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Evaluation of Secondary Packages for Tetra Top on the Italian Market

– supportive tools for decision-making

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Abstract

Title	Evaluation of secondary packages for Tetra Top on the Italian market– supportive tools for decision-making.
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Problem Setting	<ul style="list-style-type: none">• What requirements do the actors in the supply chain have on the secondary packages?• What are the values and benefits of different secondary packages for the actors in the supply chain?• What are the pros and cons of the secondary packages currently on the market in Italy?• Is there a “best choice” among the different secondary packages?
Objective	To evaluate different secondary packages at three dairies in Italy. Provide Tetra Pak and future customers with key requirements and supportive tools for decision-making regarding suitable secondary package(s) to implement together with the Tetra Top primary package.
Method	This master’s thesis is based on a descriptive case study. Observations and interviews form the qualitative base whereas quantitative data has been collected with questionnaires.
Conclusions	<p>The big variety of demands and requirements from different customers preclude the possibility of finding one universal secondary package suitable for all supply chains. Often, it is also unsuitable to use the same packaging system for different distribution channels with different properties.</p> <p>Three evaluation tools have been developed to facilitate choice of suitable secondary package(s) to implement according to the individual requirements from future customers.</p> <p><i>Packaging Function Analysis</i> – analyses values and benefits, but also failings of existing packaging systems for different actors in the supply chains.</p>

Strengths and Weaknesses Tables – comprehensive collections of pros and cons regarding packaging systems currently on the Italian market.

Conclusive Packaging Evaluation Matrix – objectively grades a variety of key properties of different secondary packages. Can be used with two different methods of application.

Other thesis conclusions:

- Activities related to the secondary packages are clearly dominated by logistical aspects on the observed market. Marketing aspects are of no great concern as secondary packages are rarely displayed to end-consumers; also, environmental aspects play a minor, but growing, role.
- It is hard to optimize a packaging solution for the whole supply chain. Reducing the complexity at one actor can increase complexity at another actor in the supply chain.
- It is not sufficient for a packaging supplier to objectively evaluate different packaging systems and expect the customer to be satisfied according to this evaluation.
- It seems like the packaging suppliers could market and inform about its distribution equipment more extensively to customers.

Key Words Cardboard Tray, Cardboard Wraparound Box, Italy, Packaging Scorecard, Packaging System, Rollcontainer, Shrink Film, Secondary Package, Tetra Top.

Preface

This report constitutes the compulsory master's thesis carried out for the Master of Science degree at the two separate programs of Mechanical Engineering and Industrial Management and Engineering. The thesis was written at the Division of Packaging Logistics at the department of Design Sciences, Lund Institute of Technology (LTH), Lund University, Sweden. Tetra Pak Italiana S.p.A solicited the master's thesis.

We would like to thank our supervisor Annika Olsson, Department of Design Sciences, Division of Packaging Logistics, LTH and Armando Francione, Technical Director at Tetra Pak Italiana S.p.A for their help and support throughout the duration of this thesis. Furthermore, we would like to thank Bengt Halén, Market Support Manager, Tetra Pak Carton Chilled AB, Business System Tetra Top for his introduction to the Tetra Top product portfolio. Also, we would like to thank Rene Olsen, Distribution Manager, Kent Nilsson, Project Manager, and Kent Hammar, Technical Manager at Tetra Pak Carton Chilled AB for their kindness and patience when answering our questions.

Lastly, we would like to thank Pietro Albini for helping us with translations of the packaging scorecard and Giovanni Radighieri for helping us with interpretation during interviews and presentations. Without your help our work would not have been possible.

September 5th 2004, Lund, Sweden.



Viktor Eriksson



Monica Towman

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1 Introduction

This chapter introduces the reader to the master's thesis. After a short background, the problem setting, objective, and focus of the project are presented. The chapter also includes company and target group presentations, definitions of important terms, and an outline intended to facilitate further reading. The chapter ends with the time frame of this master's thesis.

1.1 Background

In 1989, Tetra Pak introduced a new product portfolio. The product, Tetra Top, was a paper-based package with an injection moulded plastic top.¹ Since 2002, Tetra Pak's market company in Italy, Tetra Pak Italiana S.p.A, has sold Tetra Top filling machines to different dairies around Italy.

Tetra Pak has performed transportation tests with a variety of secondary packages suitable for the Tetra Top. The test results showed that the only one-way package with proper protection results is the cardboard wraparound box.² Based on the test results, only a cardboard wraparound box is recommended to future customers. Compilation of characteristics regarding other secondary packaging solutions is not structurally presented to future customers.³

The dairies implementing the Tetra Top packaging system have not always followed the recommendation from Tetra Pak Italiana S.p.A. Regarding the packaging system involving the Tetra Top, one dairy has implemented the use of two different secondary packages: the use of cardboard trays and rollcontainers. A second dairy uses three different secondary packages: shrink film with cardboard bottom and dividers, cardboard trays, and rollcontainers. A third dairy has implemented only one solution: a cardboard wraparound box. Hence, today there are at least four different packaging systems in use in Italy regarding Tetra Top.

¹ www.tetrapak.com, 040331.

² Interview with Francione, A..

³ Interview with Jacinto, M.

1.2 Problem Settings

The following questions disclose the problem definition of this master's thesis:

- What requirements do the actors in the supply chain have on the secondary packages?
- What are the values and benefits of different secondary packages for the actors in the supply chain?
- What are the pros and cons of the secondary packages currently on the market in Italy?
- Is there a “best choice” among the different secondary packages?

1.3 Objective

This master's thesis evaluates different secondary packages in three Italian supply chains. The objective of the evaluation is to provide future customers with supportive tools for decision-making regarding suitable secondary package(s) to implement with the Tetra Top primary package. Moreover, the evaluation is intended to provide Tetra Pak with useful information regarding key requirements from actors in the supply chain.

1.4 Focus and Limitations

Figure 1.1 depicts the supply chain for the observed distribution channels in Italy. The focus of this thesis is on packaging systems in use at dairies, transporters, distribution centers, and retailers. Mainly, requirements from the dairy have been evaluated; the rationale of this focus is found in the discussion chapter, see Section 7.1.

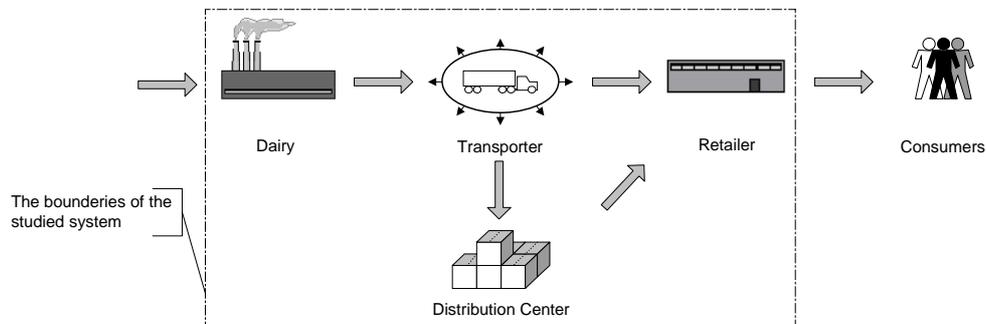


Figure 1.1 The supply chain for the observed distribution of Tetra Top in Italy.⁴

Concentration is on the secondary package; the tertiary package is only briefly evaluated. The primary package, that is, the Tetra Top Base 1 liter with screw cap S38, is considered to be set and, hence, not evaluated. The top of the Tetra Top primary package involved in the distribution at the different case companies are Flat Off, Orinoco, and Pacaya. Other Tetra Top tops as well as other models in the product

⁴ For more detailed information about the supply chain for the observed distribution, see Appendix E – Flowchart 1.

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portfolio such as Tetra Top Mini and Tetra Top Midi are disregarded from the master's thesis. These restrictions are enforced due to limited access of available case study dairies in Italy.

Furthermore, this master's thesis is carried out in conjunction with another thesis.⁵ The information regarding the empirical studies in Italy is collected together with the Italian author whereas the rest of the work is done separately. However, there has been an open information exchange between the authors.

The main focus of this master's thesis is on logistic aspects. Aspects concerning marketing and environment will be briefly discussed. Cost issues are not taken into consideration. These issues are, instead, evaluated in Radighieri, G. (2004). The division of focus is implemented in coherence with the theory presented in Section 3.3.5. The different focuses of the two theses aim to result in a comprehensive description of the packaging systems.

1.5 Company Presentation

1.5.1 Tetra Pak

Tetra Pak develops, manufactures, and markets complete systems for the processing, packaging and distribution of food and liquid food. Tetra Pak currently has 58 market companies around the world, 65 packaging material plants (including licensees), and 15 packaging machine assembly factories. The company has 21 100 employees and in 2003 reached net sales of € 7.3 billion. Tetra Pak products are sold in over 165 markets.⁶ Tetra Pak Italiana S.p.A is Tetra Pak's market company in Italy. It is based in Rubiera in Northern Italy. The Italian market company solicited the evaluation of the packaging systems presented in this master's thesis.



Figure 1.2 The Tetra Pak logotype.⁷

1.5.2 Case Study Dairies

In order to maintain anonymity of the respondents and the case study dairies, no company names are specified in the master's thesis. Instead, the three case study dairies are named Dairy A, Dairy B, and Dairy C. Sensitive information contributing to disclosure of individual companies has been excluded.

⁵ Radighieri, G. (2004).

⁶ www.tetrapak.com, 040911.

⁷ Ibid, 040620.

1.6 Target Group

The primary target group of this master's thesis is Tetra Pak Italiana's future customers. In addition, the master's thesis aim to be useful for Tetra Pak Italiana S.p.A and Tetra Pak Carton Chilled AB, Business System Tetra Top. According to guidelines from Lund Institute of Technology, the master's thesis is also intended to target Master of Science students at later stages of engineering studies.

1.7 Definitions

To facilitate reading of this master's thesis, some definitions need to be further explained:

- **Cardboard:** In this thesis, cardboard means corrugated cardboard unless anything else is stated.
- **Cardboard blanks:** unfolded empty secondary packages made from cardboard material.
- **Cardboard tray:** One-way cardboard box without roof.
- **Cardboard wraparound box:** One-way cardboard box with roof.
- **Clients:** another expression for the dairies' customers, i.e. the retailers.
- **Consumer:** end customers buying the Tetra Top primary package in the retail stores.
- **Customer:** the following step in the supply chain. For example, Tetra Pak Italiana's customers are the dairies.
- **One-way packages:** Packages intended to be used only once.
- **Packaging Supplier:** the company supplying the primary package material, for example, Tetra Pak.
- **Returnable packages:** Packages intended to be used several times.
- **Rollcontainer:** Returnable package made of metal and equipped with wheels.
- **Shrink film solution:** One-way package with cardboard bottom and divider, wrapped in a shrunk plastic film.
- **TT:** Abbreviation of Tetra Top.

1.8 Outline

The paper is divided into seven major chapters:

- **Chapter 1 – Introduction:**
The first chapter introduces the reader to the thesis. After a short background, the problem setting and the objectives are explained. Following are, among other things, the focus, delimitations, and definitions.
- **Chapter 2 – Methodology:**
In this chapter, different research approaches are evaluated. The chosen approach and different means of collecting information are described and justified.

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- **Chapter 3 – Frame of Reference:**
Chapter three provides the reader with a theoretical overview to issues later discussed and analyzed.
- **Chapter 4 – Empirical Studies:**
In this chapter, the collected information is objectively presented. To large extent, the empirical studies consist of interviews and observations from the case study dairies in Italy.
- **Chapter 5 – Analysis:**
In the analysis chapter, the frame of reference and the empirical chapter are brought together. The information is structured and analyzed; it results in three evaluation tools.
- **Chapter 6 – Conclusions:**
Chapter six briefly concludes the analysis with suggestions of answers to the questions stated in the problem setting. The conclusions address future customers as well as packaging suppliers.
- **Chapter 7 – Discussion and Suggested Future Research:**
In this chapter, unpredictable events that have arisen during the work are discussed. Finally, the author's suggestions on future research related to this master's thesis are presented.

1.9 Time frame

This master's thesis is carried out during the spring and summer of 2004. The time span of the thesis is 20 weeks with a scheduled break for three weeks. To facilitate the planning and execution of the thesis, the work is divided into activities. The time frame of the different activities in the project is shown in Appendix A – Time Frame.

To ensure that each activity has been allocated its time needed, the project schedule is continuously updated and revised throughout the duration of the thesis.

2 Methodology

In this chapter, possible approaches to the thesis are described and evaluated. The methods chosen, as well as the practical procedure, are further discussed and justified.

2.1 Different Approaches to the Thesis

In general, scientific research can be divided into three main approaches: the analytical approach, the systematic approach, and the approach of actors.

2.1.1 The Analytical Approach

The analytical approach is based on the assumption that an observation, as a whole, always equals the sum of its parts. An observation is considered to consist of several parts that can be independently and objectively analyzed.⁸

2.1.2 The Systematic Approach

In the system approach, the reality is believed to consist of groups of interacting components. Focus is on the connections between the parts and how the system cooperates as a whole.⁹ This approach arises from the need to follow, understand, and plan for flows of material, information, and money in complex situations. Fundamental, yet important is to define the boundaries of the system.¹⁰ Also, the type of system is to be set. The system is termed open if the relation to its environment is studied. On the contrary, if the system is considered to be an independent unit, cut off from the surrounding world, then the system is, by definition, closed.¹¹

2.1.3 The Approach of Actors

The vital point in the approach of actors is how different actors understand, interpret, and act in their reality.¹² According to this approach, a system consists of a socially constructed reality with the producing actors and its product - the reality. Carried out correctly, the approach of actors increase the knowledge of the processes that socially construct the reality.¹³

⁸ Arbnor, I. & Bjerke, B. (1994), p.80.

⁹ www.fek.su.se/home/ja/MUPP96.doc, 040329.

¹⁰ Wallén, G. (1993), p. 26.

¹¹ Arbnor, I. & Bjerke, B. (1994), p.128.

¹² www.fek.su.se/home/ja/MUPP96.doc, 040329.

¹³ Arbnor, I. & Bjerke, B. (1994), p.94.

2.2 Case Studies

A case study is a research strategy defined as

“...an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used.”¹⁴

This method is suitable for evaluations where the studied objects are complex and difficult to examine with other methodologies.¹⁵ Case studies can be further classified: for example, explorative, descriptive, or explanatory studies.¹⁶ The relevant objective of a case study is based on the level of knowledge. In the absence of basic knowledge, the explorative case study is suitable. If there is a general understanding of the problem, a descriptive study is preferable, whereas the objective in a study of a well-known phenomenon should be explanatory.¹⁷

2.3 Qualitative and Quantitative Methods

Disregarding what research strategy is used, information collection can be separated into two main groups:

- Qualitative methods
- Quantitative methods

Both methods refer to how the collected information is studied and analyzed.¹⁸ The quantitative method is used when the studied phenomenon is statistically measurable, for example with the use of tests or questionnaires.¹⁹ Consequently, the quantitative method is structured, but at the expense of a limited flexibility. In the qualitative method, the empirical studies are frequently expressed verbally, often to create an understanding of relationships or complex interactions.²⁰ This method is used to obtain a deeper understanding of a subject and is suitable with interviews and observations.²¹ Alternatively, both methods may be used in different parts of a project to combine the advantages and to compensate for disadvantages of each separate method.²²

¹⁴ Yin, R.K (1985), p.23.

¹⁵ Backman, J. (1998), p. 49.

¹⁶ Ellram, L. M (1996), p.98.

¹⁷ Rosengren, K.E & Arvidson, P. (1992), p. 90.

¹⁸ Patel, R. & Davidsson, B. (1994), p. 12.

¹⁹ Backman, J. (1998), p. 31.

²⁰ Ellram, L. M (1996)

²¹ Björklund, M. & Paulsson U. (2003), p.63

²² Rosengren, K.E & Arvidson, P. (1992), p. 19.

2.4 Methods Chosen

This master's thesis dealt with flows of material and information among several interacting actors in complex systems marked off from the surroundings. Hence, the systematic approach was best adapted for this thesis. The relation to the outer environment is disregarded, only connections between the specified actors in the supply chain are analyzed; therefore, the type of system in this thesis is to be considered as closed. As the different actors in the supply chains interact and create a complex situation, where the situation is more than the sum of the individual subsystems, the analytical approach was inexpedient. Further, the non-social focus of this thesis made the approach of actors inappropriate.

The strategy was to perform a comparative case study. The level of knowledge and the expected outcome of this thesis made it appropriate to perform a descriptive study rather than an explorative or explanatory study.

Furthermore, to facilitate the comparison between the different systems observed, a combination of qualitative and quantitative information collection methods was chosen. The techniques used to collect data are further described in Section 2.6.

To conclude, the outcome of this thesis was a descriptive comparative case study with a system approach and a combination of the two information collection methods. This thesis approach is illustrated in Figure 2.1.

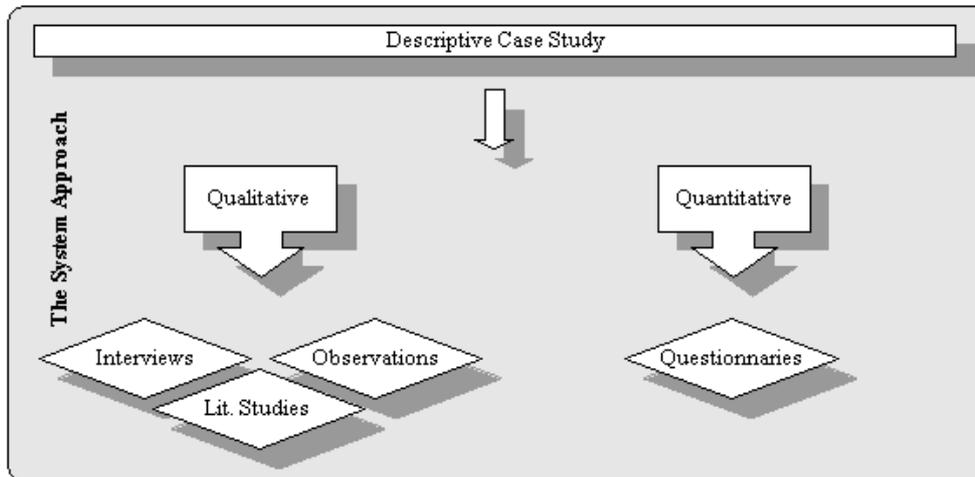


Figure 2.1 The approach of this master's thesis.

2.5 Quality of Data

To ensure the quality of data and, by that, the outcome of the thesis, the level of relevance and objectivity of the data collected must be taken into consideration.

2.5.1 Concepts to Consider

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The following concepts are used to increase the quality of data:

- **Validity:** measure solely what you intend to measure.²³
- **Reliability:** assure that the research gives a reliable and stable outcome.²⁴
- **Objectivity:** determine to what extent the authors are affected by non-scientific values.²⁵

When conducting a case study, another concept is important to assess:²⁶

- **Generalization:** if the findings can be valid for other situations.

2.5.2 Criticism of the Sources

Different literature, documents, and other sources are not always completely objective. For example, a lot of material available within the field of packaging logistics comes from the Swedish industrial research institute Packforsk. Hence, a significant part of the frame of reference, for example the packaging scorecard, originates from the same source. This dominance can lead to a one-sided account.

During the field studies in Italy, an interpreter was used to translate between Italian and English. The interpreter was himself involved in the research due to the situation described in Section 1.4. The reliability of the information collected in Italy is, hence, based on the ability of the interpreter to correctly translate the interviews.

2.6 Collection of Data

Collection of data was made through several different sources: interviews, observations, questionnaires, pilot study, and literature studies.

2.6.1 Interviews

The intention of interviews is to give a deeper understanding of the problem and improve the reliability of the collected information. There are different kinds of interviews based on two aspects:²⁷

- **Structuring:** to what extent the interview questions are open for different answers and interpretation.
- **Standardization:** to what extent the interview questions are set in advance.

Hence, there are four combinations of the aspects. The four combinations are presented in Table 2.1. Carried out correctly, standardized interviews can often provide good reliability.²⁸

²³ Patel, R. & Davidsson, B. (1994), p. 85.

²⁴ Samuelsson, K. (2003), p. 6.

²⁵ Wallén, G. (1993), p. 25.

²⁶ Kvale, S. (1997), p.210.

²⁷ Patel, R. & Davidsson, B. (1994), p. 62.

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Table 2.1 Different types of interviews based on the two aspects of Structuring and Standardization.²⁹

		<i>Degree of Structuring</i>	
		High	Low
<i>Degree of Standardization</i>	High	Interviews where one wishes to carry out a quantitative analysis of the results	Projective method Interviews with open questions
	Low	Focused interviews	Journalistic interview One wishes to carry out a qualitative analysis of the results

Chosen Approach

To be able to compare the different packaging systems and to find similarities between supply chain actors in the different systems, interviews with open questions were chosen. Interview manuals were created to ensure a high degree of standardization and to improve reliability. Also, the questions were formulated so that the interview person could freely add information to the interview, this to have a low degree of structuring. The interview manuals can be seen in Appendix B – Interview Manuals.

The interview respondents were kept anonymous towards other dairies in the final documentation of this master’s thesis. Anonymity was required due to the competitive situation on the market.

To ensure the reliability of the interviews, two persons have concurrently registered the interview answers. Moreover, recordings of interviews were carried out where possible. During interviews that could not be recorded, two persons documented the answers manually. Table 2.2 shows a summary of the different interview respondents. In total, 27 respondents were interviewed.

²⁸ Patel, R. & Davidsson, B. (1994), p. 87.

²⁹ Ibid, p. 62. The table is freely translated from Swedish.

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Table 2.2 Setup of interview respondents. * indicates that two marketing directors also acted as managers within other fields.

	<i>Supply Chain A</i>	<i>Supply Chain B</i>	<i>Supply Chain C</i>
<i>Dairy</i>			
General Director	-	1*	1
Production Resp./Mgr.	1	1	2*
Marketing Dir	1	1*	1*
Purchasing Mgr	-	1	-
Logistic Mgr	1	-	-
Prod. Maint. Mgr	-	1	-
Distr. Log. Mgr	-	1	-
Cold Area Resp.	-	-	2
<i>Transporter</i>			
Truck Mgr	-	1	-
Truck Driver	2	1	1
<i>Retailer</i>			
Cold Area Resp.	2	-	1
Merchandiser	1	-	-
Store Mgr	2	-	-
Operator	1	-	-

2.6.2 Observations

The purpose of an observation is to study behaviors and course of events in a natural situation when they actually occur.³⁰ Observations can be split into two main groups:

- Structured observations
- Unstructured observations

In a structured observation, the problem is well defined, the observed situations can be anticipated and observation schedules can be made in advance. In contrast, characteristic of an unstructured observation is the explorative purpose to collect as much information as possible, i.e. to register “everything”. Hence, strict observation schedules cannot be used.³¹

Chosen Approach

In this thesis, the observed situations can be anticipated to a large extent. Also, the purpose of the thesis was not explorative and information about “everything” was not useful. Therefore, structured observations were carried out at the three dairies.

To ensure reliability of the observations, observation schedules were used. The schedules can be seen in Appendix C – Observation Schedule. In addition, the use of

³⁰ Patel, R. & Davidsson, B. (1994), p. 74.

³¹ Ibid, p. 76.

two observers on every occasion improved the reliability of the observations. The observation results are only presented in the empirical chapter when they add significant value to the analysis.

2.6.3 Questionnaires

Questionnaires are a method to collect information based on written questions. The structure of a questionnaire determines the ways in which the respondent can answer. Normally, questionnaires have a high level of structure as the questions are formulated to allow only a limited number of answers.³² The data gathered in structured questionnaires are often well arranged and constitute directly comparable information. In this thesis, structured questionnaires have been used to collect data at different dairies, see Appendix D – Packaging Scorecard.

2.6.4 Pilot studies

In a pilot study, observations schedules, interview manuals, and questionnaires are tested in a situation resembling the actual situation. This is carried out in order to ensure the overall quality of observations and interviews and to further improve the schedules and manuals before the visits to Italy.

A pilot study was carried out on May 5th, 2004 at a dairy in Sweden. The pilot study was of great value as it indicated that the initial questionnaires were too complicated, see Section 3.4.1.

2.6.5 Literature Studies and the Internet

In this thesis, literature from the University Library in Lund, former theses from the division of Packaging Logistics at Lund University, and information from Tetra Pak in Lund and Italy have been used. Also, several articles from the Internet have been studied. Keywords in the search for literature have been e.g. *Tetra Top*, *distribution*, *Tetra Pak*, *logistics*, and *package*. Moreover, some information about Tetra Top has been found at Tetra Pak's intranet. Literature and electronic data are the main sources of secondary data.

³² Patel, R. & Davidsson, B. (1994), p. 60.

3 Frame of Reference

In this chapter, applicable areas from the theoretical studies are presented. In some cases, current models and theory has been modified to better suit the scope of this master's thesis.

3.1 Packaging Related Issues

To provide the reader with background information about packaging, the fundamental fields of packaging related issues affected in this thesis are briefly described.

3.1.1 Definition and Purpose of Packaging

In the European Parliament and Council Directive, packaging is defined as:

“...all products made of any materials of any nature to be used for the containment, protection, handling, delivery, and presentation of goods, from raw materials to processed goods, from the produce to the user or the consumer. 'Non-returnable` items used for the same purposes shall also be considered to constitute packaging.”³³

Being the interface between products and the surrounding environment, packaging fulfills a vast number of functions. From a business point of view, packaging should contribute to an efficient logistical flow, marketing and selling the product, and a reduction of the environmental load in the goods flow.³⁴ These three different functions are further discussed in Section 3.3.

3.1.2 Packaging System

Packaging can be divided into three different levels: primary package, secondary package, and tertiary package. The different levels together constitute a packaging system, which is depicted in Figure 3.1.

³³ European Parliament and Council Directive 94/62/EC (1994).

³⁴ Johansson, K. & Weström, P. (2000).

