated by identifying the logistics unit, including characterising the form features and describing the contents of a unit. A logistics unit is a form of identifiable packaging that contains goods. Note that no direct connection is indicated between goods and documents. Identification of goods "goes through" the logistics unit. Packages may therefore be regarded mainly as a logistics resource used to mediate between actor needs and activities since information about goods is adapted through goods' identification, thus using the package as an information source.

The adaptation of information contents concerning goods for different uses is facilitated through characterising the physical features of the package. Adaptation of information about goods is dependent on information exchange to provide different types of information to be combined and processed in an information system, and to communicate documents with regard to different activities. Accordingly, packages link information contents about goods in the flow of information with the flow of goods through facilitating reliable and accurate identification of the present state of goods. Accuracy and reliability are facilitated by the role of the package as an information carrier when control of goods is carried out against documents, while information exchange involves the package in its role as an information source.

Consequently, the package viewed in the supply chain as an information resource, may be ascribed an important role in a supply chain context. This view is based upon that the package facilitates the provision of information through mediating between actors and activities and by helping to adapt information that may be exchanged between supply chain actors. The package as an information resource is a technical component that is a part of the glue that holds the supply chain together. These aspects of using the package as an information resource are discussed in the following and final chapter.

9. Concluding Discussion

In this concluding chapter, three issues are discussed that have become evoked based on the preceding analysis regarding the role of the package as an information resource. The first issue discussed in Section 9.1 is concerned with how the package as an information resource is of importance and thereby plays a core role in a supply chain. Section 9.2 places focus on how the package links the flow of goods with the transformation of information. Section 9.3 discusses how the package contributes to information exchange between various supply chain actors. Finally, in Section 9.4, some concluding remarks are accompanied by suggestions for further research directions based on this study.

9.1 The Package as a Core Logistics Resource

The provision of goods is often conceptualised as a "flow of goods". This flow, together with the complementary flow of information, is, in accordance with Arlbjørn and Halldorson (2002), regarded as the core of logistics. In the flow of goods, the package is viewed as a logistics facility that is designed to protect goods and provide utility with regard to logistics activities (Twede and Parsons 1997). These are the physical functions of the package embedded in the flow of goods. Ballou (1987) argues that it is the package, and not the product, that must be dealt with in the flow of goods. This is a view primarily concerned with the physical characteristics of the package.

While Ballou (1987) underlined the importance of packages in the flow of goods, this study places focus on the role of the package as a resource that is also embedded in the flow of information. According to Twede and Parsons (1997), the communicative function is one of three functions of the package in a supply chain. This communicative function may be split into two: a function of the package as an information carrier and as an information source. It is, therefore, possible to classify the package as having two physical and two communicative functions.

The preceding analysis in Section 8.2 has shown how the two physical and the two communicative functions of the package are intertwined. When goods are contained in packages, it is, as Ballou (1987) states, the package and not a product that has to be handled. Features of the package, accordingly, influence the provision of utility as regards logistics activities. When goods are packed and combined through layers of packaging containing goods they are identified and therefore also primarily regarded as logistics units. In accordance with Ballou (1987), the shape and size features

of logistics units and labels carried on this type of package are identified, controlled, and registered into an information system. Therefore, it is not the product that is in focus when carrying out logistics activities in a supply chain. When goods become packed, the product literally disappears from view, and the package takes over the role as the core resource that must be identified, controlled, and registered in the documents. Therefore, the logistics unit, which at its observable outer level is a type of packaging, is the entity in the supply chain that is used to identify goods and hence has to be managed when it comes to logistics activities.

In the supply chain, when goods are packed, the product dimension does not lose its importance. Goods contained in packages need to be informed about, and features of a product (as discussed in Section 6.1) play an important role in this respect, influencing how goods are transformed and informed about. The product is of importance since an end-user is essentially seeking a product to satisfy his/her needs. In addition, upstream in the supply chain, product names and product-based classifications are still evident in documents used by various actors when assigning goods to logistics activities.

Products are used to classify different types of goods, providing name to the logistics units that are identified and handled. Packages represent information contents embedded in an information system that is combined on equal terms with other information elements. When a logistics unit is identified, this entity is described by accounting for 1) the product name, 2) size and shape features of packages used to contain goods, 3) form features of the goods contained in the package, and 4) time and location features concerning the environment of the logistics unit. Packages represent an integral part of the information contents concerning goods. The information contents may then be combined with other types of information in order to adapt it to user needs (previously discussed in section 8.3).