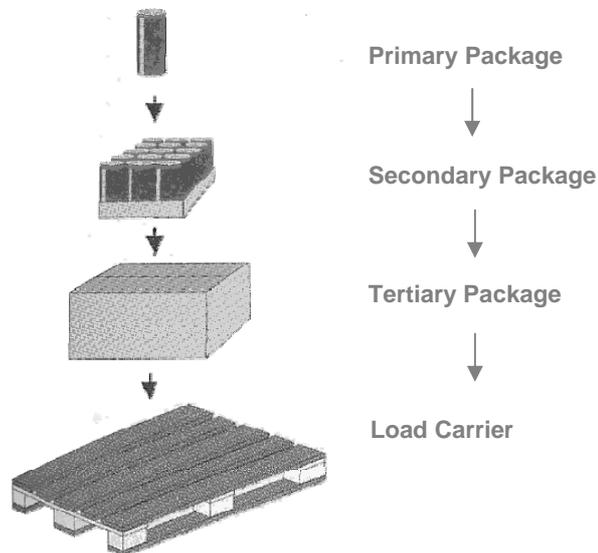


Figure 3.1 Different packaging levels and the load carrier.³⁵

Packaging Levels and Load Carrier

The primary package refers to the consumer package. It is the package that encloses the actual product (contains one sales unit) and makes the product available to an end-user or a consumer at a sales outlet.³⁶ Another function of the primary package is to protect and preserve the quality of the product.³⁷ Examples of primary products are milk cartons and bottles.

In contrast, the secondary package is a multi-unit package that contains a number of primary package units.³⁸ It is designed to facilitate the handling of the primary package; also, it could act as an additional barrier to preserve the product and package quality. Furthermore, the secondary package can be used as an information and marketing carrier. Examples of secondary package are corrugated cardboard trays and plastic crates.

The third level, the tertiary package, refers to the transport package. It facilitates the handling and transportation of many primary or secondary packages.³⁹ Examples of tertiary packaging are stretch film, corrugated cardboard, plywood boxes, and crates.

In combination with the three levels mentioned above, a load carrier, for example a wooden pallet or a container, is often used in order to facilitate handling and stacking of goods.⁴⁰

³⁵ Dominic, C. et al (2000).

³⁶ Johansson, K. et al (1997), p.13.

³⁷ Ibid, p13.

³⁸ Johansson, K. et al (1997), p.13.

³⁹ Ibid, p.14.

3.1.3 Packing and Stacking Patterns

A packing pattern describes how primary packages are grouped into a secondary package. A packing pattern is described on a standard XxY measure, where X indicates the number of faces displayed and Y the number of sides displayed. The use of brackets indicates multi units; a third digit indicates the number of such units.⁴¹ Examples of different packing patterns are depicted in Figure 3.2.

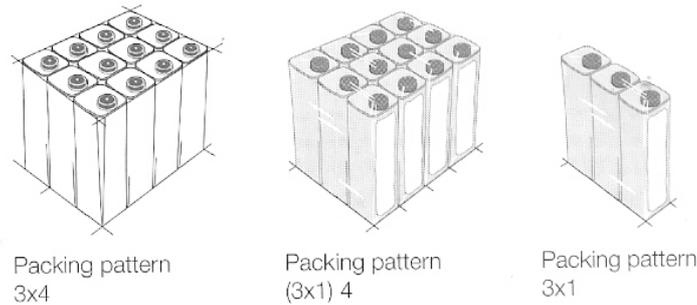


Figure 3.2 Examples of different packing patterns.⁴²

The four most common ways of stacking packages onto pallets are of block, brick, row, and pinwheel type. The block-stacking pattern is often used when the packages have the same height and width measurements; however, it does not have any benefits of creating enhanced load stability. In contrast, increased load stability can be obtained with the three other stacking patterns by using an interlocking technique. Here, the packages are placed at 90-degree angles to each other.⁴³ Combinations of stacking patterns are possible to achieve high volume efficiency. The different stacking patterns are presented in Figure 3.3.

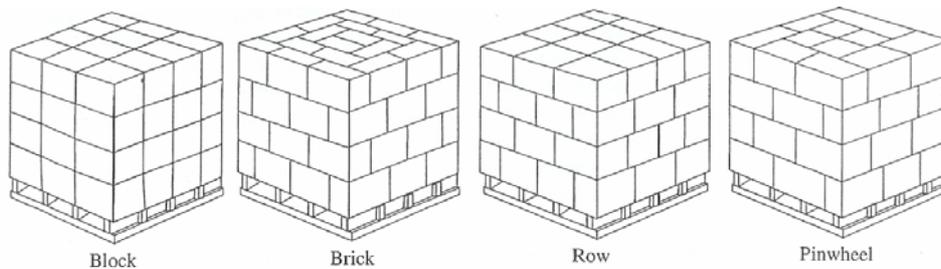


Figure 3.3 Basic stacking patterns for pallets.⁴⁴

3.1.4 One-way vs. Returnable Packaging Systems

There are two types of packaging systems: one-way and returnable systems. One-way systems are only used once for its original purpose whereas returnable systems are

⁴⁰ Johansson, K. et al (1997), p.14.

⁴¹ Tetra Top FDM (2004), p.45.

⁴² Ibid, p.45.

⁴³ Bowersox, D., Closs, D., and Boxby, M. (2002), p.414.

⁴⁴ Ibid, p.414.

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used multiple times for the same original purpose.⁴⁵ There are no set rules for when to implement the two different systems; instead, the choice must be based on several factors such as cost, marketing, environmental image, and distribution channels.⁴⁶ Nevertheless, there are some general factors influencing the choice of the packaging system; these factors are stated in Table 3.1.

Table 3.1 Factors influencing the packaging system choice.⁴⁷

	<i>One-way</i>	<i>Returnable</i>
Variations in demand	High	Low
Transport distance	Long	Short
Delivery frequency /Turn-over speed	Infrequent/Uneven	Frequent /Even
Storage time	Long	Short
Steps in the supply chain	Many	Few
Production Volume	Low/High	High
Hygienic demands	High	Low
Customers	Many and small	Few and large

The relations between the two factors “Variations in demand” and “Transport distance” is depicted in Figure 3.4.

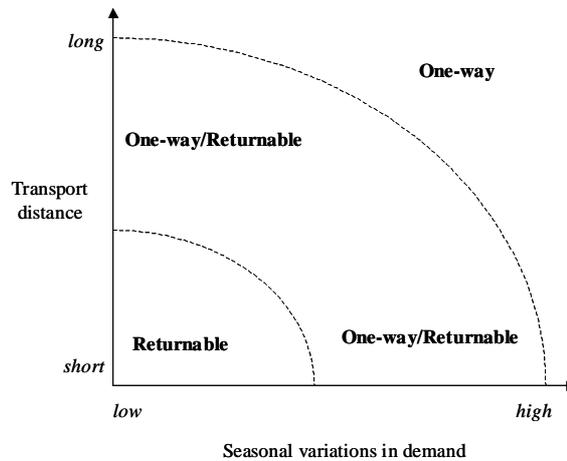


Figure 3.4 Factors influencing the choice of packaging system.⁴⁸

Often, one-way packaging systems are more weight and volume efficient than returnable packaging systems. The reason for this is that returnable packaging systems are usually made more robust in order to withstand the repeated use. Arguments for a returnable packaging system are, on the other hand, reduced consumption of material resources and reduced waste throughout the life cycle.

⁴⁵ Packat i Pocket, (2000), p.102.

⁴⁶ Johansson, K. et al (1997), p.71.

⁴⁷ Modified from Johansson, K. et al (1997), pp.71-75.

⁴⁸ Modified from Johansson, K. et al (1997), p.71.

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However, these arguments must be considered against the necessity of return transportation and cleaning.⁴⁹

Returnable packaging systems can be based on a system where the actors in the supply chain pay a deposit in accordance with the number of returnable units they access. This depository system is often essential to implement since the returnable system otherwise can be subjected to great losses of units. However, the use of a non-depository system can be successful if it is limited to transportation in a closed system.⁵⁰

3.1.5 Packaging Material

Packaging systems are made of a number of different materials. Below are brief descriptions of some materials commonly used in secondary and tertiary packages, applicable to this thesis.

Corrugated Cardboard

Corrugated cardboard consists of layers of flat and wavelike papers glued together. The flat layers (i.e. liners) give the corrugated cardboard its strength capabilities whereas the wavelike layers (i.e. fluting) give the material the properties to withstand impact and stress.⁵¹ Different material qualities, structures (i.e. number of layers), and thicknesses (i.e. the fluting height) can be chosen to attain the required properties of the corrugated cardboard. The different layers of a corrugated cardboard are depicted in Figure 3.5.

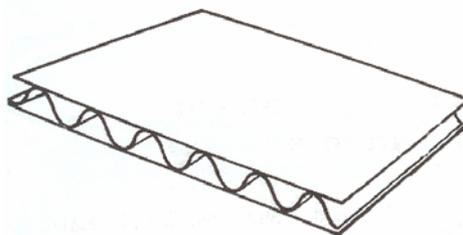


Figure 3.5 The different layers of a corrugated cardboard.⁵²

A great advantage of the corrugated cardboard is that it is easily adapted to a specific product; it is easy to fold, die-cut, print, and glue. It can also be adapted to various shapes and sizes.⁵³

Corrugated cardboard is made of pulp containing fibers from coniferous and broadleaf wood.⁵⁴ The glue, which is used to combine the liners and flutings, is made of cornstarch; it can be dissolved in water and is free from hazardous substances.⁵⁵

⁴⁹ Johansson, K. et al (1997), p.72,75.

⁵⁰ Packat i Pocket, (2000), p.46.

⁵¹ Dominic, C. et al (2000), p.15.

⁵² Jönson, G. and Johnsson, M. (2001), p.55.

⁵³ Packat i Pocket, p.64.

⁵⁴ Erlöv, L., Löfgren, C. and Sörås, A. (2000).

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Today, great volumes of corrugated cardboard are used and recycled from actors such as industries, stores, and hotels. After use, the corrugated cardboard is transported back to the paper mill where the material is steeped in water and turned into paper pulp and finally new cardboard.⁵⁶

When materials are recycled, there is always a technical breaking-down process involved. Hence, the materials can only be recycled a limited number of times. Therefore, used materials are diluted with some new materials in the recycling process to ensure the quality of the recycled material.⁵⁷

Plastic

There are a number of different plastic materials available, all with different properties.⁵⁸ Most plastic materials are made from oil or natural gas, which are refined in several steps.⁵⁹

Due to its various properties, plastics can be used in both rigid and flexible packages. Rigid packages, consisting of different materials, can often quite easily be separated and recyclable. On the other hand, flexible packages often consist of integrated materials, which make it more difficult to separate and recycle the packages. Instead, the best way of taking care of flexible packages is through energy recovery. In contrast, flexible packages consisting of only one type of material, such as plastic films, are well suited for recycling.⁶⁰ Polyethylene is the most common material in the manufacturing of plastic films.⁶¹

Plastic film is not recycled to the same extent as corrugated cardboard. Recycling of plastic is a much younger branch of industry. Used plastic is taken to recycling plants where it is ground to pieces, melted and eventually used as material to, for example, plastic bags.⁶²

⁵⁵ Packat i Pocket, p.66.

⁵⁶ Email from Nyström, T.

⁵⁷ Ibid.

⁵⁸ Erlöv, L., Löfgren, C. and Sörås, A. (2000).

⁵⁹ Packat i Pocket, p.76.

⁶⁰ Erlöv, L., Löfgren, C. and Sörås, A. (2000).

⁶¹ Jönson, G. and Johnsson, M. (2001), p.49.

⁶² Email from Nyström, T.

3.2 The Supply Chain

A supply chain could be defined as

*“the entire set of activities involving the organization and flow of material and other resources to produce and deliver the product to the final customer”.*⁶³

Activities involved are the physical distribution of material, the flow of information and the flow of money. The purpose of Supply Chain Management (SCM) is to coordinate and integrate these activities so that

*“the right product [is delivered] to the right place at the right time”.*⁶⁴

A supply chain usually consists of a manufacturer, intermediary actors such as distributors and transporters, a retailer, and the end consumer.⁶⁵ As seen in Figure 3.6 different packaging levels are adapted to different actors in the supply chain. The manufacturer and the distributors handle large volumes whereas the retailer must allow the end consumer to pick a single package. Consequently,

*“an efficient packaging system is a catalyst to fulfil the supply chain efficiency.”*⁶⁶

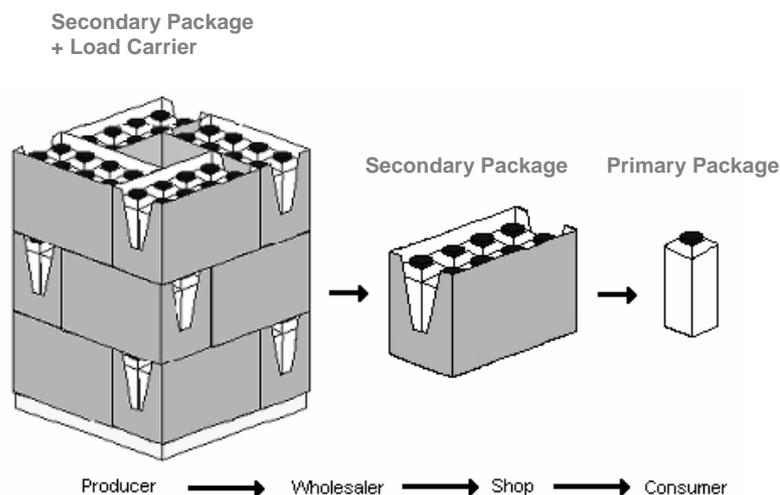


Figure 3.6 Different packaging levels in the supply chain.

3.2.1 Distribution Related Terms

⁶³ Schary, P. & Skjøtt-Larsen, T. (2001), p.23.

⁶⁴ Meredith, J.R. and Shafer, S.M. (2001), p.260.

⁶⁵ Angerhofer, B. & Angelides, M., (2000).

⁶⁶ Dominic, C. and Olsmats, C. (2001).

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An essential part of the activities involved in SCM is concerning distribution. This concept covers all logistics activities aiming at supplying the market with the finished product⁶⁷: that is, the physical distribution of material or a product.

In more detail, CLM defines distribution as

“the activities associated with the movement of material, usually finished goods or service parts, from the manufacturer to the customer. These activities encompass the functions of transportation, warehousing, inventory control, material handling, order administration, site and location analysis, industrial packaging, data processing, and the communications network necessary for effective management. It includes all activities related to physical distribution, as well as the return of goods to the manufacturer.”⁶⁸

Furthermore, a distribution channel is defined as

“One or more companies or individuals who participate in the flow of goods and services from the manufacturer to the final user or consumer.”⁶⁹

3.3 Packaging Logistics and Packaging Functions

A definition of packaging logistics describes the concept as

“...the process of planning, implementing and controlling the coordinated packaging system of preparing goods for safe, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery, reuse or disposal and related information combined with maximizing consumer value, sales and hence profit.”⁷⁰

As mentioned in Section 3.1.1, a packaging system fulfills a vast number of functions. In addition, the definition of packaging logistics suggests that there are many activities associated with the packaging system. These functions can be divided into three aspects: logistics, marketing, and environment.⁷¹ Figure 3.7 illustrates that in the optimal condition of a packaging system, all three aspects are taken into consideration. In some cases, the functions co-operate. In other, the conflicting demands cause tradeoffs. The tradeoffs are further discussed in Section 3.3.4.

⁶⁷ Johansson, K. et al (1997), p. 27.

⁶⁸ www.clm1.org/Downloads/Resources/glossary03.pdf, 040428.

⁶⁹ Ibid, 040428.

⁷⁰ Saghir, M. (2002).

⁷¹ Jönson, G. and Johnsson, M. (2001), p.25.

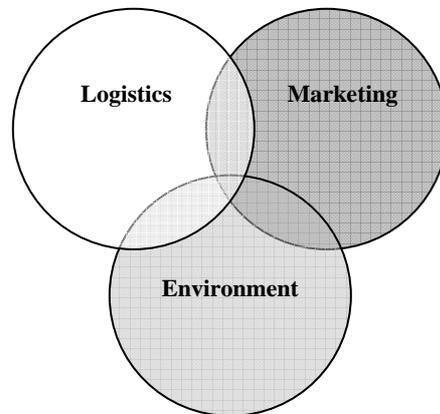


Figure 3.7 Packaging functions: Logistics, Marketing, and Environment.^{72,73}

3.3.1 Logistics

The logistical aspect is generally related to transport, handling, and storage. But there are several other properties of packages that contribute to an improved logistic flow.⁷⁴ The first, and often most associated with packaging, is the ability to protect the product. From a logistic point of view, the number of delivered packages in perfect condition is a method of measurement of the protection. In short, packaging should reduce the occurrence of damage, spoilage, or loss through theft or misplaced goods.⁷⁵ Also, the need to identify the product and inform the actors in the supply chain illustrates the importance of the package as an information carrier.⁷⁶ Additionally, the handling efficiency is in several ways affected by the properties of a packaging system:⁷⁷

- Ease to pack, empty, open, close, reseal, grab, stack, and clean.⁷⁸
- The stability of the package.
- Space utilization and storage efficiency.
- The degree of standardization.

Aspects related to space utilization and storage efficiency are weight and volume efficiency. The volume efficiency is a measurement of how the volume is utilized (i.e. the actual volume of the package divided by the available volume). Examples of properties that affect the volume efficiency are the physical packaging dimensions (size and shape) and stackability. Similarly, weight efficiency is defined as the weight

⁷² Modified from Johansson, K. et al (1997), p. 21.

⁷³ Jönson, G. and Johnsson, M. (2001), p.25.

⁷⁴ Johansson, K. et al (1997), p. 21.

⁷⁵ Prendergast, G. and Pitt, L. (1996).

⁷⁶ Dominic, C. et al (2000), p.56.

⁷⁷ Olsson, A., Lecturer, Packaging Technology, (2003).

⁷⁸ Dominic, C. et al (2000), p.76.

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of the products divided by the weight limit of the filled package. The importance of high volume and weight efficiency depends on the distance to the market.⁷⁹

Also, the package system must be designed to provide each actor in the supply chain with the right quantity. The grouping of packages into one physical unit for handling and transportation is called unitization.⁸⁰ It is, however, not enough to distribute the right amount of packages; also, the size of the package must appeal to the consumer.⁸¹ These diversified demands give rise to new package solutions such as minipacks and multipacks⁸² and are often referred to as the ability of the package to be apportioned. Decisions regarding unitization and apportionment affect e.g. packaging design, packaging material, handling, transportation and warehousing. In addition it influences the customer service level.⁸³

3.3.2 Marketing

The market function includes activities that add value to the product in relation to the end-user. Marketing decisions generally fall into the four categories: product, price, place (distribution), and promotion⁸⁴. These variables are known as the marketing mix or the four P's of marketing. Traditionally, this model includes packaging in the product-P, but packaging has been the subject of a future fifth P in the marketing mix.⁸⁵

Modern packages often act as marketing tools as they try to persuade the consumer to buy the product. Attracting attention to a product and reinforcing a product's image is made via its graphical design and format, i.e. printed information, different sizes, and colors.⁸⁶ Premium products, which are sold on the basis of quality, require additional expense to develop a package that reflects and reinforces this image.⁸⁷

Not only the primary package affect the selling ability. Also, uniform design of the whole packaging system can add value to a product.⁸⁸ Today's frequently used expopallets are an example of packages that perform the combined functions of transport protection and sales promotion.⁸⁹

3.3.3 Environment

⁷⁹ Johansson, K. et al (1997), p. 72.

⁸⁰ Bowersox, D., Closs, D., and Boxby, M. (2002).

⁸¹ Dominic, C. et al (2000), p.72.

⁸² Bowersox, D., Closs, D., and Boxby, M. (2002).

⁸³ Lockamy, A. (1995).

⁸⁴ www.netmba.com/marketing/mix, 040911.

⁸⁵ Johansson, K. et al (1997), p.51.

⁸⁶ Jönson, G. & Johnson, M. (2001), p.25.

⁸⁷ Prendergast, G. and Pitt, L. (1996).

⁸⁸ Dominic, C. et al (2000), p.35.

⁸⁹ Ibid, p.35, p.83.

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During its lifetime, a secondary package affects the environment in several different ways. Obviously, the use of materials harmful to the environment has to be minimized in production. Also, to minimize the environmental impacts, the amount of packaging material must be reduced. This should be carried out not only to reduce the use of resources (for example energy consumption) in production of raw material, but also to reduce the waste amount after consumption. It is also important that the waste material of the packaging system is recyclable. If the material cannot be efficiently recycled, it must be landfilled or burned with energy extraction⁹⁰.

In addition to the environmental impacts of the actual packaging material, the distribution of the product and its packaging system also affect the environment. Different packaging systems chosen for the same product can have various impacts on the environment. Examples of characteristics of the packaging systems that affect the environmental impact of distribution are size, weight, and volume efficiency.

Figure 3.8 depicts different sources of environmental impacts regarding one-way packages. The manufacturing of the raw materials often becomes the most important part of a life cycle regarding environmental impact. In the filling step, the main environmental impact is related to the energy consumption of the filling machines. Waste material usually plays a minor role at this stage.⁹¹ The environmental impact from transportation can often be disregarded when comparing different packaging systems, as differences in emissions due to different materials are not only negligible but also immeasurable.⁹²

Both recycling and energy recovery generally results in a net environmental credit as the used material replaces the need for production of new material. For waste scenarios, neither recycling nor energy recovery score better in all environmental aspects. Therefore, neither option can be said to be categorically better than the other. Landfilling of cardboard contributes to the global warming process as methane is produced in the breaking-down process.⁹³

⁹⁰ Barkman, A. et al, (2000). p. 6.

⁹¹ Ibid, p.13.

⁹² Interview with Wallén, E., 040607.

⁹³ Barkman, A. et al, (2000). p. 6.

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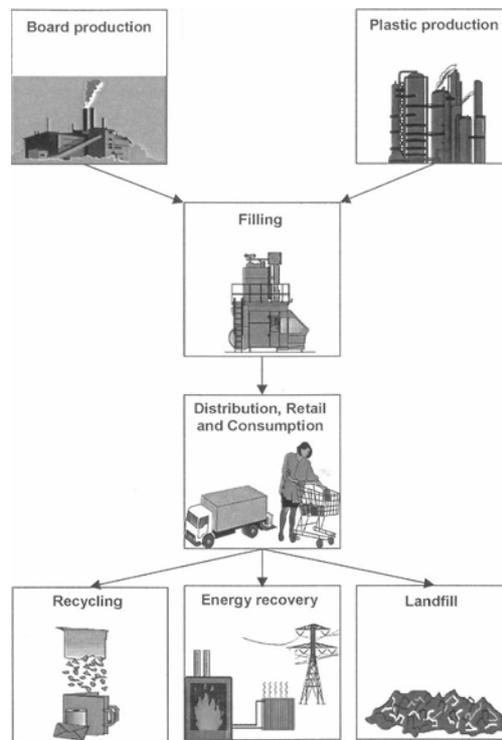


Figure 3.8 Sources of environmental impacts regarding one-way packages.⁹⁴

It is often irrelevant to compare the energy used to produce and handle a certain mass of different materials. A more interesting way to compare the environmental impact is the materials needed per liter product enclosed. For example, a harmful material can end up being the most environmentally friendly alternative if the amount of material used, per unit of the product, is lower than a more harmless material.⁹⁵

Table 3.2 compares the energy consumption for cardboard and plastic film. The feedstock energy, i.e. the energy content of the materials, is excluded. The energy consumption for production of rollcontainers is not as easy to obtain. Rollcontainers are only speculated to be a more environmentally friendly alternative due to its long lifetime⁹⁶.

⁹⁴ Barkman, A. et al, (2000). p. 3.

⁹⁵ Interview with Wallén, E.

⁹⁶ Interview with Wallén, E. and email from Chester, Ch.

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Table 3.2 Approximate energy consumption in production of cardboard and plastic film.⁹⁷

<i>Material</i>	<i>Energy consumption (MJ/kg)</i>
Cardboard	14.5 ⁹⁸
Plastic film	34.9 ⁹⁹

3.3.4 Requirements and Trade-offs in the Supply Chain

The different actors in the supply chain can have different and even conflicting requirements. A packaging system developed with regards to only one actor in the supply chain often has the implication that it is inefficient with other actors; a so-called sub optimization then occurs. Hence, it is essential to consider the whole supply chain when designing the packaging system to ensure the common objective – the satisfaction of the end consumer.

Also, within an actor there can be conflicting demands.¹⁰⁰ These conflicting demands give rise to trade-offs between or within the different packaging functions.

3.3.5 Trade-offs between Requirements and Cost

The packaging system has a high performance when it fulfills the requirements of different actors in the supply chain. There is, however, a trade-off between the performance parameter and another parameter, i.e. cost. An optimal solution is when a high performance is combined with a low cost of the system.¹⁰¹ Nevertheless, in some situations, a less effective packaging system could be tolerated if it has a low cost.¹⁰² The relations between performance, requirements, and cost can be seen in Figure 3.9.

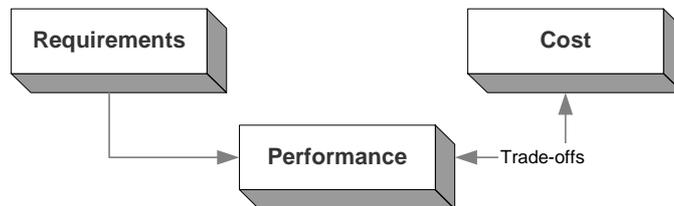


Figure 3.9 Performance, requirements, and cost.¹⁰³

Without the packaging system, the product would not be able to reach its final destination. Accordingly, Prof. Sten Wandel¹⁰⁴ suggests that packaging should not be

⁹⁷ For plastic, data represent manufacturing without recycled material whereas the cardboard has a recovery rate of 75 % (the average recovery rate in Europe).

⁹⁸ Interview with Wallén, E.

⁹⁹ *ECO-profiles of the European plastics industry*, (2003).

¹⁰⁰ Dominic, C. et al (2000), p.32.

¹⁰¹ Saghir, M. (2002).

¹⁰² Ibid.

¹⁰³ Modified from Saghir, M. (2002).

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seen as a cost; instead, it is a supply chain enabler. Furthermore, Johansson et al¹⁰⁵ propose that packaging should not be regarded as a pure cost item but as an opportunity to make the flow to the market more efficient.

3.4 Packaging Scorecard

Packaging Scorecard (PS) is a methodology for evaluating the package performance in the supply chain.¹⁰⁶ The method is based on, among other things, the Balanced Scorecard¹⁰⁷ and ECR¹⁰⁸. A packaging scorecard¹⁰⁹

- helps to show how well the package performs.
- supports a fourth party with a good bird's-eye view to consolidate the supply chain for evaluating.
- helps to structure and pick up information in the supply chain.