Since goods are physically concealed from observation when packed, it is important that the features of the logistics unit be identified and informed about. This involves characterising the size and shape of different packages combined into a logistics unit, and characterising features of the goods contained in specific types of packaging. Features of logistics units need to be coordinated with other types of logistics resources. Additionally, as the package links the information system with the flow of goods through the identification of logistics units, this provides an additional perspective on the core role of the package in a supply chain.

The communicative functions of the package as an information source and as an information carrier are intertwined since goods cannot be characterised precisely without being identified accurately. The different functions of packaging are embedded in the core flow of information and flow of goods. Packages, therefore, play an important role, not only as a physical resource, but also as an information resource facilitating the identification of goods and characterising goods.

9.2 Packages and the Transformation of Information

The transformation of information about goods involves, as discussed in Section 8.3, identifying goods, adapting information about goods by combining different types of information elements within an information system, and then communicating this information to users. Information is used to direct the transformation of goods through logistics activities to provide utility to actors in the supply chain.

In logistics literature the information flow is commonly described as playing a supporting role to the flow of goods (e.g. CSCMP logistics management definition). Information systems are used as a database to coordinate, plan, and control the flow of goods and, in addition, to achieve customer service (e.g. Christopher 2005:183). This shows that information regarding the transformation of goods may also be used for marketing purposes. In a supply chain, information is needed that both provides market information and information about the flow of goods (ibid. p. 224).

In a volatile environment, information concerning goods plays a key role in achieving a supply chain that is flexible and thereby may adapt to variations in the flow of goods and other environmental contingencies (Christopher and Peck 2004). The most evident purpose of the flow of information is, however, to direct the flow of goods. Information directing the flow of goods is based on orders and forecasts. Orders represent a form of information exchange that is based on actual sales, while forecasts are based on information exchange regarding anticipated sales. The transformation of goods is, accordingly, dependent on these types of order or forecast information.

This study has shown, especially through the analysis in Chapter 7, how the flow of goods and the flow of information are closely intertwined. Information based on orders and logistics plans is of importance in directing the flow of goods. Furthermore, this analysis shows that when goods are transformed through logistics activities, the flow of goods also affects the

flow of information through identifications and registrations of transformed goods.

Through a sequence of sorts, goods are identified and registered into the information system. When transformed goods are identified, this contributes to the transformation of information, which takes place in three stages. First, the transformation of goods updates information about goods through their identification, control, and registration in the information system. Second, in the information system this updated data is combined with other types of data regarding goods (possibly also combined with data concerning other types of goods), and features of different logistics resources. This represents the potential for adapting information about goods to user needs. Third, this combined information resource is then, on demand, adapted to user needs to assign goods to logistics activities and for other potential purposes.

It is difficult to distinguish whether the transformation of goods or the transformation of information is more important or regarded as "coming first" in a supply chain. The transformation of goods has a vital impact on how information is transformed, and this transformed information, influenced by preceding identifications of transformed goods, is used to direct the flow of goods. This illustrates how the flow of goods is influenced, not only by orders and plans, but also by how goods have been transformed in the flow of goods. This means that the short-term (operational) logistics plans evident in documents used to direct the flow of goods at a specific sort may be influenced by previous transformations of goods.

The package plays a particular role in the interplay between the flow of goods and the flow of information that interlink different sorts in a supply chain. The package is used as information content concerning goods when these flows literally "meet" when registering and assigning goods. Packages may therefore be viewed as playing a mediating role between actors and activities in the supply chain.

Packages are physical objects that are not location-specific and therefore follow goods in the supply chain. Through its function as an information carrier, the package facilitates an accurate linkage between the information system and the flow of goods. Logistics units are identified and registered at sorts when goods need to be controlled against plans, thus influencing how the flow of goods has an impact on the transformation of information. This control activity is facilitated through the use of information carriers registered both in documents and on labels or tags.

Packages, therefore, facilitate how information content is exchanged and involves controlling incoming goods and assigning goods to logistics activities. The package also assists with adapting information to user needs as a piece of information contents, linking the controlling of goods from past logistics activities with the assigning of goods to future logistics activities. Through its role as an information source, packages are used facilitate the registration of goods into an information system, transforming information contents about goods, and directing the flow of goods. At a sort, it is therefore evident how the two communicative functions of the package, as an information carrier and as an information source, are closely interrelated.