The method is based on questionnaires and interviews. Firstly, participants are asked to rank the importance of different general requirements (i.e. what properties any secondary package should have according to the respondent) related to the packaging system; the different requirements are weighted and normalized according to the importance stated by the participants. Secondly, interviews are carried out with the participants in order to assess how well the current packaging system performs for the individual requirements. Thirdly, the normalized weights regarding the requirements are multiplied with the packaging systems score set after the interviews. The total packaging system score, which shows the level of satisfaction, is obtained by adding the individual scores for each requirement.

3.4.1 Criticism of the Packaging Scorecard

A closer look into the packaging scorecard reveals failings associated with the method. Firstly, the weighted criteria are very broad and do not include any subcategories. Secondly, the pilot study (see Section 2.6.4) indicated that the weighting of the general requirements is hard for respondents to estimate with the initial 0-100% scale. Thirdly, the packaging system scores seem to be completely objective and it is not evident if subjective views from the respondents are considered. Fourthly, the scoring of the packaging scorecard is not traceable. Hence, no explanations to the chosen figures are to be found.¹¹⁰

¹⁰⁴ Prof Wandel, S., Lecturer, Packaging Logistics, 040428.

¹⁰⁵ Johansson, K. et al (1997), p.27.

¹⁰⁶ Dominic, C. and Olsmats, C. (2001).

¹⁰⁷ The Balanced Scorecard was developed by Robert S. Kaplan and David P. Norton.

¹⁰⁸ ECR stands for Efficient Consumer Response.

¹⁰⁹ Dominic, C. and Olsmats, C. (2001).

¹¹⁰ Section 3.4.1 expresses the opinions of the authors of this thesis.

3.4.2 Modifications of the Packaging Scorecard

The concept of PS has been further developed to better suit the objectives of this and future studies within similar fields of application. Following is a description of the alterations to the initial model.

The PS, in its original form, deals with the whole packaging system. It concentrates to a great extent on the primary package; the other packaging levels are only briefly discussed. The primary package is disregarded in this thesis. Therefore, only criteria regarding the secondary and tertiary package are considered in the altered model. This means that some criteria must be removed and replaced with other criteria more specific for the outer levels of the packaging system. In addition, the modified PS includes more detailed criteria derived from different sources.¹¹¹

Also, the initial method regarding the PS describes two independent packaging systems for two different products. Hence, a comparison of the scores for the different packaging systems cannot be made. One part of the altered model allows, however, for a comparison between the different packaging systems, as the same primary package is considered in all cases. Here, the authors have set the scores objectively (see Section 5.2.4). A comparison when the respondents have set the scores subjectively is, unfortunately, still not possible.

In addition, the PS primarily compares how the packaging system performs in relations to the requirements of other actors in the same supply chain. In this thesis, the essential part is instead to compare how actors in the same part of similar supply chains perceive the different packaging systems. Therefore, a great deal of attention is given to enable a comparison in the improved PS model used in this thesis.

Nevertheless, the modified PS model still resembles the original PS model to a great extent with regards to tallying the weighted individual scores regarding different criteria in order to compare the different packaging systems. However, the initial 0-100% scale has been replaced with a 1-5 scale.

¹¹¹ Dominic, C. et al (2000), p.95, Weström, P. (2002), Engström, S. (2003), and Samuelsson, K. (2003), p.27.

4 Empirical Studies

This chapter contains a survey of the packaging systems currently in use for the Tetra Top at three different dairies on the Italian market. Interviews and questionnaire responses from three supply chains are presented. The empirical studies were mainly carried out in Italy during the last two weeks of May, 2004.

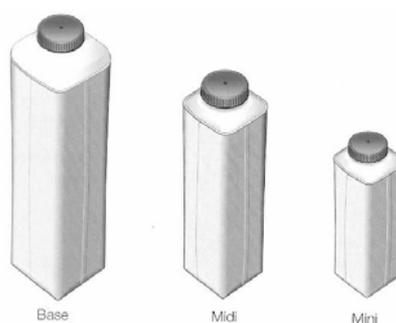
The reader can disregard the different interviews that are summarized in each subsection of the three supply chains without implications for the understanding of the following text. The summaries are included in this thesis to provide valuable information for continuing projects originating from this thesis; also, they are included to give the interested reader a comprehensive view of the current situation on the Italian market.

4.1 The Primary Package

As mentioned in Section 3.1.2 (subsection Packaging Levels), the primary package encloses the actual product and contains one sales unit to the consumer at a sales outlet.

The primary package studied in this thesis is the Tetra Top package. In its original shape, Tetra Top was introduced on the market in 1985. Today, the main configurations of the Tetra Top are Base, Midi, and Mini, see

Figure 4.1. Tetra Top Base, in commercial operation since 1994, is the generic term for Tetra Top packages with a 70-millimeter straight square bottom and a lid dimension of 75*75mm with rounded corners.^{112,113} The one liter size is suitable for family sized chilled pasteurized products and is designed to target a value added



product segment.¹¹⁴

¹¹² Tetra Top FDM (2004), p.14. A filled TT is bulging.

Hence, the outer dimension is about 78x78 mm.

¹¹³ *Tetra Top Inspiration Brochure*, Tetra Pak. (2002).

¹¹⁴ *Ibid.*

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Figure 4.1 Tetra Top family: the Base, Midi, and Mini package.

The different panels of the Tetra Top are named Side (S) and Face (F), see Figure 4.2. The height (H) of the one liter Tetra Top varies with the top used (H=228,3mm for Flat Off and Orinoco, H=235,0mm for Pacaya)¹¹⁵.

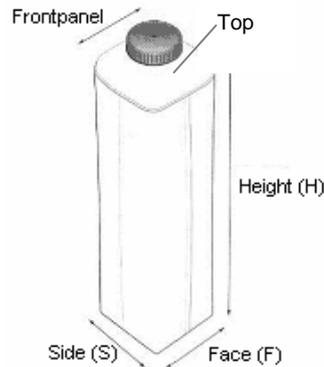


Figure 4.2 The different measurement definitions of the Tetra Top.¹¹⁶

The top of the paper-based Tetra Top package is characterized by the injection moulded polyethylene top with a screw cap.¹¹⁷ The opening device is designed to facilitate opening, pouring, and re-closing.¹¹⁸ At the Italian dairies studied in this thesis, the Tetra Top Base 1 liter packages are equipped with three different screw caps: Orinoco S38, Flat Off S38, and Pacaya S38, see Figure 4.3.¹¹⁹



Figure 4.3 The Orinoco S38, Flat Off S38, and Pacaya S38 cap.^{120,121}

¹¹⁵ Tetra Top FDM (2004), p.14.

¹¹⁶ Modified from Tetra Top FDM (2004), p.11.

¹¹⁷ Tetra Top Packages, (2003).

¹¹⁸ www.tetrapakusa.com, 040429.

¹¹⁹ S38 indicates the diameter of the cap, 38mm.

¹²⁰ Tetra Top FDM (2004), p.18.

¹²¹ www.tetrapak.com/docs/cartonchilled8681.pdf, 040510.

Fel! Formatmallen är inte definierad.

For the case study dairies, the product filled in the Tetra Top Base is fresh milk. It has a consumer price at around € 1.3 per liter.¹²² On the Italian market, fresh milk is considered to be a premium product.

4.2 Secondary Package, Tertiary Package, and Load Carrier

There are three different types of secondary packages for the Tetra Top Base 1 liter currently in use at the case study companies: cardboard trays, cardboard wraparound boxes, shrink film solution with cardboard divider and bottom, and rollcontainers. Furthermore, EUR-pallets with shrink film and minipallets supplement the packaging levels. Table 4.1 is a summary of the different packaging systems in use at the different dairies. Table 4.2 shows the packing and stacking patterns for the different packaging systems.

Table 4.1 Summary of the different packaging systems in use.

	<i>Dairy A</i>	<i>Dairy B</i>	<i>Dairy C</i>
Primary package			
TT top	Orinoco	Flat off	Pacaya
Secondary Package			
Cardboard solution	✓ (tray)	✓ (tray)	✓ (box)
Shrink film + cardboard divider/bottom		✓	
Rollcontainer	✓	✓	
Tertiary package/Load Carrier			
Shrink film wrapping		✓	✓
Minipallets	✓	✓	
EUR-pallets		✓	✓

¹²² Observations at different retailers.

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Table 4.2 Packing and stacking patterns for the different packaging systems.

	<i>Dairy A</i>		<i>Dairy B</i>			<i>Dairy C</i>
	Cardboard tray	Rollcontainer	Cardboard tray	Shrink film	Rollcontainer	Cardboard wraparound box
Packing pattern	2x4	5x8	2x6	2x6	5x8	2x5
<i>Rollcontainer</i>						
No. of layers		2/3/4			2/3/4	
Total load (liters)		80/120/160			80/120/160	
<i>Minipallet</i>						
Stacking pattern	Pinwheel		Row	Row		
2 nd per layer	4		3 (1x3)	3 (1x3)		
No. of layers	3		4	4		
Total load (liter)	96		144	144		
<i>EUR-pallet</i>						
Stacking pattern			Block	Block		Row
Minipallets/2 nd per			M ¹²³ : (2x3)	M ¹²³ : (2x3)		15 (2x5 + 5x1)
No. of layers			M: 1	M: 1		5
Total load (liters)			M: 864	M: 864		750

¹²³ M indicates the use of minipallets loaded onto EUR-pallets.

4.3 Supply Chain A

Supply Chain A was examined for three days. The first day was devoted for interviews and observations at the dairy. During the second day, the distribution of milk was examined by following different truck drivers. Also, interviews and observations at retailers were performed. During the third day, the interviews with retailers continued. In addition, supplementary information was collected at the dairy. The different interview respondents are presented in Table 4.3.

Table 4.3 Summary of interview respondents in Supply Chain A.

<i>Supply Chain Actor</i>	<i>Position</i>	<i>No.</i>
Dairy	Production Responsible	1
	Marketing Director	1
	Logistics Manager	1
Transporter	Truck Driver	2
Retailer	Cold Area Responsible at Hypermarkets	2
	Merchandiser at Hypermarkets	1
	Store Manager at Superettes	2
	Operator at Superettes	1
Total		11

4.3.2 Packaging System A

Primary Package

The TT primary package is equipped with the Orinoco top with S38 screw cap. Only one logotype is produced, but with two types of fat contents. Hence, there are two different printings on the TT with separate accompanying screw cap colors.

Secondary Package

Dairy A uses two different secondary packages: cardboard trays and rollcontainers.

The cardboard tray, with a thickness of two millimeters, holds eight TTs with a packing pattern of 2x4. About 60% of the produced fresh milk is loaded into cardboard boxes.¹²⁴ On the cardboard tray, there are big printings on the two long sides and smaller printings on the two short sides. Printings on the cardboard regarding the fat contents are different for the two types of milk. The cardboard material is of one-well type with a thickness of 2 mm. On each short side of the secondary package, the cardboard has a small hole that could be used as a handle.

¹²⁴ Marketing Director, Dairy A.

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For the remaining 40% of the production, rollcontainers are used as secondary package.¹²⁵ The most commonly used rollcontainer has a big logotype on its back and contains three layers; also, two and four layers exist. The packing pattern of the rollcontainer is 5x8 TTs per layer. Hence, the capacity of a rollcontainer varies between 80, 120, and 160 liters of TTs.

Load Carrier

The cardboard boxes are loaded onto plastic minipallets. On every pallet, three levels of four boxes are stacked on top of each other in a pinwheel stacking pattern, see Figure 4.4. Consequently, every minipallet holds 96 liters of TT. When stacked on the minipallet, the cardboard trays stick out on each side of the minipallet.

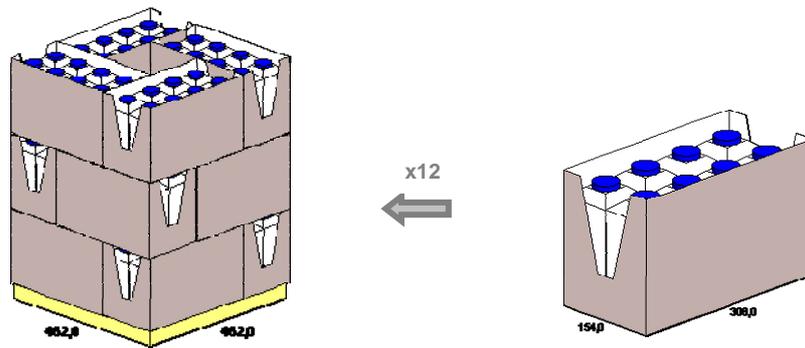


Figure 4.4 Dairy A's cardboard packaging solution.¹²⁶

4.3.3 Dairy A

During the first quarter of 2004, Dairy A launched the production of Tetra Top in two TT/3 machines. The machines produce one brand of milk with two different fat contents. The dairy delivers fresh milk to both retailers and distribution centers. almost 90 % of Dairy A's clients are small clients, located within 25 km from the dairy.¹²⁷ Activities carried out at Dairy A are shown in Appendix E – Flowchart 2.

Observations at the Dairy

- It is wet on the floor in the production, cold cell, and loading area.
- Several rollcontainers at Dairy A have logotypes from other dairies.
- The loading into trucks of the rollcontainers and minipallets, each with a weight of about 100 kilos, looks insecure and heavy.
- When cleaning the trucks, unsold secondary packages get wet.

¹²⁵ Marketing Director, Dairy A.

¹²⁶ Picture generated by CAPE PACK '99. Approximate measurements: Material thickness (cardboard = 2mm, shrink film = 0mm), minipallet height ($H_{\text{Minipallet}}=50\text{mm}$), and cardboard tray height ($H_{\text{CB Tray}}=237\text{mm}$).

¹²⁷ Ibid.

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- Detergent is used during the washing of the cold cell. For the conveyor belt, a shampoo containing a lubricant is used.
- The trucks are loaded from the side. The truck driver stands on the ground and pulls, at waist height, the minipallets into the truck. The driver never jumps into the truck. Instead, a stick is used to move the minipallets to the right position.

Interview with Marketing Director

The respondent thinks that the current loading process is easy and efficient. It rarely happens that secondary packages fall off during the loading procedure. Occasionally, it might happen in the trucks, but not during the loading.

Instead, the problems lie in the current packaging system. In the future, the respondent would like to replace the current solution of cardboard trays and rollcontainers and use only one type of secondary package. This would make the production more efficient.

“We only want one type of secondary package if possible.”

The dairy has explored the possibilities to use plastic crates, stacked in three or four levels. With crates, the TTs are well displayed and it is easy for the end consumer to pick a container of TT at the retailer. Also, plastic crates are easily handled with trolleys in the distribution. The problems with plastic crates are the low volume efficiency, the continuous loss of crates in the supply chain, and the need for transportation of secondary packages back to the dairy.

According to the respondent, only shrink film cannot be used in secondary packages since it hurts the cap of the TT. Nevertheless, a solution with shrink film has been tested; six TT primary packages, placed in a 2x3 packing pattern, were shrink-filmed only around the vertical sides. On the shrink film, the logotype was printed and a flexible divider adapted to the caps was used between the layers. This solution was abandoned due to several shortcomings:

- The TTs were exposed to dirt, especially in the bottom.
- The TTs were easily damaged.
- The secondary package was unstable.
- Only six primary packages in shrink film required more handling than secondary packages with eight liters.

Cardboard Solution

The solution with cardboard boxes on minipallets is far from perfect; hence, the respondent is not very satisfied:

“The cardboard solution was chosen because at that time, there were no other solutions.”

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The first problem with the cardboard solution is that the dimensions of the boxes do not fit the minipallet. As a result, the trays can get damaged. Secondly, cardboard is expensive. Thirdly, the cardboard material is easily affected by water and humidity. Rainwater and water from cleaning in the production makes the cardboard weak and causes the boxes to break. Also, the trucks are washed with water every day. If the trucks are not dry when they are loaded, the cardboard might get weak and damaged.

Minipallet

As some of the TTs are sent to distribution centers, it could be a problem that the minipallet is not adapted to fit EUR-pallets. The respondent contemplates:

“Maybe it is possible to remove the use of [mini] pallets.”

Rollcontainer

The problem with rollcontainers is that they carry far too many primary packages to fit the demand of small customers. Hence, they can only be used for bigger customers. Nevertheless, a big advantage is that the rollcontainers are very easy to move and handle in the distribution chain.

When it comes to marketing issues, rollcontainers are neutral and do not affect the image of the product. The rollcontainers from different dairies are frequently mixed with each other.

Interview with Internal Logistics Manager

The respondent would like to see a flexible secondary package that could be used to satisfy all types of customers. It is important that the package is stable and also helps marketing the product.

The dairy uses cardboard of a lower quality than suggested for the Tetra Pak packers. However, the quality is perceived to be good enough and there are no problems with damaged goods:

“Less than one percent of the TTs are damaged.”

The respondent does not think that water and humidity in the production is a problem. However, the washing with water has to be carefully performed to keep the secondary packages dry.

Plastic film is more water resistant than cardboard. Also, a shrink film solution can be easily designed with holes used as handles that facilitate handling. With shrink film, only one hand is needed to lift the secondary package, which is not the case for cardboard:

“Cardboard is less easy to handle than shrink film in terms of grabbing.”

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In addition, the TTs are less protected in a cardboard box; however, at the dairy this is not a problem. Succinctly, the respondent is not very satisfied with the cardboard solution:

“I wish that cardboard is only a temporary solution.”

Dairy A has also tried a cardboard solution where the long sides of the top of the box had cardboard wings. This increased the stability of the minipallet. Also, it prevents the primary packages from falling out of the secondary package. On the other hand, the wings contribute to additional packaging material and create problems when TTs are leaking:

“Then you cannot just replace the product and clean with water. Instead, the leaking primary packages stay unnoticed in the cardboard that gets weak.”

Nonetheless, the respondent states that leaking primary packages are generally not a big problem.

On the Italian market, there is no need for a multipack solution of fresh milk. The shelf life is too short and the consumption of fresh milk is poor.

Rollcontainer

With rollcontainers, there are no complaints about handling. Instead, the respondent thinks that rollcontainers have another major drawback:

“Disappearing returnable secondary packages is always a big problem.”

The respondent estimates that about 40% of the rollcontainers in the system disappears every year. This is very expensive as rollcontainers are very expensive.

The respondent does not believe in a deposit system where the retailers pay for returnable secondary packages and get the money back when they are returned. This would mean more work for the retailers; the risk is that they would choose another supplier not imposing this depository system.

Interview with Production Responsible

The most important property of a secondary package is to support “one-touch” merchandising, i.e. a simple package does not require a lot of handling. In addition, the secondary package should be easily identified and not create large amounts of waste material.

Moreover, the problem stated by others that the cardboard gets weak from water is not recognized by the respondent:

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“It is not a problem with water in the production.”

Cardboard Solution

The respondent comments the cardboard solution currently in use:

“Cardboard is not the best solution. The best alternative would be to only use rollcontainers.”

The problems with the cardboard solution are the relatively high material cost and that the pallets with unfolded cardboard blanks occupy too much space. Also, cardboard trays are less practical to carry in comparison to, for example, shrink-filmed units.

Rollcontainers

There are about 600 – 700 rollcontainers at the dairy. In the whole system, there are approximately 1000 pieces. One rollcontainer costs about €100. The dairy buys about 500 containers every year from a supplier in Finland. Consequently, a rollcontainer has an average lifetime of one year.

Although there are some major problems with disappearing rollcontainers, the respondent is very satisfied with this solution:

“Rollcontainers are perfect from a handling point of view.”

4.3.4 Transporter A

All distributors are employed by the dairy.

Truckdriver A1

Interview

The respondent is of the opinion that the cardboard trays break more often than the old solution with shrink film that was used before the introduction of the TT.

After being in the profession for six years, the truck driver complains about pain in the back and neck as a result from heavy lifting.

During the summer months, the outside temperature often reaches 40 °C. This is a problem for the milk quality. To overcome this problem, the truck driver wishes for a secondary package that keeps the TTs cold even at high temperatures.

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Observations

An average stop on the route lasts about 5-7 minutes where 4-5 containers of TT cardboard packages are unloaded together with other products, mainly to smaller size customers. The truck driver stopped at about 35 different customer stores; the whole route took about 6 ½ hours.

A metal stick with a vertical metal rod is used to move the secondary packages inside the truck. Different types of equipment are used as tertiary packages: small manual trolley lift, big rollcontainers from the stores, small store trolleys. At the most, 12 cardboard packages are loaded onto the trolley lift. At reloading, the cardboard packages are stacked on top of each other in a block stacking pattern with the load on the TT cap.

Truckdriver A2

Interview

The respondent thinks that the cardboard tray breaks quite easily during handling. Another disadvantage of the cardboard solution is that it sometimes gets wet and weak. This increases the portion of damaged secondary packages.

Depending on how the secondary packages are handled, sometimes the cardboard package fall off the minipallet. Using a stronger cardboard quality would protect the TTs better.

4.3.5 Retailer A

Retailer stores are divided into three groups based on store size: hypermarkets (~10000 m²), Supermarkets (~2000 m²), and Superettes (small supermarkets, 400-850 m²).

Hypermarket A1 – Rollcontainers

Hypermarket A1 gets the TT milk delivered in rollcontainers. About four rollcontainers (with three layers) containing TTs from Dairy A are delivered everyday to the hypermarket. During Wednesdays and Saturdays the demand is at its peak. A merchandiser, on contract with Dairy A, works about three hours at the hypermarket every morning with displaying the products.¹²⁸

Interview with Cold Cell Responsible

The cold cell responsible at Hypermarket A1 wants to eliminate the use of rollcontainers in the future. The respondent has two main reasons for this statement: Firstly, dirt (on the floor of the refrigerator) is especially visible to customers; Secondly, when unpacking the individual primary packages onto shelves, it looks more neat with the straight lines and it also looks more full on the shelves. In the rollcontainers, the shelves do not look full once the customers have started to pick the

¹²⁸ Cold Cell Responsible, Hypermarket A1.

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milk. Using a cardboard solution would perhaps mean more handling but the respondent has the priorities set:

“I prefer good marketing and image before handling.”

Replacing the use of rollcontainers would mean that the merchandiser would have to spend additional time at the store, a cost that does not affect the store but the dairy. The cold cell responsible estimates that it would take about 10 minutes more to unpack the products into the shelves instead of using a rollcontainer.

The truck drivers of rivalry dairies pick up the rollcontainers outside the store on a first-to-come basis:

“It is not our [the retailer’s] problem with disappearing rollcontainers.”

Primary packages leaking are not a big problem, but can occur when customers are reaching for products on lower layers. The customers can then manage to squeeze the primary package between the rollcontainer layer dividers. Using shelves instead of rollcontainers minimize the problem of customers reaching for other products than the front-most.

A multipack solution containing two or three liters of TT would not be beneficiary, except maybe for weekends when customers sometimes buy more than one liter. Nevertheless, even on weekends, the respondent believes that a multipack solution would not be good.

Observations at Hypermarket A1

The front hatch of the rollcontainer is not opened; hence, customers have to reach down far to get access to the lowest layer. Also, customers might injure themselves when collapsing the layer dividers when reaching down to lower layers.

Further observations were made during the visit:

- The primary packages look clean and undamaged.
- The floor surrounding the rollcontainer looks quite dirty.
- Dairy A’s rollcontainers with logotype are used by competitors.

Hypermarket A2 – Rollcontainer

Hypermarket A2 only uses rollcontainers as the secondary package for TT. About four rollcontainers (with three layers) are delivered from Dairy A to the hypermarket every day. On Fridays and Saturdays, the demand is doubled. Everyday, a merchandiser works for 1.5 hours with displaying the products.

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Interview with Cold Area Responsible

In general, the respondent is satisfied with rollcontainers. If not using this solution, the hypermarket would have to have more personnel putting TTs into the shelves – a solution that would not be viable. Also, when it comes to ergonomics, the respondent believes that rollcontainers are the best solution for the hypermarket:

“It would be a big problem to change the secondary package. It is useful with rollcontainers...For big clients, rollcontainers are a must.”

Furthermore, the attention of the hypermarket is on easy handling. The advantages of rollcontainers are the good protection and the good structure of the primary packages:

“The TT looks good and orderly [in the rollcontainer] still after two hours. Milk in shelves needs more attention from the operator; the order in the shelves do not last for long...The rollcontainers do not need any attention during the day, but the [store] shelves take a lot of attention”

A negative aspect with using rollcontainers is that the lowest layer is not displayed properly; it is hidden because of the refrigerator design. Depending on the operator, the products left on the lowest layer are sometimes manually rearranged to the higher layers.

It rarely happens that the primary packages fall out of the rollcontainer and break. However, when it does happen, it is when the rollcontainer is fully loaded and customers just have started picking the TTs. Hence, the problem is only occurring during the mornings. The respondent thinks, however, that it is more important that the customers can take from whatever shelf in the rollcontainer that they wish. Primary packages falling down from store shelves are not as frequently occurring.

Dirty primary packages are generally not an issue; only when it rains it could be a problem. Additionally, dirt on the floor is not a problem.

There are no problems of primary packages being damaged upon arrival. The respondent is of the opinion that the TTs are very protected in the rollcontainers.

Not until the rollcontainers have been completely emptied, they are taken into the storage area. No attention is put on what competitor has been delivered the rollcontainer; instead, all rollcontainers are stored together.

A multipack solution would, according to the respondent, not work in the hypermarket. The shelf life is considered to be too short. Saturday is the only day that customers buy two or three liters. Customers would instead try to break the multipack and take out a single product, similar to how they handle water in multipack.

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Interview with Merchandiser

It takes the merchandisers about three minutes to take a rollcontainer from the cold storage and put it into the store shelf. Generally, the merchandiser is satisfied with the rollcontainer since it is faster to display the primary packages in the store this way. Using a cardboard solution instead, the merchandiser estimates that it would take about 20-30 minutes to unload the same amount of primary packages.

Observations at Hypermarket A2

- The rollcontainer hatch is open.
- The primary products look whole and clean in the rollcontainer.

Supermarket A1 – Rollcontainer

Supermarket A1 gets the TT milk packages delivered in rollcontainers containing two layers.

Observations at Supermarket A1

- The rollcontainer hatch is open.
- Additional TTs are loaded ontop of a fully loaded rollcontainer.

Superette A1 – Cardboard Solution

The TTs are being delivered to the superette in cardboard. The truck driver puts the secondary package in a small trolley at the retail entrance. About seven cardboard packages are delivered to the superette; that is, the average demand is about 56 liters per day. The demand is at its peak on Saturdays.

Interview with Vice Director

The vice director rolls the trolley in a cold storage room or, alternatively, into the store where the primary products get unpacked into the shelves. The cardboard is collapsed after the primary packages have been emptied. A truck comes twice a week and collects the cardboard with all other waste material.

The respondent believes that there are no problems with damaged primary packages getting delivered in the cardboard solution. When comparing the shrink film solution used for plastic bottles with the cardboard solution used for TTs, the respondent has no direct preference:

“Maybe it takes a little bit less time for unpacking [the primary packages] with the cardboard, but there is no big difference.”

Superette A2 – Cardboard Solution

Only cardboard solutions are used for the TTs in the superette. The truck driver puts the cardboard boxes on the floor next to the store shelf. Later, the shop operators

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unpack and put the TT into the shelves. The total demand for the two different fat contents of milk in TT from Dairy A is 5-7 pcs of secondary packages per day, i.e. 40-56 liters/day.

Interview with Store Manager

Milk in plastic bottles, delivered in shrink film, is also delivered to the superette. In general, the store manager thinks that there are no big differences between the two solutions:

“Cardboards are easier to unpack. They take little less time than shrink film, but it is quite the same anyways.”

However, the cardboard box has to be collapsed and put in a special rollcontainer where it waits for recycling. The shrink film, in contrast, is put with the other trash. This means that the cardboard is a bit more time consuming during collapsing, which counterbalance the time gained during unpacking:

“In the end, it takes the same amount of [handling] time for shrink film and cardboard.”

When it comes to environmental issues, the respondent is not very interested.

The secondary packages are less dirty in the cardboard solution in comparison to the shrink film; however, dirt is not a problem in general. Rarely, damaged primary packages are delivered to the superette.

Superette A3 – Cardboard Solution

Every day, about eight cardboard packages are delivered to the superette. After the cardboard has been emptied, it is collapsed and thrown away with other trash instead of being recycled.

Interview with Operator

The respondent is satisfied with the cardboard solution used for TT. In comparison to the shrink film solution used for plastic bottles, the respondent prefers the cardboard solution:

“Cardboard is better. When using a knife [to open the secondary packages], it may happen that the plastic bottles are cut.”

When it comes to environmental issues, the respondent does not care if cardboard or shrink film material is used because the superette does not recycle; everything goes in the same trash.

The respondent thinks that there are no problems with neither damaged nor dirty primary packages.

Observations at Superette A3

The TTs are displayed in a quite complex pattern: in the front, TTs are lying down with every other layer (three in total) shifted 90 degrees; in the back, TTs are standing with one layer of lying down TTs on top as load on the caps.

4.4 Supply Chain B

Supply Chain B was examined for two days. During the first day, interviews and observations at the dairy were performed. The second day was devoted for the observations of the transportation from a distribution center to retailers; also, additional interviews at the dairy were carried out. The different interview respondents are presented in Table 4.4.

Table 4.4 Summary of interview respondents in Supply Chain B.

<i>Supply Chain Actor</i>	<i>Position</i>	<i>No.</i>
Dairy	Production Maintenance and Service Manager	1
	Production Manager	1
	Purchasing Manager	1
	Marketing Manager/General Director	1
	Distribution Logistics Manager	1
Transporter	Truck Manager	1
	Truck driver	1
Retailer	See Dairy A ¹²⁹	-
Total		7

4.4.2 Packaging System B

Primary Package

The TT primary package has a Flat Off top with the S38 screw cap. Fresh milk is produced in four different logotypes with two different types depending on fat contents. Consequently, each logotype is produced in two different printings with separate screw cap colors.

Secondary Package

For one of the logotypes produced at Dairy B, a cardboard tray is used as secondary package. The cardboard tray contains 12 primary packages of TTs in a 2x6 packing pattern, see Figure 4.5. The cardboard material is produced by an Italian company and is of one-well type with a thickness of 2mm. Similar to the cardboard tray in Supply Chain A, big printings on the long and short sides display the logotype and type of milk. For the two different fat contents types, different printings are used on the

¹²⁹ See comments under Section 7.2.

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cardboard. Approximately, 55-60% of the total use of secondary packages at Dairy B is cardboard.¹³⁰

A shrink film solution with cardboard divider and bottom is used for the rest of the brands. The shrink film is made of polyethylene; the cardboard bottom and divider is of two-well type. Similar to the cardboard box solution, the shrink film secondary package contains 12 liters of TTs in a packing pattern of 2x6, see Figure 4.6. The cardboard bottom and divider as well as the shrink film are neutral and do not have any printing. About 35-40% of the secondary packages delivered from the dairy are of this shrink film solution.¹³¹

Also, rollcontainers are used to a small extent for delivery from the dairy to big customers. Rollcontainers are filled in two, three, or four layers with 5x8 liters on each layer; that is, a rollcontainer is filled with 80, 120, or 160 liters of milk. About five percent of the produced TTs in the dairy are delivered to retailers in rollcontainers.¹³²

Load Carrier

Both secondary packaging solutions are loaded automatically onto minipallets.¹³³ One minipallet is loaded with four layers, where every other layer is rotated 90 degrees relative to the surrounding layers in a row stacking pattern. On a fully loaded minipallet, the secondary packages stick out on the sides.

Additionally, some of the minipallets are loaded automatically onto a EUR-pallet. The minipallets are stacked 2x3 in a block pattern.

Tertiary Package

After being loaded onto a load carrier, all types of secondary packages are wrapped with plastic film as tertiary package. This is done to increase the stability and protect the cardboard packages from humidity.

¹³⁰ Production Manager, Dairy B.

¹³¹ Ibid

¹³² Production Manager, Dairy B.

¹³³ The dimensions of the plastic Mariani minipallet used at Dairy B are 45cm x 45 cm x 5 cm.

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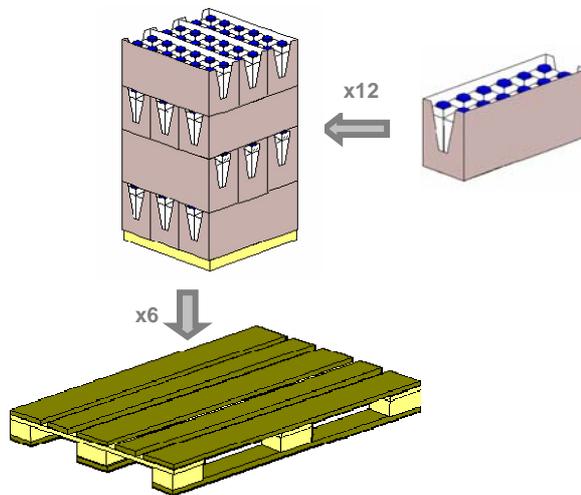


Figure 4.5 Dairy B's cardboard packaging solution.

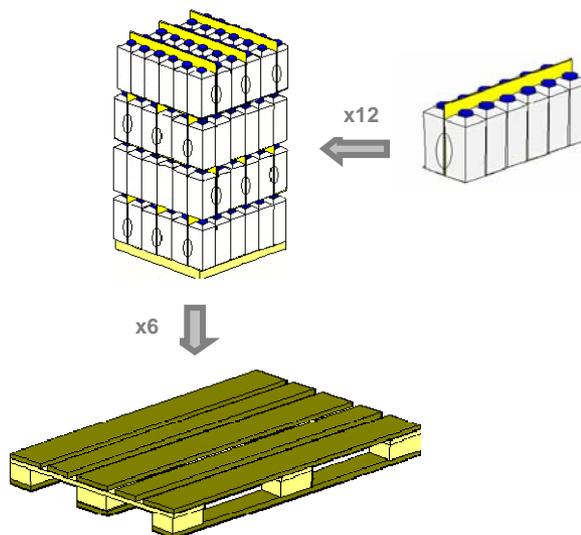


Figure 4.6 Dairy B's shrink film packaging solution.

4.4.3 Dairy B

In 2002, Dairy B bought its first TT/3 machine. One year later, another TT/3 machine was installed in the production area. The production in the two filling machines is focused solely to TT Base 1 liter. Somewhat more than half of the TT quantity produced is distributed within a big city (in cardboard trays); the rest is distributed outside the urban area to the surrounding countryside in the whole county (in the shrink film solution).

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Activities carried out at Dairy B are shown in Appendix E – Flowchart 3. All secondary equipment at Dairy B comes from the Italian packaging solutions company Mariani.

Observations at the Dairy

- Some water was noticed in the bottom of a filled cardboard package. This could have been caused by condensation.
- When cleaning the production area, some of the empty cardboard blanks on pallets get wet.

Interview with Production Maintenance & Service Manager

The cardboard secondary package was chosen because Tetra Pak had told Dairy B that this solution was the only secondary package safe enough for the protection of the TT cap. The respondent concludes:

“Tetra Pak provides only one solution for everybody; the recommendations are not flexible”

Nevertheless, it was noticed that the cardboard solution was not very useful and personnel at Dairy B started to think about new solutions. In 2003, Dairy B came up with the shrink film solution. With help from Mariani, the new preferred solution was invented.

As mentioned, the cardboard tray is not working satisfactorily. The respondent would prefer to use only the shrink film solution but because the machine is already in use, Dairy B will have to continue using it; replacing the machine would be too expensive.

The respondent gives the following general requirements of a secondary package:

- The secondary package should be possible to palletize.
- The secondary package should be efficient in internal logistics handling.
- The secondary packaging machine should be uncomplicated.
- The secondary packaging machine maintenance should be easy and cheap.

In general, the respondent thinks that the secondary packages fulfill his requirements; although, the shrink film solution is perceived to be somewhat superior. The two different packers (cardboard and shrink film) have both about the same need of maintenance. Nevertheless, the film packer is more complex than the cardboard packer and is, therefore, more expensive to repair. In contrast, the shrink film solution is better than cardboard tray when it comes to palletizing and handleability.

The respondent gives the following reasons why the shrink film solution is preferred to the cardboard tray:

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- **Cost issues**, the respondent is, although, not fully sure of the costs differences of the different secondary packages.
- **Handleability**: the shrink film solution can be lifted with one hand, the cardboard tray needs two hands.
- **Stability**: the shrink film package remains stable even when the secondary package is not full, as is the case when truck drivers deliver less than 12 liters of TT to one customer.
- **Storage**: the empty cardboard trays require more space during storage.

The decision of dimensioning the secondary package to contain 12 liters was made solely to utilize the area on the minipallet as good as possible.

Cardboard Solution

The cardboard tray, as it looks today, is not very stable in the middle. The reason for this is the length of the box. This has the implications that the long sides of the secondary package flex. According to the respondent, using a higher quality of cardboard would not be a solution to this problem. Instead, a strip on the top connecting the two long sides could be used; this solution is, however, too costly to implement.

Another improvement to the cardboard is that the wing originating from the bottom of the box folding over the short side could be somewhat higher to improve stability.

Another negative aspect with the cardboard package is that if the cardboard tray breaks then all the primary packages fall out. On average, primary packages in cardboard trays are more often damaged in comparison to the use of shrink film solutions and rollcontainers; damaged products are, however, generally not a problem.

The filled pallets are moved when cleaning the cold cell; wet cardboard is therefore not a problem, but the operators have to put attention to it.

Shrink Film Solution

The cardboard bottom is used in the secondary package in order to provide stability to the shrink film. The vertical cardboard divider is used in order to prevent damage of the TT cap and top when stacked. The shrink film solution is considered to be more stable than the cardboard tray. Also, if the secondary package breaks and some primary products fall out, then the remaining products in the shrink film solution are still contained in the secondary solution.

The respondent is generally very satisfied with the shrink film solution, although there are some minor problems. Firstly, the respondent perceives that there still could be some problems regarding the support from the cardboard divider:

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“The weight from the higher levels when stacking the secondary packages is not solved to 100%; The TT do not break, but with only a little bit of damage on the top, then the customers do not want to buy the product.”

Secondly, during the “shrinking” process in the oven the plastic film surrounding the primary product also gets warm. The two films (i.e. the shrink film of the secondary package and the plastic film on the primary package) stick to each other. This can damage the printing on the primary package when the shrink film is removed later on in the supply chain. According to the respondent, this problem only occurs where the shrink film puts the main pressure to the primary products: that is, on the corners of the outermost primary packages in the secondary package. The respondent believes that this problem is rather small and a solution to this minor problem would be very costly for the dairy.

Rollcontainer

The rollcontainer is perceived as being the worst of the three different secondary solutions. It is bad from an ergonomic point of view since the operator has to do a rotative motion in order to grab the primary packages from the passing conveyor bands. The operator also has to bend in order to place the primary packages on the lower shelves of the rollcontainer. Nevertheless, the respondent has heard that an automatic filler machine breaks down frequently and that long time is spent on repairing the machine instead of keeping it in production.

The respondent believes that there are no problems with damaged primary products in the rollcontainers.

Disappearing rollcontainers is a big problem for Dairy B. The company has an objective to reduce the loss of rollcontainers, as truck drivers are told to bring home as many rollcontainers as possible.

Interview with Production Manager

The production manager is more satisfied with the shrink film solution than with the cardboard. Firstly, the problem with cardboard material is its limited ability to withstand humidity and water. Secondly, the shrink film is more compact in storage. Thirdly, the shrink film is much better in handling.

Interview with Purchasing Manager

The cardboard solution was chosen in the beginning due to Tetra Pak’s recommendations that the TT should be packaged in this material. The shrink film solution was created first after the buying of the cardboard packer. The cost difference of the two different solutions is minor.¹³⁴ If the respondent would have

¹³⁴ The cardboard secondary packaging material costs €0.126/secondary package. The shrink film secondary packaging material costs €0.028/secondary package, and the cardboard divider and bottom cost together €0.085/secondary package (that is, €0.028 + €0.085 = €0.113/secondary package in total).

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more money to spend on account of Dairy B, a new film packer would be bought to replace the cardboard packer. The respondent was not aware that Tetra Pak sells distribution equipment and implies that maybe Tetra Pak did not provide with enough information.

The packing pattern of 2x6 was chosen to fit the minipallet. A pattern of 2x3 would be a too small quantity for the retailers.

Cardboard Solution

There are two major problems with the cardboard solution: firstly, the cardboard material has no good resistance against humidity; secondly, when the cardboard tray is damaged it is most often due to the fact that the wings of the short sides break. However, damaged primary packages are usually not a problem. Replacing the existing cardboard material with a higher quality would cost too much. Yet, another solution to the second problem is currently worked on, where Dairy B is looking for another glue to use.

Shrink Film Solution

Damaged products are not at all a problem in the shrink film solution. The purchasing manager prefers the shrink film solution:

“Shrink film is not the perfect solution. But, at the moment, it is the best of the current alternatives.”

The advantages of the shrink film solution are

- **transparency:** the transparency of the shrink film is good for marketing issues.
- **handleability:** easy to grab with one hand and good to pick out one or two primary packages.

A negative aspect with the shrink film is that the machine is more complex; it is not a one-step machine. Instead, a sequence of activities is carried out in different machines.

Rollcontainer

The loss of rollcontainers is rather large; about 300 new rollcontainers are bought every year.¹³⁵ In total, about 2000 rollcontainers are in the system. Using a deposit system for rollcontainers would be impossible due to the reluctance from powerful retailers. There are many explanations to why the rollcontainers disappear: they break, corrode, are misplaced, and are forgotten.

¹³⁵The cost of a rollcontainer is €89.

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Desirably, the respondent would like for Dairy B to be able to stop using the rollcontainers. This is, however, not possible because of the requirements from the hypermarkets. The main reason for replacing the use of rollcontainers is that, even though the first and second layers are good to take from, picking from the third bottom layer is a disaster. Often, these primary packages remain unsold and are sent back to the dairy.

Minipallet

About 1000 new minipallets are bought every year to be used for all the different products produced at Dairy B.¹³⁶ The purchase is most often a result of replacing broken minipallets; the theft rate of the minipallet, in contrast to rollcontainers, is not large.

Plastic crate

Although Dairy B no longer uses plastic crates, the respondent has had some experienced with them. Using plastic crates instead of the existing alternatives is not an option:

- The plastics crate needs washing.
- TTs would not be stable in the plastic crates.
- Materials with no reuse are preferable.

Interview with Marketing Manager/General Director

The dairy followed the suggestions, made by Tetra Pak, to use cardboard as the material for the secondary packaging solution. The production in the cardboard packer covers the demand from the big city area. When Dairy B expanded, it chose to implement the shrink film solution for the new TT products. If the respondent could start over again, only the shrink film solution would be implemented.

From a marketing point of view, the respondent does not think that the secondary package is interesting because the secondary package is never displayed to the end consumers.

In comparison, marketing possibilities are greatest on the cardboard tray due to the printing possibilities. Unprinted cardboard material could be used but the cost difference would be minimal. The cardboard material has been, in the past, more synonymous with higher quality; shrink film was more synonymous with the low price UHT milk. However, this is not the case anymore.

Although Italy does not generally have a high degree of sensibility of waste and environmental issues, the TT is to some extent marketed as being more environmentally friendly than plastic bottles. The respondent expresses the opinions of using a returnable secondary solution:

¹³⁶ One minipallet costs about €4.

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“The best solution is with waste material.”

According to the respondent, the secondary package is not very important as an information carrier.

The decision of putting 12 liters in a secondary package was based on the dimensions of the minipallets and EUR-pallets.

Rollcontainer

The respondent sees the use of rollcontainers as an old solution. There are many reasons why rollcontainers should be substituted. The rollcontainers

- are difficult to fill.
- are difficult to transport.
- bring back a lot of unsold milk back to the dairy.
- have no marketing possibilities (made of iron).

The fact that rollcontainers from different dairies often are mixed and, hence, company logotypes get mixed is of no great concern to the respondent:

“Customers do not care about this. Maybe it is not a good thing, but it really does not matter.”

Interview with Distribution Logistics Manager

The company was the first one in Italy to produce TTs and, hence, did not know what secondary package to use. Now it has the cardboard packer and has to use the machine.

The respondent indicated that more handling time for the truck drivers is not a cost for the dairy. Since the truck drivers only get paid for the amount delivered, longer time for handling is therefore really not a concern. On the other hand, handling time for the merchandiser affects the cost for the dairy.

Cardboard Solution

The respondent's opinion is that the cardboard tray is the worst solution of the three current solutions at the dairy. The arguments are as follows:

- **Humidity:** Opening and closing the truck frequently cause condensation on the secondary package, which makes the cardboard weak. The respondent considers this to be a major problem.
- **Handling:** Milk is transported to many small customers. This distribution gives rise to a lot of handling of the secondary package, which is not suitable for the cardboard tray.

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- **EUR-pallet filming:** Tension caused by the stretch film enclosing the filled EUR-pallets affect the gluing points of the secondary package. When the stretch film is removed, the sides of the cardboard package break and the TTs fall out. The filming was earlier automatic, but had to be replaced by a manual operation to decrease the problem of broken cardboard trays. However, the problem still exists to some extent.

Shrink Film Solution

The respondent prefers the shrink film solution due to its properties: more handleable, more hygienic, more resistant to humidity, more compact, and more economic. Nevertheless, a negative property of the shrink film is that it demands more attention from the merchandiser; the merchandiser has to be careful when opening the secondary package (in order not to cut holes in the primary package). In addition, the merchandiser has to take care of both the shrink film and the cardboard divider and bottom: that is, to take care of two different materials.

Rollcontainer

In general, the respondent is of the opinion that use of returnable secondary packaging should be minimized due to the large problems of theft in Italy.

The big customers influence the dairies's choice of secondary package. Many of the big customers have expressed that they would like to replace the rollcontainer fridges in the stores and only use shelves. The reason for this change is that the rollcontainer fridges are not efficient in preserving the temperature: the cold is sipping out along the floor where the loading of the rollcontainers takes place. Putting all the primary packages onto the shelves would require additional work for the merchandiser. Demands have been made that the merchandiser, employed on contract by Dairy B, should stay for four hours per day in the big stores. Refusing this demand could cause the big customers to find other suppliers for milk.

With a greater demand of rollcontainers, Dairy B could automate the filling process. But, because of the rather low demands of great quantity to individual retailer and due to the uprising demands from the big customers of replacing the rollcontainers, investing in an automatic filling machine is not efficient.

In general, the respondent disapproves of the rollcontainers due to the inability of the secondary package to preserve temperature. Furthermore, the respondent gives additional reasons for the dislike of rollcontainers:

- **Cost:** A rollcontainer cost a lot.¹³⁷
- **Loss:** A lot of rollcontainers disappear.
- **Unloading docks:** Not all trucks have lifts so rollcontainers cannot be used when distributing to customers without unloading docks.

¹³⁷ One rollcontainer cost €80-90.

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- **Lift weight:** Trucks with lifts cannot be loaded with maximum load due to weight constraints of the loaded truck.¹³⁸ However, this is only of concern on Saturdays when the trucks are fully loaded.

4.4.4 Transporter B

The logotype loaded into the cardboard tray is never transported to distribution centers. Instead, it is directly transported with the trucks to the retailers. On the other hand, the logotypes filled in the shrink film solution are further transported to distribution centers.

The truck driver work for Dairy B, but are not directly employed by the dairy. Instead they get a fixed salary per day. However, if the truck driver's total driving distance is over a certain amount, the driver gets additional compensation. An average route for the truck driver is about 130 km with 60 stops.¹³⁹

Observations during loading into trucks

The trucks are always loaded from the back. When the demand is a full EUR-pallet, one operator from the Dairy B takes the pallet from the designated storage place and puts it on to the loading dock with the help of a forklift. Soon after, the truck driver uses a smaller forklift to transport the filled EUR-pallet into the truck.

Regarding smaller quantity than a whole pallet, the truck driver manually loads four levels of TTs in cardboard on top of each other onto a small trolley. Sometimes also a fifth layer is added. Every other layer is rotated. Occasionally, the cardboard tray breaks somewhat during manual handling. This demands more attention from the truck driver.

Rollcontainers are manually rolled into the truck and secured with a strap. Additional products (about 60 liters of milk) are sometimes loaded on top of the top layer of the rollcontainer. Also, other products are temporarily loaded on top of the additional weight on the rollcontainer.

Interview with Truck Manager

The truck manager prefers the shrink film solution due to the following reasons:

- **Humidity:** the shrink film solution withstands the condensation caused by temperature changes.
- **Hygiene:** the shrink film solution protects the primary products better from dirt and other factors.
- **Water:** the shrink film solution protects the primary package against water from washing the truck and from the cooling aggregator in the truck.

¹³⁸ The lift adds to the total weight of the truck. Less products can therefore be loaded into the truck due to the total weight constraints.

¹³⁹ Distribution Logistics Manager, Dairy B.

Interview with Truck Driver B1

The truck driver likes the shrink film solution better because it is easier to handle:

“When manually taking the cardboard trays with my hands, it is a big problem. Cardboard trays need the use of two hands.”

Also, the truck driver points out another negative aspect with cardboard:

“When it rains, the cardboard material is a big problem. It gets weak.”

Although the shrink film solution is preferred, there are some problems with this secondary package. According to the truck driver, customers often buy less than 12 liters. The picking of only a few TTs takes time.

The truck driver is of the opinion that damaged products in the secondary packages are not frequently occurring. Nevertheless, damaged products are more frequent in the cardboard package than in the shrink film solution. Also, leaking products (although, not commonly occurring) can create a problem in the cardboard solution:

“If a TT leak, you cannot see it in the cardboard. In the shrink film you can see the leakage.”

Observation at Distribution Center

Smaller trucks at the distribution center are loaded with only one level of secondary packages; bigger trucks have 3-4 levels of secondary packages.

Only whole pallets are present at the distribution center. The corners of the fully loaded EUR-pallet are somewhat damaged due to the tension of the stretch film surrounding the pallet. The cardboard bottoms of the shrink film solutions, loaded on the pallets situated on the loading dock, are a bit wet due to condensation.¹⁴⁰ Also, the shrink film of the secondary packages is somewhat wet.

On some of the pallets, the individual layers are somewhat askew causing the caps of the outermost primary packages on the corners to take most of the load instead of the intended cardboard divider, see Figure 4.7.

¹⁴⁰ The loading is carried out outside of the cold cell.

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Figure 4.7 Askew layers of the shrink film solution loaded onto EUR-pallets.

4.4.5 Retailer B

Big customers (so-called hypermarket) sometimes have merchandisers unpacking and displaying the products from a specific supplier. Merchandisers are not employed by Dairy B, but are under contract of the Dairy. Hence, they are not being paid by the hypermarket.¹⁴¹

No retailer visits were made during the investigation of Supply Chain B. Instead, for observations and interviews regarding the cardboard solution, the reader is referred to Retailer A. The arguments for this statement are presented in Section 7.2.

4.5 Supply Chain C

Supply Chain C was examined for four days. Two days were devoted for interviews and observations at the dairy, one day for visits at the distribution center, and one day for interviews and observations with truck drivers and retailers. The different interviews are presented in Table 4.5.

Table 4.5 Summary of interview respondents in Supply Chain C.

<i>Supply Chain Actor</i>	<i>Position</i>	<i>No.</i>
Dairy	Production Responsible	1
	Cold Area Responsible	1
	Production Manager/Marketing Manager	1
	General Director	1
	Cold Area Responsible at DC	1
Transporter	Truck driver	1
Retailer	Cold Area Responsible at Hypermarkets	1
Total		7

¹⁴¹ Distribution Logistics Manager, Dairy B.

4.5.2 Packaging System C

Primary Package

Due to a special production process, the product has an extended shelf life of ten days. On the other hand, the milk requires a storage temperature between zero and four degrees.

The primary package is equipped with the Pacaya top and the S38 screw cap. Currently, one logotype with two different fat contents is produced at Dairy C; that is, primary packages with two different printings and separate cap colors exist. In the future, another logotype will be added.

Secondary Package

The only secondary package in use at Dairy C is cardboard wraparound boxes. The secondary package, with a two-millimeter thick one-well cardboard material, encloses ten TT primary packages in a 2x5 packing pattern. On the cardboard box, there are big printings on the two long sides. For the two different fat contents, different printings are used.

The roof of the cardboard is provided with a hole to make it possible to see the expiry date on the primary packages. There are no handles on the cardboard so the only way to carry the secondary package is from underneath.

Load Carrier

All cardboard boxes are loaded on EUR-pallets. Every pallet is loaded with 75 cardboard packages, see Figure 4.8. Consequently, a pallet carries 750 liters of milk.