The package is a core facility in the flow of goods and plays a key role in the control of goods against documents. Based on facilitating the identification of goods packages also play a core role as information contents in the information flow. Accordingly, the package plays a key role in the transformation of information by interlinking the flow of goods with the flow of information. Moreover, the package plays a key role in facilitating information exchange, which also has impact on how information is transformed. This issue of information exchange is discussed in the following section.

9.3 The Package as a Facilitator of Information Exchange

Information exchange connects different actors in a supply chain. The degree of actor integration is a key issue of supply chain management (e.g. Lambert el *al.* 1998b). Furthermore, how actors are technically interlinked through information exchange is an important feature of how supply chain actors are linked. In this respect, information exchange plays a vital role through facilitating the coordination of various resources managed by different actors in the supply chain, thereby contributing to the efficiency of logistics activities (see Heskett et *al.* 1973, Lambert et *al.* 1998, Gadde and Håkansson 2001: 71-75, Christopher 2005:285). The efficiency of the flow of goods depends on whether goods are delivered on time, in the prescribed condition, at the desired location, in an economically feasible manner (Ballou 1999). In order to transform the time, place and form features of goods efficiently through logistics activities, information that is adapted to carry out these activities must be provided from both an internal information system and from different supply chain actors.

The package, as previously discussed in this chapter and in Section 8.3, is regarded as a resource that mediates between actors and different activities. Packages contribute to "earmarking" goods with intended time, place and form features directing the flow of goods by facilitating their identification

as discussed in the previous section. How well these aims, in addition to the feature of linking the flow of goods with the flow of information, are achieved also depends on how information is provided to actors through information exchange. This entails not only that information exchange is dependent on the information contents being adapted to logistics activities and other purposes, but also on this information being timely and accurate.

Timely and accurate information is regarded as essential in order to achieve a supply chain that efficiently adapts to environmental contingencies (Christopher 2005:285). In section 2.2 it was primarily discussed how information must support the flow of goods. In addition, information concerning goods must be transformed (communicated and adapted to use as discussed in Chapters 7 and 8) in an efficient manner. Holmberg (2000), therefore, in relation to features regarding the efficiency of information exchange, calls for the design of a unifying logistics measurement system to electronically link the different information systems of various supply chain actors to achieve what is often termed as a more "seamless" type of information flow. This involves reducing the role of manual intervention in information exchange.

Information exchange is facilitated by ICT. The use of ICT influences the degree of automation in information exchange, which again influences features of information exchange regarding its contents, accuracy, and timeliness. According to Ellram et al. (1999), the transformation of information through communication is, in practice, hampered by how ICT has been implemented in a supply chain, influencing how information systems used by different actors are interconnected. This is evident in the cases of this study regarding how various information systems used by different supply chain actors are tied to each other. Examples were found regarding how information exchange within a firm often is carried out using an advanced ERP system, while e-mail, fax, and telephone calls are used in communication between different supply chain actors. This reduces the degree of standardisation in information exchange. The use of different types of communication media dependent on different types of ICT to facilitate information exchange also increases the complexity of the flow of information. In the same manner as the flow of goods consists of features of time, variation, and frequency regarding how goods are transformed, an information flow may be described as consisting of actors interlinked through information exchange using information systems applying different types of ICT.

Manual communication and different types of electronic communication are dependent on communication standards between actors. However, the use of

different ICT-based communication facilities also leads to the use of different types of information carriers in the supply chain. When different information standards are used in supply chains to exchange information, actors often turn to information provided by the firm's accounting system rather than updated information about goods to manage and operate the flow of goods, since this type of information may be regarded by an actor as more comprehensible and reliable (Holmberg 2000). The provision of incomprehensible, untimely, and unreliable information may lead to relatively inefficient searches for alternative information sources. This is described in the cases especially regarding how product tracing and tracking goods is or may be carried out through a trial and error process. The cases show a piecemeal-designed mix of manual and automated forms of information exchange in supply chains. Actors are also poorly integrated since different information systems are linked together using different standards involving relatively slow and inaccurate manual forms of information exchange.

The adoption and use of seamless electronic data interchange in a flow of information is an example of how ICT may contribute to increase the efficiency of information exchange. A "seamless" information exchange could, therefore, not be accounted for between independent actors. In more or less manual forms of information exchange, the package, based on its standardised physical features, contributes to a greater degree of standardised information contents, thereby having an impact on how information is exchanged.