Tertiary Package

To increase the stability and protect the cardboard packages from humidity, the secondary packages are automatically wrapped with stretch film, after being loaded onto a load carrier. About 80% of the cardboard box load is automatically wrapped with plastic film. Due to reloading in the trucks, the remaining 20 % of the load is left without plastic film to facilitate manual picking in the distribution.¹⁴²

¹⁴² Cold Cell Responsible, Dairy C.

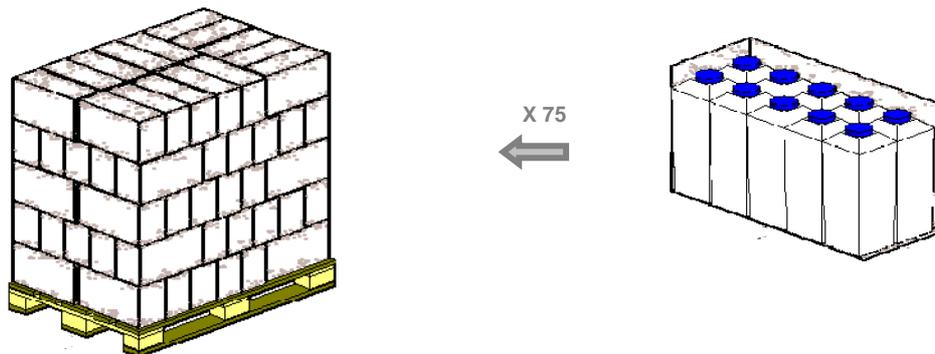


Figure 4.8 Dairy C's packaging solution.

4.5.3 Dairy C

At the time for the collection of data, Dairy C had recently launched the production of one brand of fresh milk in one TT/3 machine. About 90 % of the production is sent to distribution centers, whereas the remaining 10 % is directly distributed to local retailers.¹⁴³ Activities carried out at Dairy C are shown in Appendix E – Flowchart 4.

Observations at the Dairy

On the conveyor belt, lubrication liquid is used in order to make the TTs slide on the belt. Otherwise the packer machine is said to break down.¹⁴⁴ This means that the TTs are somewhat wet in the bottom, which can make the cardboard box weak.

Interview with Production Responsible

Today, cardboard is the only secondary package material at the dairy. Earlier, a secondary package solution with plastic crates was in use. This solution was abandoned for several reasons:

- The crates disappeared in the supply chain; purchase of new crates created high costs.
- The crates came back dirty and had to be cleaned, which occupied one additional operator.
- The crates are returnable which requires more handling in the distribution.

Cardboard Solution

The respondent is very satisfied with the cardboard solution. However, the dairy has never taken other secondary packages into consideration. Because the TT, with its

¹⁴³ Ibid.

¹⁴⁴ Production Responsible, Dairy C.

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fragile top, is incapable of standing pressure, the dairy has to use a cardboard. The opinion that cardboard is better is based only on production reasons:

“Environmental issues have not been taken into consideration.”

According to the respondent, there are no problems with damaged TTs at the dairy. However, there is one problem regarding the gluing of the roof. The edge of the roof is designed to stick to the side of the cardboard at four gluing points. The cardboard is too thick and the perforations in the cardboard are too small. Consequently, the roof does not stick to the side of the cardboard and frequently remains open as it leaves the cardboard packer. The use of thinner cardboard to prevent this from happening is not a good solution. Instead, the cardboard has to be provided with deeper perforations or a pre-folded roof.

Interview with Cold Cell Responsible

As most customers order full pallets together with some additional secondary packages, most loading in the trucks requires manual picking to some extent. Normally, the picking takes place inside the cold cell.

According to the respondent, the use of rollcontainers is a bad solution. They are hard to transport and some retailers do not have fridges that can fit the rollcontainers. In these cases the rollcontainers would have to be repacked at the retailer. In addition, the respondent is of the opinion that even the big clients are satisfied with cardboard boxes and do not require rollcontainers.

Cardboard Solution

According to the respondent, the cardboard box was chosen as secondary package due to its good stacking ability and product protection. The five layers of cardboard on the pallets are heavy and create a high pressure on the bottom layers:

“TTs has to be stored in a secondary package with roof because of the risk of damaged products.”

Damaged products are not considered to be a problem in the cold cell and the respondent prefers to use the existing cardboard solution to other possible alternatives. In exceptional cases, a TT is leaking; this can cause the cardboard material to get weak and the box to break.

Interview with Production and Marketing Manager

About seven years ago, Dairy C changed the secondary package from plastic crates to cardboard. The reasons for the replacing were that the plastic crates disappeared in the system and had to be cleaned before use.

Cardboard Solution

The respondent was responsible for the development of the existing secondary package. Different packaging solutions were observed in Sweden. Afterwards, a

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cardboard box, adapted to the needs of Dairy C, was developed. The secondary package was planned in consideration of the distribution centers. For example, the packing pattern 2x5 was chosen to fit the EUR-pallet.

A secondary package containing ten liters is suitable for the distribution center; but at smaller customers, the truck driver must split the cardboard box. However, big customers correspond to about 99 % of the selling volume; therefore, focus has been on distribution to the distribution centers.

“The best solution is the cardboard box as this solution can be used for all our distribution channels.”

Dairy C has tried a lot of different types of cardboard types and qualities. For example, brown cardboard was used earlier. The current solution is so strong that it can carry five layers of TTs loaded on to a pallet. At present, the cardboard is much stronger than the glue. In the future, the perforations in the cardboard material have to be made bigger in order to prevent the problem of the cardboard box top opening after the gluing process. The fact that the material quality of the cardboard is relatively expensive¹⁴⁵ is not considered to be a problem:

“The major concern is the distribution, cost comes second.”

Thinner cardboard is not possible to use when five layers of secondary packages are loaded on top of each other. With the current quality, it is not possible to stack a sixth layer on to the pallet; instead, a thicker cardboard would have to be used. Also, using a sixth layer would create problems in the palletizer as well as later on in the supply chain.

Humidity and water that damage the cardboard is not considered being a problem neither in the production nor in the trucks. The pallets that are sent to the distribution center are stretch-filmed and the products in the trucks are all loaded on pallets to avoid damage from the water on the floor. Not even the recently started distribution in smaller trucks seems to have problems with humidity.

Interview with General Director

The dairy never consulted Tetra Pak in the choice of secondary package. Instead, they performed an analysis on their own to map their requirements. The cardboard box was chosen for several reasons:

- Dairy C’s technicians had already experience of the maintenance of cardboard packers.
- Dairy C was satisfied with the cardboard solution used for other products, such as the Tetra Brik.
- The cost of disappearing plastic crates made the cardboard solution cheaper.

¹⁴⁵ The cardboard blank costs €0.174.

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A solution with shrink film as secondary package would harm the primary package, as the material is bad at preserving temperature. The milk produced at the dairy demands very low temperatures compared to, not only normal milk, but also other types of fresh milk. Furthermore, the distribution would be more difficult as a shrink film solution is harder to stack.

The respondent has not heard about any problems with damaged goods with the existing cardboard solution. Also, the cardboard box does not create any waste material at the dairy.

The big volumes on every pallet (750 liters) enable low logistical cost per primary package. According to the respondent, transport costs are more relevant than production and secondary package cost. The main concern is instead another issue:

“Number one priority is the quality. Cost comes second.”

Dairy C is very conscious of environmental concerns; the fresh milk is marketed as an environmentally friendly product. Also, the secondary package solution was also chosen with environmental issues in mind:

“Cardboard is a perfectly recyclable material.”

Some big clients use refrigerators suitable for rollcontainers. However, since the TTs are delivered to the retailer in cardboard boxes, the operators at the retailer manually have to put the TTs in the rollcontainers.

Interview with Cold Cell Responsible at the Distribution Center

During weekdays, the trucks arrive from the dairy in the morning. The products are unloaded and stored at a designated place in cold cell. At the distribution center, everything is put on EUR-pallets. Earlier, the personell have tried to load other products on top of the TT pallet, but that created too much weight.

In the afternoon, trucks are loaded for further distribution. At the distribution center, goods are picked manually in trolleys or on pallets. The trolley or pallet is transported on forklifts within the cold cell.

“This is the worst part of the work [as it involves heavy manual lifts].”

The distribution center participates in a deposit system where the retailers have to pay €125 for a trolley. This money is given back as the trolley returns to the distribution center. As new trolley costs €100, disappearing trolleys do not create any problems.

The only waste created at the distribution center is the stretch film wrapped around the pallets. This film is removed after unloading.

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Cardboard Solution

The operators use the barcode on the cardboard box to read the type of product and then put a new barcode on every arriving pallet for the internal handling. This barcode is used to find the storage place for the pallet and also to collect information about volumes and expiry dates.

The respondent does not perceive that there is a problem with damaged or leaking TT products at the distribution center. The use of a cardboard box is a better solution than, for example, a shrink film solution because it protects the sensitive top of the TT. However, it may not be optimal for the retailers because they have to open the package.

The distribution center has never handled TTs in shrink film. In addition, the respondent thinks that rollcontainers and minipallets would create problems for the distribution center whereas the current solution is satisfying:

“The cardboard solution [from Dairy C] works perfect.”

About 20 % of the customers are hypermarkets with average deliveries of 15 cardboard boxes. Remaining 80 % are supermarkets and superettes with an average demand of three cardboard boxes.

The packing pattern in the cardboard box is said to be a good size to handle:

“Ten containers in one box is optimal.”

The hole on the top of the box is only used to observe expiry dates and not as a handle. Instead, the secondary package is lifted with two hands: one under the box and one in the lid from the side.

Observations at the Distribution Center

Many TTs on the lower levels on the pallets are damaged because the top of the cardboard box is not glued as supposed. Instead, the lid is only stuck into the secondary package. The weight from upper levels on the pallet then presses down and deforms the tops of the TTs, see Figure 5.11.

Also, some cardboard packages are damaged and appear to have been lifted in the hole solely intended for checking expiry dates, see Figure 5.10.

4.5.4 Transporter C

Interview with Truck Driver C1

The truck driver delivers fresh milk to about 40 clients. The majority are clients that currently buy about 40 liters each. This volume is presumed to increase as this distribution channel (direct deliveries of TTs to retailer stores), was recently set up.

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A secondary package with shrink film is not optimal as the TTs cannot efficiently be stacked on top of each other. Nevertheless, the respondent thinks that shrink film might be easier to handle due to the handles, which enable the use of only one hand.

When it comes to environmental concerns, waste materials are still preferred. Furthermore, the respondent does not believe in a deposit system for returnable secondary packages.

Cardboard Solution

The respondent thinks that cardboard boxes are a good solution, mainly because they are easier to stack than rollcontainers and shrink-filmed TTs. The boxes are easy to lift but break if they are lifted in the middle hole.

The packing pattern of 2x5 is working fine; ten kilos is not too heavy to handle. The respondent never splits cardboard packages as the deliveries go to rather big clients. No information on the secondary package is used and, hence, not needed in the distribution.

Furthermore, there are no problems with damaged goods in the cardboard solution:

“Actually, there are no problems at all. If the TTs are damaged, it happens in the production. There are no problems with damaged goods in the distribution.”

Instead, humidity is a big problem because of condensation inside the truck, which makes the cardboard weak. From that point of view, plastic crates would be a better solution than cardboard.

Observations of Truck driver C1 Route

The following observations were made during the observations of the work carried out by Truck Driver C1:

- The cardboard boxes in the trucks are always loaded on pallets.
- The cardboard boxes are sometimes lifted in the hole on the top when the truck driver is reaching for the secondary package on the truck floor.

4.5.5 Retailer C

Interview with Cold Cell Responsible at Hypermarket C1

The respondent is satisfied with the cardboard solution. Sometimes the secondary package is somewhat damaged at arrival to the store, but there have not been any problems with damaged or leaking TTs.

Rollcontainers have never been taken into consideration. Plastic crates is said to be useful but it is a problem that they have to be returned. From a handleability point of view, a shrink film solution would be equal to the cardboard. Both solutions have to be manually opened. A cardboard tray could save a few seconds of handling time.

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Waste is not considered to be a problem. The operators at the hypermarket collect everything and sort it in different containers. Later on, the cardboard is compressed and collected for free by the municipality. The taxes of the hypermarket are reduced if they sort the waste materials.

Observations at Hypermarket C2

During a short visit to a hypermarket, it was noticed that rollcontainers were used for the TTs produced at Dairy C. The primary packages looked clean and undamaged in the secondary package.

Observations at Supermarket C1

During a short visit at Supermarket C1, where the TT primary packages were loaded onto shelves, observations were made of primary packages with almost all of the tops deformed.

4.6 Packaging Scorecard

4.6.1 Collection of Packaging Scorecard

Questionnaires were distributed and collected in all supply chains. The actors received one questionnaire regarding general requirements of a secondary package, and one questionnaire regarding every type of secondary package used by the actor. The responses from the packaging scorecards are collected in Appendix F – Results from Packaging Scorecard

5 Analysis

In this chapter, the empirical studies are analyzed and combined with the theoretical framework. First, the packaging system strategies at the dairies are established. Following is the evaluation of the packaging scorecards. Eventually, the analysis present three evaluation tools intended to provide future customers with recommendations on suitable packaging systems to implement according to their specific requirements. The evaluation tools are

- *Packaging Function Analysis.*
- *Strengths and Weaknesses Tables.*
- *Conclusive Packaging Evaluation Matrix.*

The comprehensive collection of information in the Packaging Function Analysis is a complement to the Conclusive Packaging Evaluation Matrix. The first-time reader is advised to flip through the Packaging Function Analysis and return after reading the two other evaluation tools.

5.1 Packaging System Strategies

As mentioned in Section 3.1.4, there are some factors influencing whether it is advantageous to implement a one-way or a returnable packaging system. Different properties of the dairies are illustrated in Table 5.1 and

Table 5.2. Bold characters indicate the dairy situation. As can be seen, some dairy properties are adhering to both packaging system categories. Often, this arises from when one dairy has different distribution channels.

Table 5.1 Properties of Dairy A's situation affecting the choice of secondary package.

<i>Factors</i>	<i>Packaging System</i>	
	One-way	Returnable
Variations in demand	High	Low
Transport distance	Long	Short
Delivery frequency /Turn-over speed	Infrequent/Uneven	Frequent /Even
Storage time	Long	Short
Steps in the supply chain	Many	Few
Production Volume	Low/High	High
Hygienic demands	High	Low
Customers	Many and small	Few and large

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Table 5.2 Properties of Dairy B's and C's situation affecting the choice of secondary package.

<i>Factors</i>	<i>Packaging System</i>	
	One-way	Returnable
Variations in demand	High	Low
Transport distance	Long (via distr. center)	Short (direct deliveries)
Delivery frequency /Turn-over speed	Infrequent/Uneven	Frequent /Even
Storage time	Long	Short
Steps in the supply chain	Many (via distr. center)	Few (direct deliveries)
Production Volume	Low/High	High
Hygienic demands	High	Low
Customers	Many and small (direct deliveries)	Few and large (via distr. center)

There are different packaging system strategies to implement, see Table 5.3. Firstly, one possible solution is to concentrate on one uniform packaging system choice that matches the most important distribution channel. Hereby, the complexity of the processes carried out at the producing dairy is reduced. Using the packaging system for the other distribution channels will, however, not be very efficient with result that the complexity at other actors in the supply chain can increase.

Secondly, another solution is to implement different packaging systems for different distribution channels. This adds to the complexity at the dairy but is compensated by reduced complexity at later stages in the supply chain.

Thirdly, one solution is to implement only one packaging solution suitable for a specific distribution channel variant and try to minimize (and eventually abandon) the use of other distribution channels. In this way, the customers are satisfied and the complexity at the dairy is reduced. Yet important market shares can be lost due to omitting certain customer segments.

Dairy A and especially Dairy B could be said to target the second strategy. Dairy C could be assumed to go after the third strategy. However, as it is aiming to expand its distribution channels to more direct deliveries; hence, Dairy C is moving towards the first strategy.

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Table 5.3 Packaging systems strategies.

		<i>Packaging Systems</i>	
		One	Many
<i>Distribution Channels</i>	One	Strategy no. 3 <ul style="list-style-type: none"> • Reduced dairy complexity • Reduced complexity at other actors • Omitting customer segments 	—
	Many	Strategy no. 1 <ul style="list-style-type: none"> • Reduced dairy complexity • Increase complexity at other actors 	Strategy no. 2 <ul style="list-style-type: none"> • Increased dairy complexity • Reduced complexity at other actors

Figure 5.1 theoretically shows appropriate packaging systems to implement on the dairies with respect to transport distance and seasonal variations. As can be seen, all the distribution channels adhering to the different dairies indicate that using only a returnable packaging system is not suitable. Instead, a one-way packaging system or perhaps a combination of returnable and one-way is more suitable to use. This also reflects the current packaging system choices made at the dairies.

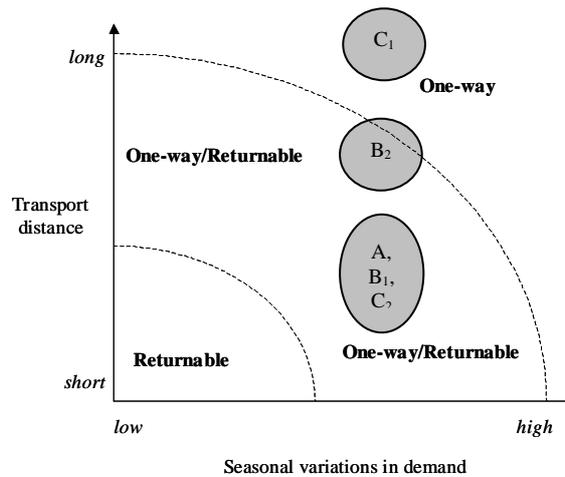


Figure 5.1 Properties of the dairies regarding two factors influencing the choice of packaging system.¹⁴⁶

¹⁴⁶ The letters are indicating where the different dairies theoretically are positioned, the number indexes are indicating different distribution channels. B₁ indicates the distribution channel involving direct deliveries of cardboard trays inside the big city area; B₂ indicates the distribution of the shrink film solution via distribution centers. C₁ indicates the distribution channel via distribution centers; C₂ indicates the distribution channel involving direct deliveries.

5.2 Packaging Scorecard

The results from the questionnaires distributed to interview respondents form the basis for the analysis of key requirements and levels of satisfaction related to the secondary package. The number of respondents is too small to make any statistically set statements, but tendencies are discussed.

As shown in Table 5.4, the respondents employed by Dairy C are more satisfied with its cardboard in comparison to the respondent adhering to the transporter. One could speculate that Dairy C is overly positive regarding its current secondary package. Perhaps, problems occurring at later stages in the supply chain are overlooked and focus is set only to issues at the dairy. Interesting would be to apply the survey on actors later on in the supply chain.

In contrast, the truck driver in Supply Chain A is more satisfied with the cardboard solution than the respondents at the dairy. This could indicate that the respondents from the dairy have a too negative overall view of the current secondary package and are, similar to Dairy C, only focused on their part of the supply chain.

Remarkably, the overall satisfaction of the respondents regarding rollcontainers is exactly the same (68%). Also, the cardboard trays in use at both Dairy A and Dairy B have got similar scores (66% and 69%).

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Table 5.4 Overall satisfaction of the secondary packages, derived from the packaging scorecard results. For calculations, see Appendix L – Overall Satisfaction Calculations.

<i>Respondent</i>	<i>Cardboard (%)</i>	<i>Shrink Film (%)</i>	<i>Rollcontainer (%)</i>
Supply Chain A			
Production Responsible	67	-	86
Marketing Director	56	-	74
Key Account Manager 1	73	-	60
Key Account Manager 2	56	-	45
Dairy A in total	66	-	68
Truck Driver	76	-	-
Supply Chain A in total	68	-	-
Supply Chain B			
Prod. Maint. & Serv. Manager	55	55	52
Prod. Manager	72	91	51
Purchasing Manager	89	92	94
Transport Manager	59	72	59
Distr. Log. Manager	74	-	78
Dairy B in total	69	73	68
Supply Chain C			
Prod. & Mark. Manager	88	-	-
Production Responsible	80	-	-
Cold Cell Responsible	81	-	-
Cold Cell Responsible (DC)	67	-	-
Dairy C in total	80	-	-
Truck Driver	63	-	-
Supply Chain C in total	77	-	-

5.2.1 General Requirements

Total Average Score

As can be seen in Figure 5.2, the total average scores for the individual criteria regarding general requirements have been grouped into seven clusters. The reason for this is to minimize the effect of only small differences in total average score between the criteria; it also simplifies the reading of the figure. All requirements regarding environment are positioned in the top and are therefore grouped together in the first cluster, although the top first criterion score is not similar to the scores for the rest of the criteria in the same group. The exact average scores can be seen in Appendix H – General Req. Average Scores.

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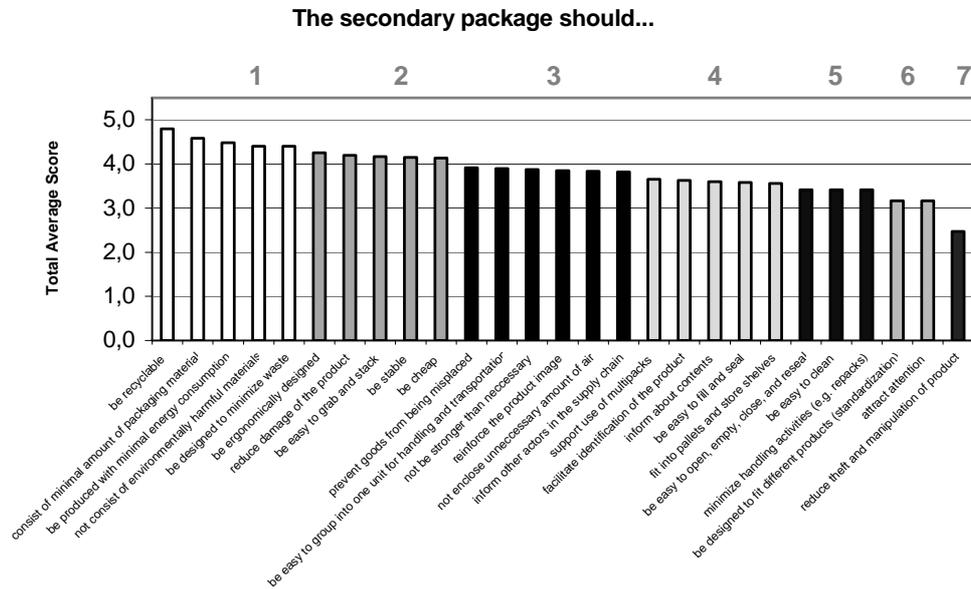


Figure 5.2 Top total average scores arranged into clusters regarding general requirements for Dairy A, B and C. ¹⁴⁷

The second cluster contains requirements from different areas such as handling efficiency (ergonomically designed, easy to grab and stack, and stability), product protection (reduce damage of the product), and cost (be cheap), criteria that also could be anticipated to score high according to the qualitative empirical studies. Moreover, clusters three and four consists of criteria adhering to different areas, whereas cluster five consists only of criteria regarding handling efficiency. Two of the handling efficiency criteria in this group deal with activities that often arise in the supply chain after the dairy (i.e. be easy to open, empty, close, and reseal and minimize handling activities). Obviously, the packaging scorecard results in Figure 5.2 are based on the responses from people at the dairies and not on actors later on in the supply chain. The emphasis on the whole supply chain, as described in Section 3.3.4, does not seem to be in effect at the dairies.

The last two clusters contain the criteria that are regarded to be of least importance: be designed to fit different products, attract attention, and reduce theft and manipulation of product. The second criterion could have got the relative low score due to that the secondary packages (excluding the rollcontainers) are not meant to be displayed to the end consumer. Of course, if this should be the purpose with any secondary package, it is a criterion of vital importance. The third criterion was not considered to be applicable for fresh milk at Dairy A and Dairy B.

¹⁴⁷ The scale is as follows: 1=Not important, 2=Somewhat important, 3=Important, 4=Very important, 5=Extremely important.

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All but one criterion in total have scores of three or higher; that is, the criteria are considered to be at least important. Hence, the diagram should not be considered to depict criteria that are of no interest to the dairies, but to show the relative importance of the different clusters.

Comparison of Dairy Results

Figure 5.3 depicts the average score for the general requirements stated by the different dairies. As can be seen, Dairy A and Dairy B often have similar general requirements, whereas Dairy C's responses differ a lot from the other dairies.

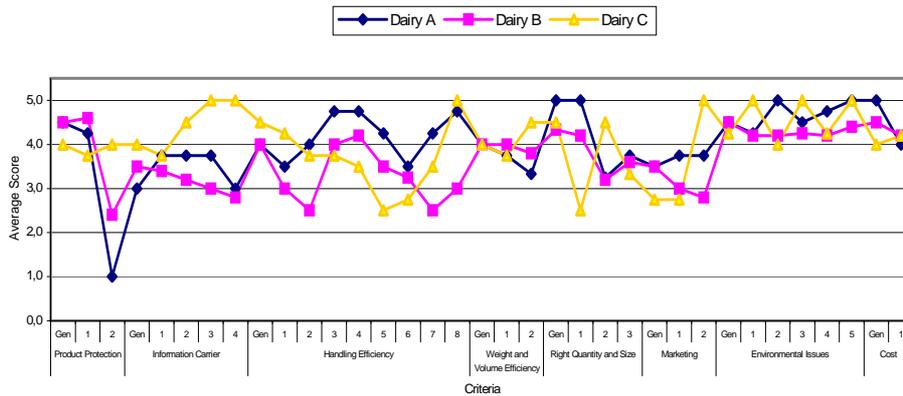


Figure 5.3 General requirements average score for Dairy A, Dairy B, and Dairy C.

This relationship becomes evident when calculating the correlation between the average scores, see Table 5.5. The explanation for the higher correlation between, Dairy A and Dairy B could be that their major distribution channel is similar (i.e. to a big city area). Dairy C's major distribution channel is instead to the whole of Italy.

Table 5.5 Correlation between the general requirements average score for the different dairies.¹⁴⁸

<i>Dairy</i>	<i>Correlation</i>
Dairy A – Dairy B	0,64
Dairy A – Dairy C	0,00
Dairy B – Dairy C	0,03

148 The equation for the correlation coefficient is $\rho_{x,y} = \frac{Cov(X,Y)}{\sigma_x * \sigma_y}$ where $-1 \leq \rho_{x,y} \leq 1$ and

$$Cov(X,Y) = \frac{1}{n} \sum_{i=1}^n (x_i - \mu_x)(y_i - \mu_y)$$

Product Protection

The criterion regarding theft and manipulation reduction is overall considered to be the least important of all criteria, see Figure 5.2. However, looking at the score for the individual dairies, one can see that Dairy C finds this criterion quite important. Hence, what is considered to be a criterion not applicable for fresh milk at two of the dairies is quite important for the third. This rather big disparity between scores can be based on the different distribution channels in use. A distribution channel containing a lot of steps and long distances are more sensitive to theft and manipulation than direct distribution channels where the dairy has control all the way from the production to the store shelf.

Information Carrier

Regarding the three last criteria related to information carrier (inform other actors in the supply chain, prevent goods from being misplaced, and inform about contents), Dairy C indicated generally a higher score than the two other dairies. Comparing these answers with the distribution channels in use, it can be seen that distribution of information along the supply chain is of greater importance when there are more steps in the supply chain and the distribution area is larger. The other two dairies' major distribution channels involve fewer steps. Hence, distribution of information is not as important.

Handling Efficiency

Dairy B extinguishes itself from the other dairies when it comes to the criterion regarding opening, emptying, closing, and resealing. Dairy B does not think that this criterion is relatively important. Also, the seventh criterion (the secondary package should minimize handling activities) is perceived to be relatively unimportant. Obviously, these criteria do not mainly belong to activities carried out at the dairy, but instead at other supply chain actors. This indicates that Dairy B does not have any requirements of the secondary package to fit actors later on in the supply chain.

Furthermore, Dairy B does not perceive ergonomically designed secondary packages to be of great importance. This, together with the fact that the rollcontainers used at the dairy were filled manually, indicates that the working environment of the operators is not of high priority at Dairy B. However, during the interviews, two of the respondents at the dairy indicated that the manual filling of rollcontainers is not ergonomic, which causes problems.

Right Quantity and Size

Surprisingly, Dairy C's average response regarding the ability of easily grouping secondary packages into one unit for handling and transportation is quite a lot lower than the rest of the dairies; also, this criterion has among the lowest scores of all the criteria in all areas. One would otherwise anticipate this criterion to be especially important for a dairy with a far stretching distribution area.

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Environment

During interviews, environmental concerns were only spontaneously mentioned once:

- Dairy C is very conscious of environmental concerns. The secondary package solution was chosen with environmental issues in mind. (General Director, Dairy C)

Dairy A and Dairy B did not consider environmental criteria as a top priority; one respondent even stated that environmental concerns are not of high importance in Italy. However, the answers from the packaging scorecards indicate that environmental issues are very important for all three dairies; the questions regarding environment at the general requirements scorecard got scores of four or higher. One speculation could be that the respondents have difficulties with spontaneously expressing environmental requirements, but have set opinions when being asked about specific environmental issues; this indicates that consciousness for environmental issues are growing in Italy.

5.2.2 Current Situation

The average score for each secondary package can be seen in Appendix I – Current Situation Average Scores. Below are discussions regarding each packaging type.

Cardboard Solution

As can be seen in Figure 5.4, the cardboard solutions from Dairy A and Dairy B have similar tendencies regarding the average score for the individual criteria; this also becomes evident when calculating the correlation between the secondary solutions, see Table 5.6.

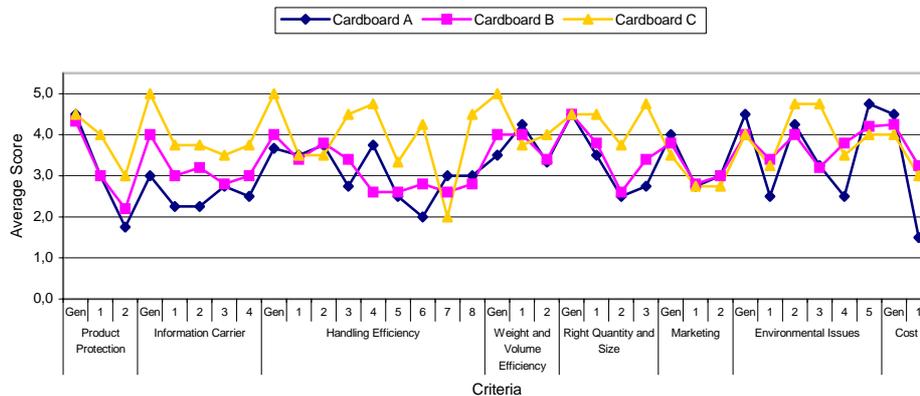


Figure 5.4 Average score regarding cardboard solutions at Dairy A, Dairy B, and Dairy C.

The correlation between the cardboard solutions from Dairy A and Dairy B are much higher than the correlation between other dairies. Hence, grouping the cardboard solutions from Dairy A and Dairy B seems to be efficient. This grouping is ultimately motivated with that the cardboard solutions in fact are the same (i.e. cardboard trays).

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Table 5.6 Correlation between the average scores for the different cardboard solutions.

<i>Secondary Packages</i>	<i>Correlation</i>
Cardboard A – Cardboard B	0,74
Cardboard A – Cardboard C	0,38
Cardboard B – Cardboard C	0,47

Rollcontainer

Notably, the overall satisfaction for Dairy A and Dairy B is the same for the rollcontainer solution (68%, see Table 5.4). Nevertheless, Figure 5.5 together with a correlation of only 0,53 shows that the opinions regarding some of the criteria differ. The differing opinions can perhaps be due to the different handling (i.e. automatic vs. manual) at the two dairies. Despite the rather weak correlation, the two average scores for the dairies have been grouped together. The grouping can be carried out since the secondary packages are identical.

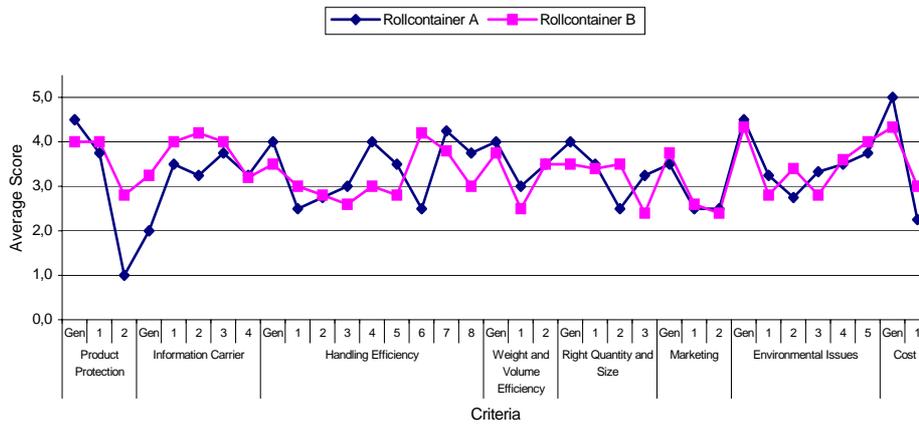


Figure 5.5 Average score regarding rollcontainers at Dairy A and Dairy B.

Average Scores for Dairy A and Dairy B

Figure 5.6 shows a comparison between the average scores for cardboard and rollcontainers at Dairy A and Dairy B. Generally, the cardboard solution is considered to be inferior to the rollcontainer regarding the information criteria. Apart from these criteria, the greatest discrepancy between the two different secondary solutions, where rollcontainer outperforms the cardboard solution, is “minimizes handling activities” (Handling Efficiency Criterion no. 7). Also, the criterion “reduces damage of the product” (Product Protection Criterion no. 1) is better fulfilled with rollcontainers. In reverse, the greatest discrepancy is “does not enclose unnecessary amount of air” (Weight and Volume Efficiency Criterion no. 1).

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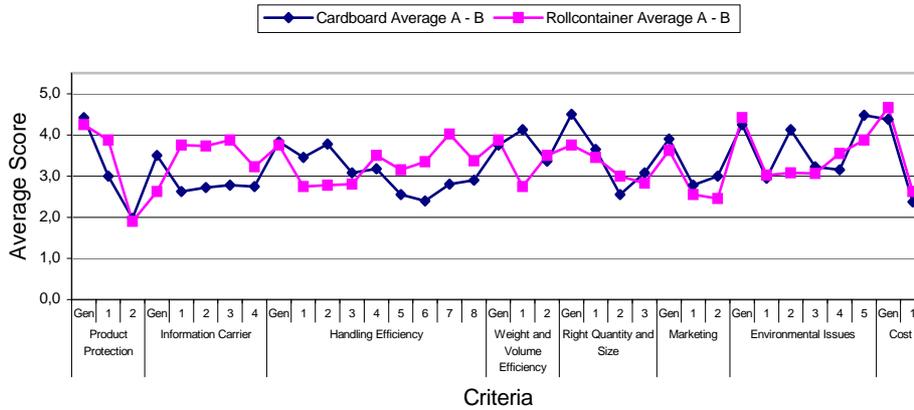


Figure 5.6 Summary of current situation for the two secondary packages used at both Dairy A and Dairy B.

Comparing the scores for the remaining secondary packages (Dairy B’s shrink film solution and Dairy C’s cardboard wraparound box) at different dairies is not possible since the different respondents filled out the questionnaire without the experience from the rest of the secondary packages.

5.2.3 Overall Satisfaction

In this section, the general requirement and the current situation scores are put together. Criteria with great positive discrepancy between the grey column heights (i.e. the general requirements) and the scores from the current situation are most important to improve in order to increase the overall satisfaction.

Dairy A

Generally, the two secondary package solutions in use at Dairy A are perceived to be performing below the general requirements. This reflects the generally negative view of the secondary package situation that was conveyed during the interviews.

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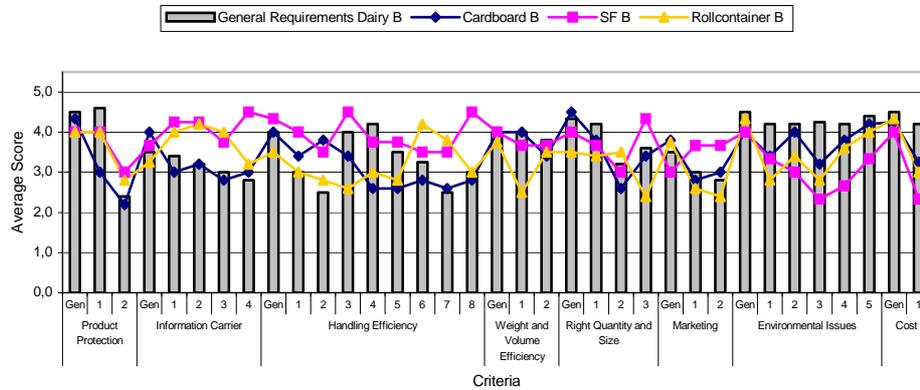


Figure 5.8 Average score regarding current situation for Dairy B's secondary solutions.

The criterion most important to improve in order to increase the overall satisfaction of the cardboard solution is “reduced damage of the product” (Product Protection Criterion no. 1). Also, Dairy B would benefit a lot if trying to improve “easy to clean” (Handling Efficiency Criterion no. 3).

Regarding the shrink film solution, the main negative criteria causing the overall satisfaction to be reduced are the environmental issues and “be cheap” (Cost Criterion no. 1). Similarly, for rollcontainers the criteria are “easy to grab and stack” (Handling Efficiency Criterion no. 3), “is stable” (Handling Efficiency Criterion no. 4), and “does not enclose unnecessary amount of air” (Weight and Volume Efficiency Criterion no. 1).

The shrink film is somewhat cheaper than the cardboard solution.¹⁴⁹ Surprisingly, the shrink film is, nonetheless, perceived as being more expensive than the cardboard solution. A speculation could be that the respondents assume that the shrink film solution is more expensive as it consists of the two different materials.

Dairy C

Figure 5.9 shows that regarding many criteria, the scores for Dairy C's cardboard solution is above the general requirements. This reflects the positive opinions articulated during the interviews.

¹⁴⁹ €0.126/cardboard package vs. €0.113/shrink film package. Source: Purchasing Manager at Dairy B.

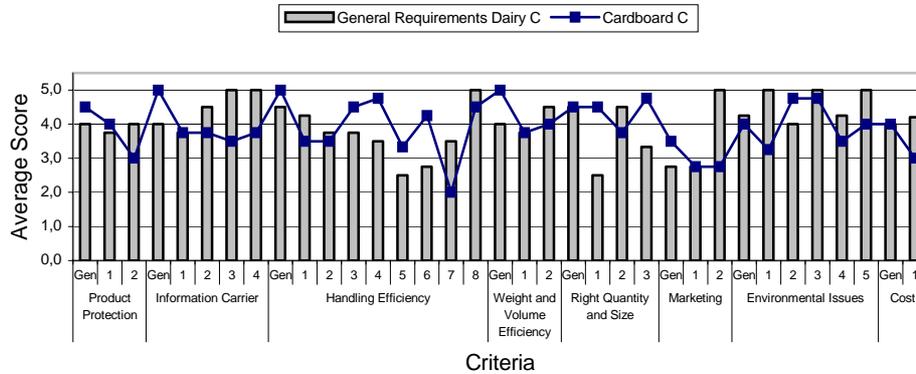


Figure 5.9 Average score regarding current situation for Dairy C's secondary solution.

The criterion “minimizes handling activities” (Handling Efficiency Criterion no.7) has the overall lowest score. Also, the two marketing criteria “attracts attention” (Marketing Criterion no. 1) and “reinforces the product image” (Marketing Criterion no.2) have relatively low scores.

Furthermore, when comparing the general requirements and current situation, one can see that the greatest discrepancy is regarding the marketing criterion “reinforcing the product image” (Marketing Criterion no. 2). This means that, if possible, improving this criterion would have a big effect on the overall satisfaction for Dairy C. In addition, two other criteria that are worth improving are “prevent goods from being misplaced” (Information Carrier Criterion no. 3) and “produced with minimal energy consumption (Environmental Issues Criterion no. 1).

5.2.4 Objective and Subjective Secondary Package Views

After having observed the packaging systems at the three case study dairies, the authors objectively ranked the criteria in the packaging scorecard for each of the current secondary packages. Criteria not applicable to specific secondary packages were in each case removed. The objective scores are presented in

J – Objective Current Situation Scores. These scores form the basis of the calculations behind the expected outcome. The subjective current situation scores used in the calculation of the overall satisfaction in Table 5.4 were altered accordingly. This generated an updated real outcome score. The expected and real outcome scores are presented in Table 5.7. As can be seen, there is some level of discrepancy regarding the two different outcome scores.

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Table 5.7 Comparison between expected (with use of objective current situation scores) and real (with use of updated subjective current situation scores) outcome regarding the dairies' satisfaction of secondary packaging solutions.¹⁵⁰

	CB tray (%)	CB box (%)	Shrink Film (%)	Rollcont. (%)
Dairy A				
Expected Outcome (Objective)	77	-	-	68
Real Outcome (Subjective)	66	-	-	68
<i>Difference</i>	<i>-11</i>	-	-	<i>0</i>
Dairy B				
Expected Outcome (Objective)	76	-	75	68
Real Outcome (Subjective)	69	-	74	69
<i>Difference</i>	<i>-7</i>	-	<i>-1</i>	<i>+1</i>
Dairy C				
Expected Outcome (Objective)	-	80	-	-
Real Outcome (Subjective)	-	80	-	-
<i>Difference</i>	-	<i>0</i>	-	-

The discrepancies in Table 5.7 illustrate that the overall satisfaction is based on the subjective scores of the performance of a packaging system currently in use and not only on different subjective general requirements. Hence, it is not sufficient for a packaging supplier to objectively evaluate different packaging systems, make an objective recommendation for one packaging system, and expect the customer to be satisfied according to this recommendation. Instead, different packaging systems must be evaluated in collaboration with the customer to ensure that the customer feels confident and satisfied with the ultimate packaging system choice.

5.3 Other Issues

5.3.1 Reasons for Implementation of Secondary Packages

Respondents from both Dairy A and Dairy B states that the reason for implementing the cardboard tray as secondary package was because only this solution was recommended by the package supplier. Dairy C, however, examined the secondary packaging options on its own and did not go after any recommendations given by Tetra Pak. Also, the shrink film solution at Dairy B was developed by the dairy itself.

¹⁵⁰ For both scores, the subjective general requirements set by the respondents have been used. The table is not intended to show how the dairies objectively *should* evaluate the secondary packages (i.e. the individual scores regarding the expected outcome are not important); instead, it is intended to illustrate that subjective opinions about similar packaging systems influence the overall satisfaction.

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The different reasons for choosing the current secondary package are presented in Table 5.8.

Table 5.8 Reasons for implementation of current secondary packages.

<i>Dairy A and Dairy B</i>	<i>Dairy C</i>
<ul style="list-style-type: none"> • <i>“The cardboard solution was chosen because, at that time, there were no other solutions”.</i> (Marketing Director, Dairy A) • <i>“Tetra Pak provides only one solution for everybody, the recommendations are not flexible”.</i> (Production Maintenance & Service/Packaging Solutions Manager, Dairy B) • Tetra Pak stated that the cardboard solution was the only secondary package safe enough for the protection of the TT cap. (Production Maintenance & Service/Packaging Solutions Manager, Dairy B) • The cardboard solution was chosen in the beginning due to Tetra Pak’s recommendations that the TT should be packaged in this material. (Purchasing Manager, Dairy B) 	<ul style="list-style-type: none"> • Cardboard has good stacking ability and product protection. (Cold Cell Responsible, Dairy C) • Dairy C’s technicians already had experience of the maintenance of cardboard packers. (General Director, Dairy C) • Dairy C was satisfied with the cardboard used for other products in the production such as the Tetra Brik. (General Director, Dairy C) • The cost of disappearing plastic crates made the cardboard solution cheaper. (General Director, Dairy C) • The secondary package solution was chosen with environmental issues in mind. (General Director, Dairy C)

The packaging scorecard survey shows that the dairies implementing the secondary package only on basis of the recommendations from Tetra Pak are not as satisfied as the dairies implementing the secondary package on basis of their own investigations, see Table 5.4. Also, Table 5.7 shows that the discrepancies between the estimated and real scores are greater for those solutions implemented only on the recommendation made by the packaging supplier. This together with the statements in Table 5.8 could indicate the need of having the dairies genuinely involved in the decision of what secondary package to implement. Again, as stated in Section 5.2.4, a packaging supplier must evaluate different secondary packages together with the customers. In doing so, the customer would feel well informed about the positive and negative aspects of different secondary packages with result that the general satisfaction of the chosen secondary package would probably increase. Having this master’s thesis as a basis for the discussion with future customers could increase the overall information regarding different secondary packaging options.

Furthermore, two of the three case study dairies did not use Tetra Pak’s packer machines. One of the respondents at Dairy B did not even know that Tetra Pak in fact provided the equipment. It seems like there could be an opportunity for Tetra Pak to market and inform about its distribution equipment more extensively to customers. A packaging supplier providing an overall solution with the primary package filling

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machine and accompanying distribution lines, could convince customers (i.e. dairies) to choose that supplier ahead of competitors.

5.4 Packaging Function Analysis

The Packaging Function Analysis (PFA) is subdivided in accordance with the packaging function areas presented in Section 3.3: logistics, marketing, and environment. The three function areas follow the structure of the criteria in the packaging scorecard. The Packaging Function Analysis forms the basis for further development of the two other evaluation tools.

5.4.1 Logistics

During the empirical studies, it became apparent that focus should be put on logistical aspects; the vast majority of requirements and reasons for and against different secondary packages were logistically related.

Product Protection

Reduce Damage

The stable rollcontainer provides the TTs with excellent protection from impact from outer sources. Also, the cardboard wraparound box is very good at protecting the TT if the top wing is glued correctly. Inferior are the shrink film solution and cardboard tray due to the risk of askew levels putting weight directly onto the top of the primary package, see Figure 4.7. However, the cardboard tray with its four sidewalls can protect the top better than the shrink film with only one wall (i.e. the cardboard divider).

Adding a top lid to a cardboard solution will in most occasions contribute to better protection of the primary package and, thus, a reduction of damage. However, when it comes to the cardboard box used at Dairy C, there is a design issue of the top that can have an indirect negative impact on the product protection: the center hole indicating the expiry date. By designing the hole in this specific way, people handling the secondary package can be tempted to use the hole as a handle, which the top is not strong enough for. During observations, it was noticed that the holes were indeed used as handles at some instances, although only for short moments. The top broke (see Figure 5.10), which contributed to damage of the primary package top as other products were loaded on top.



Figure 5.10 Broken cardboard wraparound box as a consequence of lifting in the center secondary packages as a consequence of the hole designed to facilitate the reading of teething problems of the packer machine. expiry date.

Other examples of how primary packages can be damaged later on in the supply chain, as a consequence of activities carried out in the beginning of the chain, are the teething troubles of the packer observed at Dairy C. The top of the secondary package was not glued properly in the packer; instead, it was manually closed by putting the wing of the top inside the box. This seemed to solve the temporary problem (i.e. to enable the secondary packages to be automatically stacked onto the EUR-pallet). It was later observed at actors later on in the supply chain that, due to the weight of the packages loaded on top, the top of the secondary package was depressed. This had the effect that the total load was carried by the tops of the primary packages, which were being damaged, see Figure 5.11.

The two examples mentioned above illustrates the importance of considering the consequences actions have later on in the supply chain. Hence, it is very important that one sees the different actors as part of the supply chain and not as individual players.

A parameter, perhaps not being looked upon at first sight, affecting the secondary package is temperature. Worth to reflect on is that only two of all respondents in total spontaneously stated that it was important that the secondary package helped preserving temperature of the product. Dealing with a perishable product like milk, one would perhaps predict that the temperature issue would be more often mentioned. What makes this issue even more worth to consider is the fact that Italy, in general, has a high average day-temperature. Also, the truck drivers usually make many stops and frequently open the storage space of the truck, which cause the temperature to rise inside the truck.

Of the different secondary packages examined, the cardboard wraparound box is superior when it comes to preserving the temperature of the primary package. The cardboard tray is somewhat worse but protects quite good when secondary packages are tightly loaded on top of each other. In contrast, the shrink film material has

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negligible temperature preservation. The rollcontainer is the most inferior secondary package to maintain temperature.

Another issue with the shrink film solution is that the primary packages have to go through an oven (about 190°C). This heating process, perhaps not significantly affecting the milk temperature, can be a contributory cause (together with the temperature change of going from the humid production area to the cold cell) to creating condensation on the inside of the shrink film material. The water drops that collect on the bottom of each secondary package can harm the packaging material of the primary package. To avoid this, the shrink film material can be designed with small holes to transport the water out of the secondary package.

Condensation can also occur with the cardboard solution. In this case, the cardboard absorbs the water with the result that the primary packages are not damaged. However, the absorption of water weakens the cardboard. Hence, the primary packages can be damaged as an outcome of a secondary package not being sturdy enough. The cardboard bottom in the shrink film solution functions partly as a means of removing condensation.

Regarding the rollcontainer, the condensation occurring at the primary packages is allowed to evaporate and does not harm the packaging material.

At one dairy it was especially noticed that a water solution working as lubrication was used on the conveyor band transporting the primary packages to the cardboard packer. This lubrication made the bottom of the primary packages moist with result that the secondary package gets somewhat wet. Important to learn from this is that activities and parameters carried out *before* the secondary package is added to the packaging system should be held in mind when deciding on which packaging system to implement. Hence, not only activities and parameters carried out *after* the secondary package is added to the system should form the decision basis.

Reduce Theft and Manipulation

The ability to reduce theft and manipulation seems to be of low priority at the dairies. None of the respondents mentioned problems with stolen or manipulated products. In the packaging scorecard (see Figure 5.2), the respondents ranked the criteria on the very last place.

Even though disappearing returnable secondary packages are a major problem for the dairies, there do not seem to be any problems with theft or manipulation of primary packages. To avoid theft of primary packages, during all distribution in cities and most distribution on the countryside, the milk was delivered directly to a retailer operator and not left unattended.

The cardboard wraparound box can to some extent protect against tampering; an intact box cannot be opened without breaking the glue. Also, the shrink film solution can be considered to be somewhat tamper proof. In order to replace any primary

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packages, the shrink film has to be cut opened. In contrast, the rollcontainer and the cardboard tray do not protect the primary packages from being replaced with other TTs that have been tampered with. However, in supply chains with direct deliveries to many small customers, being tamper proof is not an important property of a secondary package.

Information Carrier

Facilitate Identification of the Product

The secondary packages for TT in Italy do not seem to function as information carriers to any larger extent. None of the respondents spontaneously mentioned the need for information on the secondary package. Instead, the primary package was believed to carry sufficient information to the actors.

In cardboard wraparound boxes, the TTs are not displayed. Hence, there is a need for information on the secondary package to identify the product. The cardboard is printed white and provided with logotypes, information about the type and amount of milk, and bar codes. The expiry date is visible through a hole on the center of the secondary package top. In contrast to printings due to marketing reasons, further discussed in Section 5.4.2, the marginal printing cost can be justified for information reasons.

Cardboard trays, used for nearby distribution, display the screw caps, the number of TTs and the expiry date. The truck drivers handle only a moderate number of products and there is no problem to identify and distinguish the fresh milk from other goods. Consequently, the screw cap is, in theory, a sufficient information carrier for the truck driver. The retailer, however, handle a large number of products. Here, printings on the cardboard are useful to facilitate identification of the product.

Both rollcontainers and the shrink film solutions display the TTs and, by that, the type of milk, fat contents, and expiry date. Further information is not needed in the supply chains with direct deliveries from dairy to retailer.

Inform Other Users in the Supply Chain

Neither the truck drivers nor the operators at the dairies seem to use any information on the secondary packages. The only actor observed actively using information on the cardboard is the operator at the distribution center. Here, the barcode is scanned and the information is used in the internal communication system. For that reason, cardboard with printing ability is considered the most suitable information carrier for distribution channels with internal information systems. For other distribution channels, in particular the ones with direct deliveries, the secondary packages play a minor role as information carrier.

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Prevent Goods from being Misplaced

As the supply chains are rather short and handle only a few different products, misplaced goods during distribution is not a problem; hence, prevention of misplacement is not considered a key criterion. Instead, the real problem with misplaced goods applies to returnable secondary packages. Many rollcontainers are believed to drop out of the system after being misplaced at the retailers. A deposit system for load carriers at the distribution center in Supply Chain C has proved to reduce these losses. Unfortunately, deposit systems mean additional work for retailers. Therefore, in order to satisfy the customers, the idea of deposit systems does not appeal to the case study dairies.