The standard features of packages unitise goods, and thereby facilitate an accurate classification of goods into standard volumes. This is the foundation for the numerical classification of products and for creating a logistics unit that may be marked with a unique identity. The use of numerical coding of goods facilitates automating goods identification and electronic information exchange as discussed in Section 8.3. The numerical coding of goods through using packages lays the foundation for electronic goods identification, control, and information exchange. This also has an impact on how logistics activities are carried out since information is adapted and communicated more rapidly. The standardised physical features of packages have impact on how information content concerning goods is registered in an information system and therefore also on how this information is exchanged between actors using different information systems.

Therefore, packages may be regarded as a core element physically located in the flow of goods that also contributes to efficient linkage between different information systems. This involves using both the package's functions as an

information carrier and an information source laying the foundation for electronic and thereby potentially for a higher degree of efficiency regarding information exchange. Information exchange directly involves only the function of the package as an information source. This role is, however, based on goods having been or being identified, thereby interlinking the flow of information and the flow of goods. The role of the package in the information exchange underpins the importance of the package in a supply chain as discussed in Section 9.1.

9.4 Final Remarks and Paths for Further Research

Although supply chain actors perceive it as playing a sublime role, the role of the package as an information resource is vital. The main purpose of logistics is concerned with the transformation of goods, and the package facilitates this transformation through both its physical characteristics and as an information resource. The package is a core resource in the supply chain since it, first of all, carries goods, thereby also facilitating informing about goods.

The roles of packages in a supply chain are many-faceted. When goods are packed, achieving goods containment and utility influencing how goods are transformed provides a fundamental value. The role of the package as an information resource is on equal terms with its physical features. This view is based on the package facilitating mediation between actor needs and various activities. In addition, packages, through their role as information contents, facilitate the linkage of different supply chain actors through communication.

When goods are packed, using the package as both a physical resource and an information resource increases the efficiency of the transformation of goods. Packages, accordingly, play a core role as a goods containment facility, adapting information to user needs by accurately interlinking the flow of goods with the flow of information and by facilitating efficient information exchange. Based on the overall findings in this study, some topics for further research are suggested.

The use of the package as an information resource has been shown to have an impact, not only on logistics activities, but also other business and societal needs, including marketing and consumer requirements regarding product quality and safety. The package is, however, a result of a design conceived in the realm of packaging technology. Research issues may be found through interdisciplinary efforts involving, for instance, packaging, marketing, information and communications technology, product and

production technologies (e.g. food and foods processing), and logistics. Studies may, through using a "packaging approach", place features of packages in focus and relate this to key issues within various technical and business fields of research. Within logistics, further studies may focus on how standardised packages used to identify and register goods may also be used as electronically stored information contents with regard to logistics planning tools within information systems.

The empirical data in this study concern the distribution of fresh foods to retailers in Norway. Fresh foods are distinct from other types of products primarily due to the limited time frame within which these types of goods may be distributed. Additionally, the supply of food products often fluctuates, thereby increasing the degree of uncertainty in these types of supply chains. These features of the flow of goods influence the use of the package as an information resource, and, therefore, further studies focusing on other types of goods are called for. Product features regarding "technicality", "perishability", "bulk", and "combination with other goods" may be used to identify different product cases, e.g. involving industrially manufactured goods.

This study has primarily focused on using the package for providing, adapting, and using information about goods. It has been shown how packages as a physical resource are combined with goods and facilities used in connection with logistics activities. In addition, the communicative functions of the package regarding its use for identifying goods and as information contents have been accounted for. Further studies may direct attention to how the flow of goods impacts on the flow of information. User needs, however, have only to a limited degree been accounted for. A direction for further research may be to account for in greater detail user needs regarding adapting information contents to various actor needs concerning goods. This may involve the needs of both professional supply chain actors, and end-user actors.

In this study of logistics activities, tracking goods and tracing products are viewed as different activities based on a common database conceived in a supply chain. These logistics activities are shown to be both different and as well as closely interrelated. They all rely on information concerning temporal aspects of goods, but each has a specific focus on either the past, present, or future state of goods. Therefore, information from a common database in the supply chain may be visualised as used for these different purposes. Further studies may place greater focus on how the information flow may be used to 1) direct the flow of goods, 2) tracking goods, 3) tracing products, and 4) other business or societal uses of information concerning

goods. This involves studying in further detail how these various types of activities are interrelated through the transformation of information.

This study has brought the package out of its rather obscure logistics role "backstage" in the supply chain. Packages interplay with other packages and with goods. In addition, the complexity of packaging is heightened by its communicative purpose in the supply chain. This study shows that the foundation of the importance of the package in a supply chain is grounded, as discussed in section 9.1, in its *use* primarily as a logistics resource, and that this use also involves a role as an information resource.