Inform about Contents

The one-way secondary packages are not intended to be displayed to the end consumer. Therefore, displaying the declaration of contents is not necessary. The rollcontainer, being present in the store (and seen by the end customer) allows the declaration of contents on the primary package to be displayed. Consequently, no information regarding contents has to be added to the rollcontainer.

When it comes to informing about the number and type of primary products, both the shrink film solution and the rollcontainer displays the TTs. However, the number of primary packages is not immediately observed, as is the case on the cardboard solutions due to the printing. The cardboard tray displays the screw caps, whereas the primary packages are totally hidden in the cardboard wraparound box.

Handling efficiency

Easy to Fill and Seal

All the different secondary packages are filled and sealed automatically, except for the rollcontainer at Dairy B.

The secondary packer machines for the cardboard trays and wraparound boxes are fairly similar although two of them are from Mariani and one is from Tetra Pak. Only one material input has to be added by the operator to the machine magazine. The cardboard tray packer is less complex than the wraparound box packer, which demands an additional activity (i.e. gluing the top lid).

The teething troubles at Dairy C (discussed in Section 5.4.1 subsection Reduce Damage) created problems in the packer machine where the top was not sealed properly. One solution to this problem is found below (see Section 5.4.1 subsection Easy to Grab and Stack); another solution could be found in making the perforations larger. The teething troubles experienced should however, not affect this fill-and-seal criterion since it only is an initial problem.

The shrink film packer machine at Dairy B is a bit more complex than the cardboard machines. It involves several steps with many different material inputs: cardboard bottom and divider input, shrink film adding and cutting, and oven throughput. The

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material magazines often have to be refilled; hence, the machine needs continual attention from one operator.

The automatic filling of rollcontainers at Dairy A seems to be rather complex. The machine had frequent downtimes during the visits at the dairy. Furthermore, it takes a lot of manual work from operators to supervise and assist the machine, see Appendix E – Flowchart 2 (Steps 8, 9, 27, and 28). Hence, although the rollcontainer filling process is carried out automatically, a lot of manual attention has to be given to the filling process.

The rollcontainer filling process at Dairy B is carried out entirely manually. The operator working with the filling process has to mount, fill, and close the rollcontainer next to the conveyor band and roll the secondary package into the cold cell (see Appendix E – Flowchart 3 (Steps 8, 9, 10, and 35)). The respondents at Dairy B are aware that the manual filling process is not optimal, but state the following reasons for not implementing an automatic filling process:

- Too low demands of great quantity to individual retailers. (Transportation Manager, Dairy B)
- Uprising demands from big customers of replacing the rollcontainers to suit new retailer store refrigerators. (Transportation Manager, Dairy B)
- An automatic filler machine breaks down frequently and long time is spent on repairing the machine instead of keeping it in production. (Production Maintenance & Service/Packaging Solutions Manager, Dairy B)

Easy to Open, Empty, Close, and Reseal

The ability to open and empty the secondary packages affects most actors in the supply chain. In fact, even the end consumers are, to some extent, involved in these activities. Truck drivers and retailers consistently open and empty the secondary packages, Appendix E – Flowchart 1 (Steps 4 and 8).

At small- and medium-sized retailers, the general belief is that cardboard solutions are the best one-way solutions for opening and emptying activities. Especially cardboard trays are popular as they are efficiently handled and do not require any opening equipment. Cardboard wraparound boxes take a few more seconds to open. In total, the handling time for the cardboard solutions end up to about the same as for the shrink film solution. Cardboard solutions are a bit more time consuming during collapsing, which counterbalance the time gained during opening. Whilst the roof of the cardboard box is manually torn, a small knife is often used to facilitate the opening of a shrink-filmed package:

“Cardboard is better. When using a knife [to open the secondary packages], it may happen that the plastic bottles are cut.”¹⁵¹

¹⁵¹ At this retailer, the shrink film solution enclosed plastic bottles and not TTs. Source: Operator at Superette A3.

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Another issue where the shrink film package is inferior to the cardboard tray is during the picking of some TTs from one secondary package. The shrink film solution requires more time for the truck driver to take out a few TTs compared to in a cardboard tray, which does not need to be opened. As cardboard trays, cardboard boxes, and shrink film solutions are one-way solutions, they are not intended to be neither closed nor resealed.

The handling of rollcontainers differs in many respects compared to one-way solutions. Rollcontainers are most often opened by the retailer operators and not by the truck drivers. The fast opening process at the retailer saves valuable time for the operator. When it comes to the emptying process, the end consumers in the store, not the retail operators, participate; the end customer both empties the rollcontainer and collapses the individual layers in order to access the hard-to-reach lower layers. Again, time is saved for the retailer operator.

Easy to Grab and Stack

The cardboard solutions from Dairy A and Dairy B have holes dedicated to be used as handles. The handles seem to be working satisfactorily when lifting the secondary packages. Nevertheless, during observations, it was noticed that the gluing lines on the short sides frequently broke. This happened when the secondary packages were being pulled along the floor of the storage space in the truck during unloading at the retailers. Thus, the handles are working properly when it comes to lifting vertically, but not dragging horizontally. Solutions to this problem could be improvements to the gluing process (applied pressure and process temperature) and glue quality, the latter unfortunately affecting the cost of the secondary package.

Regarding the stacking ability, the cardboard tray characteristics limit the performance on this criterion. The cardboard tray works acceptably when the secondary packages are stacked on top of each other in a row or pin-wheel pattern where every layer is rotated 90 degrees relative to the surrounding layers. However, these stacking pattern are not in use throughout the whole supply chain. Observations showed that, during reloading between the truck and the retailer, the secondary packages are often stacked in a block pattern instead. The load created from the layers above damages the primary product, as the top has to bear the weight. To be able to use a secondary package that requires the use of a specific stacking pattern, it must be made certain that the pattern does not change later on in the supply chain.

The cardboard box used at Dairy C has no holes that can be used as handles. Instead, the operators involved in handling the secondary package are presumed to lift the box underneath with the use of two hands. As described in Section 5.4.1 subsection Reduce Damage, operators are instead tempted to use the center hole on the top, which causes the secondary package to break. Furthermore, some operators also use the short sides of the top when lifting the secondary package, see Figure 5.12. Due to the perforations along the creasing on the long sides of the top lid, the secondary package tends to break. Hence, not including handles in the cardboard box design tempts the operators to lift the secondary package in places where the cardboard box has weak points.

III

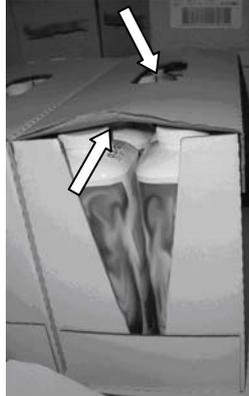


Figure 5.12 Cardboard wraparound box with arrows showing where it is lifted.

This design choice will, due to broken secondary packages, ultimately contribute to damaged products and inefficient handling. Again, it is important that also activities performed later in the supply chain are taken into consideration when designing the secondary package. Regarding the stacking ability, the cardboard wraparound box is quite outstanding. The cardboard material quality together with the top lid enable stacking of five levels; also, the cardboard box does not demand a specific stacking pattern.

The shrink film solution is easy to grab thanks to the two holes on the short sides of the secondary package. These handles allow personnel to carry the package with only one hand. The respondents stated several times that this was a major advantage of the shrink film solution. Regarding the stacking ability, the shrink-filmed secondary package needs to be stacked in specific stacking patterns, similar to the cardboard trays. Also, the risk with stacked shrink film packages is that askew levels put much pressure on the screw caps, causing the primary packages to be deformed.

The rollcontainer is neither stacked nor lifted; hence, the grab and stack criterion is not valid for rollcontainers.

Should be Stable

For natural reasons, no secondary package can compete with rollcontainers when it comes to stability. Also, rollcontainers provide the exceptionally best shock protection of primary packages. Regarding the one-way packaging solutions, the cardboard material itself is a stable material. However, the long sides of the cardboard trays are quite unstable (they tend to flex) – especially when the secondary package is filled with 12 TTs. Regarding the shrink film solution, the stability is increased by the cardboard bottom and divider.

Another issue related to this criterion is the stability of, not only the secondary, but also, the primary packages. The stability of TTs in closed one-way secondary packages is superior to the stability in rollcontainers. This is a consequence of the

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one-way secondary packages being dimensioned solely with the TT in mind; in contrast, the rollcontainer is designed according to the dimensions of many different products. Hence, the TTs cannot move in the filled and closed one-way solutions, whereas they are able to rotate in the rollcontainer.

The stability of TTs in an opened shrink film solution is a unique advantage that was emphasized by respondents at Dairy B. Small clients tend to buy only a few liters of fresh milk. With the shrink film, the TTs remain stable even when a package is opened. The TTs in a half-full cardboard box or tray are, however, allowed to move and fall, which might damage the primary package. This is also the case for the primary packages in the rollcontainers.

Should be Easy to Clean

Rollcontainers are the only secondary package intended to be cleaned, see Appendix E – Flowchart 2 (Step 25) and Appendix E – Flowchart 3 (Step 30). The manual high-pressure washing at the dairies is easy but time consuming to perform. One respondent mentioned that a returnable secondary package solution (plastic crates) had been abandoned partly because of the need for cleaning. If cleaning wants to be avoided, a package solution with waste material must be chosen.

Regarding cleaning soiled one-way packages from dirt, the shrink film is superior to the cardboard solutions. The shrink-filmed package can easily be rinsed off without affecting the TT. Also, the shrink film solution is able to withstand condensation and water spurt from floor cleaning. In contrast, the cardboard material does not have any of these properties; instead, it gets weak from water. The rollcontainer itself withstands water, but does not protect the TT from getting wet.

Designed to Fit Different Products (Standardization)

As mentioned in Section 5.4.1 subsection *Should be Stable*, the one-way secondary packages are designed according to the dimensions of the TT whereas the design of the returnable rollcontainer take into account different products. Hence, the rollcontainers perform better on the standardization criterion.

In the packaging scorecard, the respondents at the dairies regard the standardization criterion to be quite unimportant – only two criteria are considered to be less important (see Figure 5.2). For future customers, this criterion can be considered to be important if the packer machines for TT is going to be used for other products. Also, a decision of shifting the top of the TT changes the importance of this criterion. The height of the cardboard solutions and cardboard dividers for the shrink film are adapted to the top in use. If a higher top (like the Pacaya top) is going to be used, then these secondary packages have to be altered; perhaps even alterations to the packer machines are needed.

Minimize Handling Activities

Within one cycle in the supply chain, one-way packages seem to require fewer handling activities than returnable packages. The returnable rollcontainers are e.g.

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collected, transported, cleaned, collapsed, stored, and mounted before it enters a new loop in the system (see Appendix E – Flowchart 2, Steps 22-28 and Appendix E – Flowchart 3, Steps 30-36). Nevertheless, the rollcontainers often minimize the number of handling activities for the truck drivers during initial transportation and for the retailer operators. Cardboard trays, cardboard boxes, and shrink film packages demand more handling from the truck drivers but can be the only suitable solution for smaller customers. At the retailer, operators have to repack the TTs into the shelves. During this activity, both the shrink film solution and the cardboard box need opening in contrast to the cardboard tray, which saves some handling time for the operator. The cardboard solutions need, however, to be collapsed. In some cases, the retailers repack the cardboard solutions into rollcontainers to fit into the store refrigerators; this repacking adds significantly to the time needed for handling.

Ergonomically Designed

Even though many activities related to the secondary packages are automatized, manual handling at every actor in the supply chain is inevitable. At the dairies, cardboard trays, cardboard boxes, and shrink film packages are automatically filled and put on pallets. The loading into trucks is then manually performed. The filled cardboard and shrink film solutions observed weighed between 8 and 12 kilos. With the shrink film solution, two packages were carried at the time. None of the respondents at the dairies, neither managers nor the operators, believed that this manual handling was too heavy. The lack of handles on the cardboard box from Dairy C can contribute to unergonomic handling, mainly for the truck drivers and the operators at the distribution center.

Regarding rollcontainers, observations showed that manual filling of rollcontainers is bad from an ergonomic point of view. The operator continually performs repetitive and rotative lifts with five TTs and has to bend down to fill the lower layers.

The truck drivers communicate a twofold picture regarding the ergonomics of the one-way secondary packages. Most drivers do not think that the manual handling during loading and distribution is heavy. But, during interviews, complaints arose about pains in the back and neck due to heavy lifts of cardboard and shrink film packages. During observations, the truck drivers often carried two secondary packages at a time and performed strenuous motions to reach the packages in the truck. Moreover, the operators at the distribution center complained about the handling of cardboard boxes during the manual picking. The weight of the packages is not the only problem; also, the pulling and lifting of boxes can contribute to repetitive strain injuries. However, this is a general problem for the distribution center and is not to be especially associated with the distribution of fresh milk. To sum up, packages that do not require manual lifts are preferable. Therefore, with respect taken only to ergonomics, rollcontainers must be considered to be the best secondary package in the distribution.

For the retailers, the size of the store determines the choice of secondary package. Small retailers manually put the TTs in the shelf and remove the empty secondary

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package. Bigger retailers usually prefer rollcontainers as they require little manual handling. Nevertheless, the hypermarkets in Supply Chain C use cardboard boxes and are said to be satisfied with that solution. In spite of the big sales volume, operators manually put the TTs into the shelf. In some cases, the TTs are picked from the cardboard boxes and put into rollcontainers before being displayed to end consumers. From an ergonomic point of view, this rearrangement seems to be unnecessarily complicated. In addition, the lower layers in a rollcontainer can be hard to reach for the end consumer.

Weight and Volume Efficiency

It is not possible to load neither filled minipallets nor EUR-pallets on top of each other in trucks due to the material used in the secondary packages and due to the sensitive TT. In addition, the number of levels on each tertiary package or load carrier is largely depending on the quality of the material used and not the package itself. To increase the generalization of this study, the material quality is mainly disregarded. Hence, only the area efficiency, not the volume efficiency, is important to calculate. Also, the weight efficiency is depending on the quality of the material used and, therefore, disregarded in this thesis.

Not Enclose Unnecessary Amount of Air

All one-way secondary packages are developed with the regards to the dimensions of the TT Base 1 liter. Hence, these packages do not contain unnecessary amount of air. On the other hand, the returnable packaging system in use at Dairy A and Dairy B (i.e. the rollcontainer) encloses a lot of air. The primary products in the rollcontainer can be rotated and it is obvious that the rollcontainer is not developed only with regards to the TT primary package with one specific top. The volume of air required for each secondary package type can be seen in Table 5.9.

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Table 5.9 Air efficiency for the different secondary packages.¹⁵²

<i>Secondary Solution</i>	<i>Outer dimensions (mm³)</i>	<i>TTs per package (liters)</i>	<i>Air Efficiency (dm³/liter TT)</i>
<i>Dairy A</i>			
Cardboard Tray	308*154*237	8	1,41
Rollcontainer	400*660*290	40	1,91
<i>Dairy B</i>			
Cardboard Tray	458*154*237	12	1,39
Shrink Film	450*154*239	12	1,38
Rollcontainer	400*660*290	40	1,91
<i>Dairy C</i>			
Cardboard Box	383*156*239	10	1,43

Not be Stronger than Necessary

Unnecessary strong packages mean too much packaging material with increased costs, environmental impact, and need for storage space. Therefore, the strength of a secondary package should be designed with the actual treatment in mind. This reasoning is most applicable to one-way solutions. Hence, rollcontainers will be left out in this discussion.

The cardboard qualities currently in use in the supply chains are of different qualities. The cardboard divider in the shrink film solution is strong enough to support the weight from four levels of packages, which is also the case for the cardboard tray in use at Dairy B. In that sense, the two secondary packages are about equal. At Dairy C, five levels of cardboard boxes on the pallet is said to be the maximum load; hence, the cardboard box is not too strong. By increasing the material qualities it is possible to increase the number of levels and, hence, the stacking ability.

Other Weight and Volume Efficiency Issues – Storage

The number of different types of products that are produced is an important variable when choosing a packaging system. At the case study dairies, the fresh milk is produced in two fat contents. This means that if one considers using only a cardboard solution, and wants to use it as marketing and information tool, for each logotype two

¹⁵² The outer dimensions for the one-way packages are based on theoretical dimensions (see Footnote no.153), whereas the rollcontainer dimensions are based on actual dimensions of one level.

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different printings have to be used. If producing four different logotypes with two different fat contents, like one of the case study dairies, eight different printings are necessary. This has major implication on storage space required in the warehouse. Also, storage in the production area can be problematic where space often is limited.

With the shrink film solution, the same neutral shrink film on a coil can be used for all the different logotypes and fat contents. Also, the same unprinted cardboard bottom and divider can be utilized. This, in turn, means that the storage space can be significantly reduced. However, two different EUR-pallets are needed in the production area to separately store the cardboard divider and bottom, and the plastic film coils.

Mounted rollcontainers waiting to enter the filling machine are bulky and take up a lot of space (see Appendix E – Flowchart 2, Step 27). Also, dirty rollcontainers waiting to be cleaned demands storage space.

Other Weight and Volume Efficiency Issues – Load Utilization and Filling Rate

As can be seen in Table 5.10, all the secondary packages loaded onto minipallets have overhang. The eight-liter cardboard solution is the worst since it both has an overhang (see Figure 5.13) and a lower bottom load utilization than the rest of the secondary packages used with minipallets. With the use of EUR-pallets, the packaging system at Dairy C is superior to the two packaging systems in use at Dairy B. Loading minipallets onto EUR-pallets causes great overhang, see Figure 5.14.

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Table 5.10 Summary of Load Dimensions, Load Utilization, and Filling Rate regarding different packaging solutions.¹⁵³

	<i>No of 2nd /3rd per layer</i>	<i>Load per Layer (liters)</i>	<i>Outer dimension of load (mm)</i>	<i>Over- hang</i>	<i>Load Utiliz. (%)</i>	<i>Area Filling Rate (%)</i>
Dairy A						
Cardboard tray 308*154*237 mm (8 liters)	4	32	462*462	Yes	93,7	94,9
Rollcontainer 400*660*1010mm (40 liters/layer)	-	40	400*660	-	-	85,2
Dairy B						
Cardboard tray 458*154*237mm (12 liters)	3/6	36/ 216	462*462/ 924*1386	Yes/ Yes	105,4/ 133,4	95,7
Shrink Film 450*154*239mm (12 liters)	3/6	36/ 216	462*462/ 924*1386	Yes/ Yes	105,4/ 133,4	95,7
Rollcontainer 400*660*1010mm (40 liters/layer)	-	40	400*660	-	-	85,2
Dairy C						
Cardboard box 383*156*239mm (10 liters)	15	150	780*1163	No	93,4	94,2

The area filling rate in Table 5.10 gives an indication of how well the bottom area of the primary package fits the secondary package. All the one-way secondary packages have large filling rates of 94,2-95,7%, whereas the rollcontainer only have a filling rate of 85,2%. Again, it is obvious that the one-way secondary packages are adapted to the dimensions of the primary package.

The numbers in Table 5.10 are based on theoretical dimensions. In reality, the primary package is bulging when it has been filled and exceeds the outer dimensions given to the primary package. Hence, the secondary packages have to be designed to the dimensions of the bulging TT, which causes the overhang to be even greater.

¹⁵³ Calculations are based on theoretical primary package dimension of F=S=75mm and H=235mm, i.e. the dimensions of the bulging TT has been disregarded (a bulging TT has F=S=78mm). Also, no slack in between the primary products are taken into consideration. Hence, the outer dimensions of the one-way packages do not exactly match the actual dimensions. In contrast, the rollcontainer outer dimensions are the real dimensions. The dimension of the minipallet is 450*450mm; the dimension of the EUR-pallet is 800*1200mm.



Figure 5.13 The overhang of Dairy A's cardboard solution on minipallets.



Figure 5.14 The overhang of the shrink film solution with the use of minipallets onto EUR-pallets.

The overhang of the secondary packages at Dairy A and Dairy B can increase the damage of the product. One respondent at Dairy A indicated that the overhang of the secondary package loaded onto minipallets was a problem, whereas Dairy B's respondents did not mention this issue. Instead, the respondents at Dairy B indicated that the problem was the minipallets loaded onto EUR-pallets. During the observations, damages related to overhang were mostly evident with this solution. An example of this was the deformed edges of the outermost secondary packages observed at the distribution center.

Right Quantity and Size

Notably is that all three dairies only stated logistic reasons for choosing the packing pattern of the secondary package: Dairy A implemented the current packing pattern of 2x4 due to the old Tetra Brik solution; Dairy B implemented the use of 2x6 to fit the old minipallets; and, Dairy C implemented the 2x5 packing pattern in order to utilize the pallet area as efficiently as possible. Remarkable is that not even the marketing managers took other issues into consideration. As stated in Section 3.3, it is important that all the three packaging functions (i.e. logistics, marketing, and environment) are elucidated before deciding on a packaging system. For example, in this case the customer's buying pattern should be taken into account. Evidently, there will be trade-offs between this latter marketing issue and the logistical issue. Perhaps, the logistic issue will ultimately prevail.

Also, choosing a packing pattern solely based on pallet utilization can create unnecessary handling later on in the supply chain when secondary packages have to be opened and the primary packages separated to satisfy the need of other packaging quantities. During the observations related to distribution, it was often noticed that the truck driver delivered split secondary packages. This could indicate that the chosen amount does not satisfy the delivery quantity.

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Easy to Group into One Unit for Handling and Transportation

The cardboard wraparound box has superior abilities of unitization, as it does not demand any specific packing pattern. Also, the top lid, the material quality, and the dimensions of the box allow for efficient handling and transportation. Due to its limited stacking ability, the shrink film solution and the cardboard tray are inferior to the cardboard box. The shrink film solution is even more sensitive to careless stacking as askew levels more easily put weight directly onto the TTs. The use of minipallets onto EUR-pallets limits the unitization ability, as the two load carriers are not adapted to each other. The outer dimensions of rollcontainers are not adapted to the standard dimensions used for, for example, EUR-pallets.

Support the Use of Multipacks

Realistic dimensions of multipacks would be 1x2, 1x3 or maybe 2x2 TTs. All packing patterns of the secondary packages observed allow for different degrees of apportionment. In spite of its 5x8-packing pattern, only one of the suggested multipacks fit rollcontainers. Regarding the shrink film solution, a multipack of 2x2 is not possible due to the cardboard divider.

Table 5.11 Apportionment of different packing patterns.

<i>Multipack</i>	<i>Packing Pattern</i>			
	2x4	2x5	2x6	5x8
1x2	✓	✓	✓	✓
1x3	-	-	✓	-
2x2	✓ ¹⁵⁴	-	✓ ¹⁵⁴	-

The studies indicate that there is no need for a multipack solution of fresh milk on the Italian market. None of the respondents believed in a multipack solution. The consumption is believed to be too small and the shelf life too short. Further, a risk with multipack is that the end consumers would handle the package like multipacks of water, i.e. break the multipack and grab one single TT.

Fit into Pallets and Store Shelves

The area utilization on the minipallets and EUR-pallets are discussed in Section 5.4.1 subsection Not Enclose Unnecessary Amount of Air.

Regarding the ability of the secondary package to fit into shelves, there is no need to consider whether the one-way packages fit into the store shelves; the one-way secondary packages are removed at the retailer and never reach the shelves. However, if shelves are not used (as is the case at some hypermarkets where the primary packages are repacked from one-way solutions to rollcontainers), then one-way secondary packages are not suitable. For rollcontainers, it must be made certain that the dimensions of the store refrigerators fit the returnable packaging system.

¹⁵⁴ Multipack 2x2 is not possible with the shrink film solution due to the cardboard divider.

5.4.2 Marketing

The empirical studies indicate that marketing issues in the supply chains are of less importance than anticipated, as secondary packages are rarely displayed to the consumers. Nevertheless, the secondary packages have different marketing abilities and functions.

Should Attract Attention

Among the studied solutions, cardboard is superior as a marketing tool as it is the most suitable material for printing. The shrink film solution is transparent and displays the primary packages but does not add any marketing value on its own. Rollcontainers perform marketing functions thanks to visible TTs and a logotype. Besides these two features, the rollcontainer is neutral and, therefore, poor from a marketing point of view.

Rollcontainers from different dairies are mixed with each other. This has the result that the end consumer in the stores sees the logotypes of the primary packages together with competitor logotypes on the rollcontainer. It is stated by different dairy respondents that the end consumers are not aware of this and that it, accordingly, is not a big problem. However, one should try to avoid mixing the company logotype with those of the competitors, providing it is not a conscious strategy of doing so. Further, the lower layers of a rollcontainer are insufficient at attracting attention as the TTs are hidden behind the refrigerator hatch.

Should Reinforce the Product Image

Without any doubt, the primary package plays the most important marketing role. The retailer puts attention to display the TTs in a structured and attractive way, but does not display any cardboard or shrink film secondary package solutions. Hence, the one-way secondary package does not contribute to reinforce the product image to the end customer.

However, the one-way secondary packages are sometimes visible to the end consumer (for example during repacking into store shelves). With this in mind, the general belief amongst the respondents is that the use of cardboard material indicates a more premium product than the use of shrink film material. The TT, being a premium product, should be combined with a premium packaging material. Hence, cardboard material should be the most suitable, disregarding that the end customer almost never sees the secondary packages. The cardboard box can be perceived as being the most premium cardboard solution due to the top lid.

The respondents have contradictory opinions about printings on the cardboard. Obviously, neither the cardboard solutions nor the shrink film solution are meant to be displayed to the end consumer; therefore they do not fill any major marketing functions. This is confirmed in interviews and during observations. Nevertheless, the general belief seems to be that the cardboard has to be printed. Presumably, this is a consequence of the fresh milk's premium product image combined with the opinion that the printing cost is negligible. If the cost difference is insignificant, then the

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cardboard should be printed to make the packaging system uniform and hence reinforce the image of a premium product. On the contrary, if cost is a high priority, the cardboard could be kept brown, as the cardboard is not intended to be displayed to the end consumer. For example, the cardboard dividers in the shrink film solution are left unprinted, as they are not displayed to some actors in the supply chain.

For the shrink film solution, the printings on the primary package can occasionally be damaged when the shrink film is removed. This problem is created during the shrinking process where the shrink film can stick to the plastic film of the TTs. Damaged printings does not reinforce the premium product image.

5.4.3 Environment

The empirical studies present a contradictory picture of environmental issues. Whereas the packaging scorecard points out environment as top priority (see 5.2.1 subsection Total Average Score), many respondents argued that environmental issues are of minor importance in Italy. According to the qualitative empirical studies, environmental issues turned out to play a minor role in the observed supply chains. Therefore, the subject is only briefly analyzed.