The focus on the package as an information resource, however, also directs attention to that the importance of packages to transcends the borders of the supply chain and involves other business and societal functions than logistics. Designing packages should therefore encompass not only the physical features of packages regarding how they contain goods, carry labels and tags, and are combined with other packages and logistics facilities.

In addition, packages should be designed to take into consideration how goods may be efficiently informed about. User needs regarding the type of information required should have an impact on package design. This is because the shape and size features of a package and how these features are standardised, facilitate how information is adapted through combining it with other types of information. If packages are to a greater degree specifically designed for this purpose, they may contribute to providing information for different purposes in a more economical manner.

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Appendix 1: List of interviews

Date	Company	Informant function	Overall theme of interview
5.3.02	BAMA Trading	Logistics manager	Logistics operations in BAMA
6.6.02	BAMA Trading	Product manager (Apples…)	The role of the product manager
6.20.02	BAMA Trading	Product manager (Strawberries…)	Corona strawberries and BAMA
7.11.02	Farm in Nes	Strawberry farmer	Production of Corona strawberries
7.17.02	BAMA Dagligvare	Functioning leader Oslo dep.	Distribution of Corona strawberries
7.18.02	Centra Supermarket Majorstuen	Fruits and vegetables resp.	Retailing Corona strawberries
7.24.02	BAMA Trading	Leader strawberry team	Distribution of Corona strawberries
7.30.02	BARE	Director	Corona strawberries and REMA stores
7.30.02	BAMA Trading	Logistics manager	The logistics of Corona strawberries
7.31.02	BARE	Purchasing agent	Routines for purchasing and delivering Corona strawberries
7.31.02 (telephone)	BAMA Storkjøkken	Director	Corona and BAMA Storkjøkken
10.9.02	BAMA Trading	Import manager	EDI systems in BAMA
10.10.02	BAMA Trading	Packaging manager	IFCO crate and BAMA

10.12.02	JDA Software	Marketing manager	Stock replenishment systems
10.25.02	BARE	Director	IFCO crate and BARE
10.28.02	BAMA Trading	Leader production planning domestic production	Forecasting at BAMA Trading
11.18.02	BAMA Trading	Logistics manager	IFCO crate and logistics in BAMA
11.21.02	IFCO Norge	Director	IFCO in Norway
11.25.02	BAMA Trading	Product manager (potatoes…)	BAMA information system
11.31.02	REMA 1000 Skeidbanen	Assistant store manager	IFCO crate in retailing
01.31.03	BARE Oslo	Sales manager and warehouse leader (2 informants)	IFCO crate at BARE Oslo
01.31.03	TF Transport	Delivery truck driver for BARE Oslo	IFCO crate, documents and delivery transport
02.05.03	Holship Holding	President	Washing and delivering the IFCO crate
03.19.03	Trace Tracker	Manager	Food product traceability
03.04.03	Tyrholm og Farstad	Logistics manager	Port terminal
03.05.03	Klosterboer Breivika	Manager	Cold storage of fish
03.06.03	Waagan Transport	Director	Long-haul truck Transport
03.25.03	BAMA Dagligvare Oslo	Director	Business relationships of BAMA Dagligvare Oslo

03.25.03	TINE	Logistics director	LFD
05.13.03	ASKO Drammen	Purchasing manager	Business relationships between ASKO Drammen and retailers
05.14.03	TINE Trondheim	Logistics manager	LFD
05.14.03	ULTRA supermarket Solsiden	Assistant store manager	Ordering products from BAMA and TINE
07.04.03	Sitma Logistikk	Director	ICT and the materials flow
08.29.03	Dagligvarehandelens Miljø og Emballasjeforum	Manager	Product traceability and retailing
09.10.03	BAMA Trading	Product quality manager	Product traceability and BAMA
10.14.03	Gartnerhallen	Manager	Product traceability and product planning
10.17.03	Kvalitetssystem i Landbruket (KSL)	Manager	Production systems in Norwegian agribusiness
10.30.03	BAMA	Project leader	Information systems in BAMA
11.21.03	TINE BA	Packaging manager, project leader (2 informants)	TINE products, organisation and product traceability in relation to TINE
12.01.03 (telephone)	Q-free	Product development manager	RFID and tracking materials
12.03.03	Skarland Press	Senior editor	Packaging in Norway
12.08.03	Den norske Emballasjeforeningen	Director	Packaging in Norway

12.09.03	Matmerk	Director	Quality labelling of food products
01.08.04	TINE Logistikk	Responsible for product supply	Information and documents to distribute products
01.08.04	TINE Øst	Director	Lettmelk
01.22.04	TINE Øst	Terminal manager	Lettmelk, distribution and product traceability
01.27.04	TINE Øst	Sales manager	Ordering, sales and product information
01.29.04	TINE Øst	Manager Organisation department	Business relationships between TINE Øst and dairy farmers
02.04.04	TINE Øst	Laboratory manager	Quality control of Lettmelk
02.09.04	TINE BA	Export manager	Export of TINE products
02.12.04	Maersk Sealand	Export customer service	Container transport and tracking goods
02.17.04	Fjordland	Director	Marian products
03.02.04	Farm	Dairy farmer	Production of raw-milk
03.04.04	BAMA Trading	Product manger (bananas)	Bananas and BAMA
03.04.04	TINE BA Produsentrådgivningen	Manager	Livestock control
03.08.04	BAMA Trading	Manager of banana ripening facility	The banana ripening facility at Ulven
08.31.04	Fjordland	Project leader	Marian fish filet product

09.07.04	Nor-Cargo Thermo	Key account manager	Transport and tracking of Marian fish filets
09.20.04	Mattilsynet	Consultant	Food quality and traceability in Norway
10.20.04	Arctic Seafoods Hammerfest	Planning manger	Fishing and production of Marian white fish
11.02.04	DOLE Fresh Fruits Europe, Hamburg	Operations manager	Supplying and tracking Dole bananas
11.02.04	DOLE Fresh Fruits Europe, Hamburg	Quality assurance manger	Banana product quality and traceability

Appendix 2: Samples of Interview Guides

This part contains selected examples of interview guides. The interviews were mainly conducted in Norwegian and are therefore translated. While the examples show the different topics in their sequence, the actual interview guides left large open spaces between the topics providing space for making field notes. The interview guides describe the topics and are therefore not formulated as precise questions. The exact topics covered and formulation was in accordance with the discussion in chapter three emerged during the course of the interview. Therefore, these guides function, as discussed in Chapter three, mainly to show what type of information was sought from a specific informant and at the same time aiming to retain openness for new and unexpected information.

1. Director of IFCO Norge November 21st. 2002

1.1 IFCO on the world market, history, in relation to Norway
1.2 IFCO products in Norway, the IFCO crate, IFCO and products, competitors of IFCO
1.3 IFCO Norge customers. Importance of BAMA
Business relationship with BAMA. Actors involved, information exchange, documents (types of/frequency/quality/media channels of communication). Strategic level.
1.4 IFCO crate rinsing facility in Drammen, Norway. Outsourcing.
1.5 Transport of IFCO. Business relationship with transport actors.
1.6 Business relationship with producers (farmers).
1.7 The return-deposit system
1.8 Adaptability of IFCO to customer requirements
1.9 Future of IFCO in Norway

2. Manager at Gartnerhallen (producer's organisation, related to the Corona strawberry case) October 14th. 2003
2.1 Informant role within Gartnerhallen
2.2 Information provision and exchange with BAMA and producers
2.3 Routines for control and documenting product quality
2.4 Features of the competence of producers

3. Technical manger of GS1 Norway November 13th. 2003
3.1 Informants role within GS1
3.2 The network of GS1 Norway
3.3 GS1 standard
3.4 GS1 standard, use in relation to documents and packages
3.5 GS1 and technology, barcodes, RFID…
3.6 GS1 and the future

4. Dairy farmer February 2nd. 2004
4.1 Role in TINE
4.2 Milk production and delivery
4.3 Quality control system (KSL). Registration of information.
4.4 Information exchange with TINE
4.5 Contribution to product traceability

5. Director of Fjordland February 17th. 2004
5.1 Informant's role within Fjordland
5.2. Marian brand, history, Marian white fish products
5.3 The supply chain actors of Marian white fish filet.
5.4 Business relationship with TINE
5.5 Production of Marian including packaging
5.6 Documentation of product information to secure product traceability
5.7 Suggestions of other informants in the supply chain

6. Banana product manager at BAMA Trading March 4th 2004
6.1 Actors in the Dole banana supply chain
6.2 Business relationship with Dole
6.3 Product information regarding Dole bananas required by BAMA
6.4 Routines for securing product traceability
6.5 Tracking of Dole bananas
(Comment: This was a supplementary interview carried out based on the first version of the NETLOG Dole banana case)