When it comes to the transportation of dairy products to distribution centers and retailers, the environmental impact can, in this thesis, be ignored for two reasons: firstly, the emissions during transports calculated per package are very small regarding the distribution of dairy products; secondly, the environmental issues in this thesis are comparative and not absolute. The differences in emissions due to different material are not only negligible but also immeasurable.

Should be Produced with Minimal Amount of Energy Consumption

The energy consumption in production of one kilo cardboard and shrink film is stated in Table 3.2. Even though the figures originate from different sources, one can clearly identify cardboard as being the more energy efficient alternative.

Comparable energy consumption figures for production of one rollcontainer are hard to obtain. No answers were to be found at rollcontainer producers, and environmental specialists at Tetra Pak could only make the assumption that rollcontainers are the best alternative due to its long life.¹⁵⁵

Should not Consist of Environmentally Harmful Materials

Even though plastic film is recyclable, it originates from oil or natural gas, which are not renewable sources of energy. Cardboard, on the other hand, is made from coniferous and broadleaf wood and is both recyclable and a renewable source of energy.

¹⁵⁵ Interview with Wallén, E., 040607 and email from Chester, C., 040714.

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Should Consist of Minimal Amount of Packaging Material

According to Table 3.2, cardboard is preferable as packaging material. However, as stated in Section 3.3.3, a more relevant environmental measurement is to compare the amount of packaging material or energy consumption used per TT. This is presented in Table 5.12. From this perspective, the cardboard tray from Dairy B is the most environmentally friendly alternative. The figures for the shrink film solution and the cardboard trays are similar, whereas the energy consumption for the cardboard wraparound box is higher. However, this is not a complete picture of the environmental impact from the different secondary packages. Use of other values of material qualities could result in favor of other packages.

Table 5.12 Theoretical mass, volume, and energy consumption per TT for secondary packages.¹⁵⁶

<i>Secondary Package</i>	<i>Mass/TT (g)</i>	<i>Cardboard Volume /TT (dm³)</i>	<i>Energy Consumption (MJ/TT)</i>
CB Tray (2x4)	16	0.073	0.225
Shrink Film (2x6)	10 (cardboard) 3 (shrink film)	0.059	0.230 ¹⁵⁷
CB Tray (2x6)	14	0.065	0.208
CB WA Box (2x5)	19	0.089	0.270

This comparison carried out for one-way packages is not really applicable to rollcontainers. Yet, with respect taken to its long lifetime, they present a superior alternative when it comes to packaging material mass per primary package carried. Rollcontainers would be an even more attractive solution if the losses of rollcontainers in the supply chains could be reduced.

Should be Designed to Minimize Waste

As can be seen in Table 5.12, the shrink film solution contains less material regarding the weight and volume in comparison to the other one-way packages. The amount of waste created is, hence, less than the cardboard solutions. However, the shrink film solution has the disadvantage of consisting of two different materials (shrink film and cardboard); the cardboard solutions only consist of one material.

Due to the high rate of disappearing rollcontainers, the ability to minimize waste is not optimized for this returnable packaging system.

¹⁵⁶ For calculations, see Appendix G – Energy Consumption Calculations.

¹⁵⁷ 0.143 MJ/TT (CB), 0.087 MJ/TT (shrink film).

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Should be Recyclable

The ability to recycle the packaging material of the secondary package is, according to the outcome of the packaging scorecard, the most important criteria (see Section 5.2.1 subsection Total Average Score).

Even if both cardboard and plastic film are recyclable, an observed problem arises at some smaller retailers. Here, the packaging material is thrown away with other garbage, apparently without any recycling considerations. Environmental concerns at the dairies are of no use as long as other actors in the supply chains are uninterested. Bigger retailers handle more packages and recycle to a larger extent, partly because it affects their taxes.

5.5 Strengths and Weaknesses Tables

To get an overview of different package properties, comprehensive tables of strengths and weaknesses related to each package type have been compiled based on the empirical studies, the packaging function analysis, and the packaging scorecard, see Table 5.13-Table 5.15. The emphasis is on the secondary package; nevertheless, apart from for the primary package, the tables include the whole packaging systems. To increase the generalization of the tables, packing patterns and material qualities specific to individual dairies, and not to specific secondary package solutions, affecting strengths and weaknesses have been left out.

Each property is marked as a strength (+) or a weakness (-), without indications of the relative importance. Instead, it is up to the reader to decide on important properties.

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Table 5.13 Strengths and weaknesses of cardboard packaging systems. SF indicates the use of stretch film.

Cardboard Solutions in General			
+	Adaptable to fit different packing patterns		
+	Good information carrier due to printing abilities		
+	Intact boxes offer good protection		
+	Good air efficiency		
+	Good marketing possibilities due to printing abilities		
+	Recyclable		
+	Good stability of TT in filled secondary package		
-	Current solutions not standardized		
-	Not water and humidity resistant		
-	Need two hands in manual handling		
-	Unfolded cardboard sheets occupy much space in production area and in warehouse		
-	Methane created in the breaking-down process contribute to the global warming		
-	Imperfect glue lines can cause bottom wing to break		
-	Leaking TTs weakens the cardboard		
-	Create big volumes of waste		
-	Demand different printings for each logotype and milk sort		
-	TTs not stable in half full secondary package		
Cardboard Trays	Cardboard Wraparound Boxes		
Secondary packages			
+	Display of expiry dates	+	Good protection of the TT cap
+	Open trays enable easy picking of TTs	+	Stable
+	Display of screw cap	+	Tamper proof
+	Good temperature preservation when stacked	+	Good temperature preservation
-	Demand specific stacking pattern	+	Good stacking ability
-	Unstable in the middle of the long sides	-	No display of TTs
		-	Hard to find and replace leaking TTs
		-	High consumption of material
		-	Demand opening time
		-	No handles
		-	Center hole tempts lifting at weak points
Secondary packages + minipallet			
+	Protect the cardboard boxes from dirt and water on floor		
+	Minipallets are lightweight load carriers		
-	Require reverse logistics		
-	Minipallets require cleaning		
Secondary packages + EUR-pallet (+ stretch film)			
		+	Good protection against dirt (SF)
		+	Good protection against water and humidity (SF)
		+	EUR-pallet withstand heavy loads

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	-	Tension from wrapped stretch film can cause the gluing lines in the box to break (SF)
	-	Risk of disappearing pallets in the supply chain
	-	Require reverse logistic
	-	Creates much stretch film waste (SF)
Secondary packages + minipallets + EUR-pallet (+ stretch film)		
+		Good protection against water and humidity (SF)
+		EUR-pallet withstand heavy loads
+		Good protection against dirt (SF)
-		Minipallets not adapted to the dimensions of EUR-pallets
-		Require reverse logistics of two different load carriers
-		Minipallets require cleaning
-		Risk of disappearing pallets in the supply chain
-		Tension from wrapped stretch film can cause the gluing lines in the box to break (SF)
-		Creates much stretch film waste (SF)

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Table 5.14 Strengths and weaknesses of the shrink film packaging system.

<i>Shrink Film with Cardboard Divider</i>	
<i>Secondary packages</i>	
+	Transparent secondary package displays the TTs
+	Good protection against water and humidity
+	Good stability of TTs in filled secondary package
+	TTs remain stable in half full package
+	Tamper proof
+	Very air efficient
+	Recyclable
+	Adaptable to fit different packing patterns
+	Good handleability, can be lifted and carried in one hand
+	Do not occupy much storage space in warehouse and production
+	Display of TTs
+	No need for printings on cardboard bottom and divider
+	Neutral stretch film can be used for different logotypes and milk sorts
+	Cardboard bottom absorbs condensation inside the secondary package
-	Exposure to high temperatures (190 C) in the shrinking process contribute to condensation inside the secondary package
-	Cardboard bottom and divider not standardized
-	Two different types of waste material are created
-	Condensation enclosed in the package can not evaporate
-	The shrink film can stick to the outermost TTs
-	Not temperature resistant
-	Demand specific stacking pattern
-	Askew layers damage the TTs
-	Methane and carbon dioxide in the breaking-down process add to the global warming
-	Opening equipment (knife) can damage the TTs
-	Cardboard bottom gets weak from condensation
-	Hard to replace leaking TTs
-	Not easily printable
-	Plastic is not recycled to a great extent
-	Machine complexibility (involves several steps)
-	Packer demands three different types of inputs
<i>Secondary packages + minipallet</i>	
+	Protect the secondary package and the TTs from dirt and water on floor
+	Minipallets are lightweight load carriers
-	Minipallets require cleaning at the dairy
-	Requires reverse logistic
<i>Secondary packages + minipallets + EUR-pallet (+ stretch film)</i>	
+	Good protection against water and humidity (SF)
+	Good protection against dirt (SF)
+	EUR-pallet withstand heavy loads
-	Create much stretch film waste (SF)
-	Minipallets require cleaning
-	Minipallets not adapted to the dimensions of EUR-pallets
-	Require reverse logistics of two different load carriers
-	Risk of disappearing pallets in the supply chain

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Table 5.15 Strengths and weaknesses of rollcontainers.

<i>Rollcontainers</i>	
Secondary packages	
+	Interstackable after collapsing
+	Easy to open, close, and reseal
+	Good protection against rough treatment
+	Easy to replace leaking TTs
+	Good structure of the TTs
+	Timesaving handling at the retailer
+	Display the TTs
+	Able to fit different products (standardized)
+	Ergonomical distribution/transportation
+	Easy to open, close, and reseal
-	Risk of disappearing rollcontainers in the supply chain
-	Do not protect against water and humidity
-	Bad display of the lowermost layer at the retailer
-	Lowermost layer hard to reach for the end consumer
-	Not temperature resistant
-	TTs able to rotate
-	Manual filling not ergonomical
-	Different logotypes get mixed up in the supply chain
-	Require cleaning
-	Require reverse logistics
-	Require unloading dock at the retailer
-	Not air efficient
-	Not suitable for small deliveries
-	Demand specific refrigerators at retailers
-	Only suitable for 1x2 multipack
-	Demand collapsing by customers
-	Automatic filling complex and demands a lot of manual work
-	Interstacked rollcontainers take up a lot of storage space
-	Bad marketing abilities

5.6 Conclusive Packaging Evaluation Matrix

In the Conclusive Packaging Evaluation Matrix (CPEM), see Table 5.16, the authors have collected the most important properties related to an implementation of a new secondary package. The most relevant properties in the packaging scorecard are combined with important properties that have arisen during observations and interviews. The authors, with the advantage of having observed all the evaluated secondary packages, are able to set objective scores. For every property, each secondary package is evaluated and, if applicable, graded from one to five (five representing the best solution) in accordance with the packaging scorecard. To improve the reliability, the two authors have independently evaluated all scores. In cases of different opinions, a joint result has eventually been worked out.

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The scores are not explained in the matrix. Instead, the arguments for and against different packages are explained earlier in the Packaging Function Analysis. A reference to those pages where the arguments can be found is made in the matrix.

The evaluation is, in two ways, intended to be a lucid tool for future customers in their choice of secondary packages. Firstly, the customer decides on important properties and simply uses the matrix to compare the score for different packages. This method provides the customer with a brief overview of suitable secondary packages to implement, but does not take the relative importance of different key properties into account.

Secondly, the matrix can be used as a tool not only to choose an appropriate packaging system, but also map criteria most important to improve. The calculations for doing this are similar to the calculations carried out in the packaging scorecard. First, the customer fills out a “CPEM general requirement”-questionnaire, see Appendix K – CPEM General Req. Questionnaire. Then the general requirements are normalized and multiplied with the scores in CPEM for each property. Finally, the total score (i.e. the overall satisfaction) regarding that secondary package is obtained by adding together the scores of each criterion. A comparison between the final scores of the different secondary packages indicates how well different secondary packages suit the properties required by the customer. It also maps properties important to improve, similar to the figures in Section 5.2.3.

To make the matrix generally applicable, the packing and stacking pattern of the one-way packages observed at the case study dairies have not been taken into consideration. Moreover, the secondary packages can be designed in different sizes and with or without handles; this has also been disregarded in the matrix. Consequently, in order to make a decision regarding what secondary package to implement, the matrix must be complemented with the above mentioned issues together with ergonomic related issues, found in Section 5.4.1 subsection Ergonomically Designed.

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Table 5.16 The Conclusive Evaluation Matrix.¹⁵⁸

	<i>CB Tray</i>	<i>CB Wrapa. Box</i>	<i>Shrink Film</i>	<i>Rollcontainer</i>	<i>See page(s)</i>
Production Protection					
Protection of the TT top	3	4	2	5	17
Protection against water	3	4	5	2	25
Avoid damage of TT due to condensation	3	3	2	4	19
Stability of the secondary package	3	4	3	5	24
Stability of the TTs in full secondary packages	4	5	5	4	25
Stability of the TTs in half full packages	3	3	5	2	25
Temperature resistance	4	5	2	1	19
Information Carrier					
Printing ability	5	5	3	1	33
Display of primary package	3	1	5	5	21
Handling Efficiency					
Simplicity to automatically fill and seal	5	4	3	2	21
Simplicity to pick TTs in the distribution	5	4	4	3	23
Simplicity to grab and carry	3	3	5	N/A	23
Simplicity to stack	4	5	3	N/A	23
Simplicity to open and empty	5	4	3	3	22
Minimization of handling activities	5	4	4	3	25
Weight and Volume Efficiency					
Air Efficiency	4	4	4	2	28
Minimization of storage space of empty packages	4	3	5	2	28
Marketing					
Reinforce premium product image	4	5	3	3	33
Environmental Issues					
Energy consumption in production of sec. package	4	3	4	N/A	35
Minimization of waste	4	3	4	N/A	35

¹⁵⁸ N/A refers to properties not applicable to that specific secondary package type (i.e. one-way or returnable).

5.7 Best choice

As expected, the Packaging Function Analysis and the Strengths and Weaknesses Tables clearly reveal that there is no “best choice” among the different secondary packages. It would be misleading to present a general solution as different secondary packages have different properties that fit the different demands and requirements from different actors. Instead, the tools presented in this master’s thesis are meant to facilitate the choice of “best solutions” for secondary packages for each individual supply chain.

6 Conclusions

In this chapter, the most important results and conclusions of this master's thesis are concisely presented.

6.1 Recommendations to Future Customers

6.1.1 Supportive Evaluation Tools for Decision Making

The most evident outcomes of this master's thesis are three evaluation tools. These are developed to facilitate the choice of suitable secondary package(s) to implement according to the individual requirements of future customers. For closer descriptions of the evaluation tools, the reader is referred to the analysis chapter.

Packaging Function Analysis – analyses values and benefits, but also failings of existing packaging systems for different actors in the supply chains. This evaluation tool is a comprehensive body mass text used for detailed information.

Strengths and Weaknesses – presents a comprehensive collection of pros and cons regarding packaging systems currently on the Italian market.

Conclusive Packaging Evaluation Matrix – objectively grades a variety of key properties of different secondary packages. Two methods of application can be used; either, CPEM is used as a simple guide, or it is combined with the general requirements of the customer to attain an overall satisfaction. This latter evaluation method could help to distinguish among alternatives and advise on suitable secondary package(s). Also, it maps important properties to improve.

6.1.2 Supply Chain Related Conclusions

Developing a packaging system is about balancing various tradeoffs. It is hard to optimize a packaging solution for the whole supply chain. In the Packaging Function Analysis, some sub-optimizations have arisen both at specific actors and throughout the supply chains.

Reducing the complexity at one actor can increase complexity at another actor in the supply chain. Thus, the total complexity in the supply chain can increase. To avoid this, requirements from the whole supply chain need to be taken into consideration when deciding on a packaging system.

As one might expect, the big variety of demands and requirements from different customers preclude the possibility of finding one universal secondary package suitable for all supply chains. Often, it is also unsuitable to use the same packaging system for different distribution channels with different properties (for example one-way and returnable packages).

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When deciding on a packaging system to implement

- buying pattern, and not only the adaption the load carriers, must be taken into consideration when deciding on packing pattern to avoid sub-optimization between packaging functions.
- printings on cardboard should not be overrated as a marketing tool in the observed supply chains as the secondary packages are rarely displayed to the end consumer.
- activities carried out *before*, not only after, the secondary package is added to the packaging system must be taken into account.
- it must be made certain that the stacking pattern does not change later on in the supply chain for secondary packages that require a specific stacking pattern.

6.2 Recommendations to Packaging Supplier

6.2.1 Key Requirements on Packaging Systems

The quantitative packaging scorecard points out environmental issues and some issues related to handleability as key requirements at the dairies. Somewhat less important are protection and information carrying abilities. Also, weight and volume efficiency is perceived to be of some interest whereas marketing and some aspects of handling mainly performed late in the supply chain, tend to play a minor role.

The qualitative studies, based on interviews and observations, differ to some extent from the picture presented by the packaging scorecard. Environmental concerns play a minor role. Instead, activities related to the secondary packages are clearly dominated by logistical aspects. Again, marketing is perceived to be of little importance on the Italian market.

6.2.2 Other

It is not sufficient for a packaging supplier to objectively evaluate different packaging systems and expect the customer to be satisfied according to this evaluation. Instead, different packaging systems must be valued in collaboration with the customer.

It seems like there could be an opportunity for package suppliers to market and inform about its distribution equipment more extensively. A packaging supplier providing an overall solution with the primary package filling machine and accompanying distribution lines, helps to convince customers to choose that supplier ahead of competitors.

7 Discussion and Suggested Future Research

In this chapter, some events in this master's thesis are discussed. Decisions taken by the authors that affect the quality of the outcome are commented on. Further, failings and unexpected problems that have arisen are explained. Finally, the author's suggestions on future research related to this master's thesis are presented.

7.1 Packaging Scorecard

During the empirical studies in Italy, the authors tried to distribute packaging scorecards to every actor in all three supply chains to obtain requirements from different actors. Unfortunately, this turned out to be impossible due to tight schedules and lack of interest from transporters and retailers. Instead, the packaging scorecard analysis was changed to focus solely on the dairies.

In most cases, the questionnaires have not been completely filled out. All gaps in the packaging scorecards are unfortunate. As a result, a missing score from a respondent does not contribute to the results and the opinions from other respondents become more important.

To increase the reliability of the different weightings regarding the current situation scores, the original idea was to distribute packaging scorecards to the same participants twice (once during the field visit in Italy and then a few weeks later via email). However, the plan was abandoned as the first collection of packaging scorecards in Italy turned out to be much more complicated than anticipated. During the visit in Italy, only some of the distributed packaging scorecards were returned despite of the authors' lobbying. To obtain packaging scorecards via email would probably be unfeasible.

Due to somewhat unclear instructions, the eight general heading questions in the packaging scorecard were often left unanswered. As too many of the respondents failed to answer many of these questions, the authors chose to leave out all of them from further analysis.

7.2 Issues Related to Supply Chain B

The shrink film solution from Dairy B is distributed outside a big city area. During the only available time for observations regarding a route originating from a distribution center, all stores were closed and no retailers could be interviewed. For the same reason, no observations at retailers could be made. However, during interviews with retailers belonging to Dairy A, questions were asked regarding a shrink film solution used for plastic bottles. The two shrink film solutions are quite similar and there might not be any major differences of how the retailer perceives the secondary packages. Nevertheless, a significant difference is that the shrink film solution used for TTs contains two different materials: shrink film and cardboard. Therefore, opinions regarding this issue have not been evaluated.

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Most retailers visited got milk from Dairy A and B. Hence, the retailers interviewed in Supply Chain A have been in contact with both cardboard tray solutions. The two cardboard solutions are very similar; presumed is that the opinions stated about the cardboard package from Dairy A are also valid for Dairy B.

7.3 Suggested Future Research

During the course of this master's thesis, several interesting ideas have been discussed and eventually left unanswered. Some of the suggestions are continuations on this master's thesis whereas other deal with closely related topics.

7.3.1 Extended Studies of Secondary Packages

The evaluation of secondary package solutions could be extended to involve all secondary packages available on several markets. For example, plastic crates were left out in this master's thesis. Also, an evaluation including future solutions would provide future customers with further useful information on what package system to implement.

7.3.2 Multipack Solutions for Tetra Top on Different Markets

The Italian market does not seem to be suitable for a multipack solution of fresh milk in TT Base 1 liter. However, other markets, other products, and other types of TTs support multipack solutions better. It would be interesting to explore this need and possible multipack solutions on selected markets.

7.3.3 Cold Chains and Temperature Related Issues

A functional cold chain is extremely important for fresh products and especially in countries like Italy with high temperatures. It would be interesting to map temperature related activities undertaken to assure the reliability of the expiry date to the end consumer. Also, this survey would help to improve the cold chain by identify where and why shortcomings occur.

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Appendix A – Time Frame

Task	Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Planning																									
Reading + choice of method																									
Draft of int. + method. ch.																									
Literature studies																									
Draft of theoretical chapter																									
Empirical studies																									
Pilot Study																									
Draft of empirical chapter																									
Analysis brainstorming																									
Draft of analysis chapter																									
Point of no new learning																									
Draft of conclusions chapter																									
Vacation																									
Draft of discussion chapter																									
Preparation of presentation																									
Layout and references																									
Thesis report completed																									
Scientific article																									
Presentation																									

Appendix B – Interview Manuals

Introduction

- Explain purpose of the master's thesis and interview
 - Explain the participation anonymity issue
1. Explain why we want to record the interview. Is it ok that we record this interview?
If yes → Start recording device.
 → State the date and time of the interview.
 2. What is your name?
 3. What is your title?
 4. What does your title mean more specifically?
 5. Who do you work for? Employer?

General Company Information – Dairy Manager

Purpose: Get general company information for company presentation in introductory chapter.

6. How long have you been in business?
7. What does your distribution net/area look like?
8. How many customers do you have?
9. What is the customer base of your company? (e.g. hypermarkets, small shops etc.)
10. How many different products do you manufacture?

General TT Base 1 liter Information

Purpose: Get general information about the product, its volume, and customer base.

Dairy Manager

11. How long have the TT/3 been in use?
12. Is it only the TT Base 1 liter that is produced in the TT/3 machine? (That is, is it only one product?) *plant tour*
13. What is the brand name of the TT Base 1 liter? *plant tour*
14. How many of your customers buy the TT Base 1 liter? (e.g. hypermarkets, small shops)
15. What end consumer segments do you aim for regarding the TT Base 1 liter?
16. Are there big variations in the demand of the product?
17. What is the delivery frequency? *plant tour*
18. What is the (expected) annual volume produced?

Fel! Formatmallen är inte definierad.

Transporter

19. Are there big variations in the demand of the product?
20. How many different products do you transport?
21. How often do you transport secondary packages for milk?

Retailer

22. Are there big variations in the demand of the product?
23. How often do you get deliveries of milk?
24. What is the (expected) annual volume sold?

General Packaging System Questions

Purpose: Get general information about the packaging system.

Dairy

25. What secondary and tertiary packaging is used? What material?
26. Why was this packaging system chosen?
27. What kind of information did you base your decision on? TP?
28. Do you think that this amount of information was sufficient?
29. Have you changed the packaging system or distribution equipment at any stage?
If returnable
30. How long is the expected lifetime of the PS?

Transporter

31. Is anything added to the packaging system?

Retailer

32. Do you add anything to the packaging system?

Overview Questions

Purpose: Get information about other requirements that were not thought of. Also, get a general picture of how the respondent perceives the current packaging system.

33. What requirements do you have on a packaging system (in this case the outer levels, that is secondary and tertiary levels)
34. Do you perceive that the packaging system in use for Tetra Top fulfils your requirements?
35. Do you have any suggestions on how to improve the packaging system?
36. If you had a choice, would you still choose the current packaging system or would you consider another packaging system? If so, why?

Fel! Formatmallen är inte definierad.

Packaging Scorecard

Purpose: Get information about the importance of different requirements and how the TT packaging system is perceived.

- 37. Ranking of requirements importance
- 38. Ranking of current Tetra Top packaging system performance

Specific questions

Purpose: Get more in-depth information about the performance of the packaging system.

Questions specific to the actor are found in Packaging Scorecard – Specific Questions, which are not included in this Master Thesis.

Interview wrap-up

- Thank the respondent for the participation.
- Ask if we can contact the respondent again over email for further question.

Appendix C – Observation Schedule

Packaging System Information

- Type of screw cap
- Packing patterns
- PS type and material
- Weight
- Volume

Flow Chart

- What activities take place? (from end of primary package filling to retail shelf)
- How many people are involved in the handling?
- How long does each activity take?
- Is anything added? (such as extra support, more material, information tags etc.)?

Packaging Scorecard Issues

Product Protection

- Any damaged products?
- Protects the sensitive areas?
- Clean?
- Protects against weather conditions?
- Protects against pests?
- Tamper proof?

Information Carrier

- Kind of information?
 - Easily readable?
 - High quality (e.g. quality of EAN codes)
- Easily identified?
- Clearly state handling information?

Marketing

- How displayed?
- Secondary package exposed to customers?
- What pricing is used?
- Are different brands of milk sold?
 - If yes, how are the secondary packages displayed?

Environmental Issues

- Waste
 - Efficiently handled?
 - Amount?

Weight and Volume Efficiency

- Fit into shelves/storage space/transport space?
- How are empty secondary packages stored?
- Collapsible?
- Volume efficiently utilized in transport (fully loaded?)

Right Quantity and Size

- Easy to group together?
- Fit into pallets?

Handling Efficiency

- Handling equipment?
 - Package fit with handling equipment?
- Package fit with automatic handling?
- Methods carefully performed?
- Time to fill
- Easy to pack/ open/unpack/reseal?
 - Time
- Handling
 - when opened (Stable?)
 - when half filled
- Grabbable?
- Stackable?
 - How many?
- Easy to load/unload
- Ergonomical?
 - Heavy
 - Sharp edges?
 - Personnel Bend/Lift?

Appendix D – Packaging Scorecard

Packaging Scorecard - General Requirements					
Company Name					
Contact Name					
Title					
Phone					
E-mail					
<p>Instructions <i>Grade each question from 1 (not important) to 5 (very important) depending on how important you consider the criterion to be. Hence, it is NOT an evaluation of the existing packaging system, but a mapping of your requirements. It is important that you only consider the secondary and tertiary package during the scoring.</i></p>					
	Not important	Somewhat important	Important	Very important	Extremely important
	1	2	3	4	5
Product Protection	<input type="checkbox"/>				
The secondary package should reduce damage of the product	<input type="checkbox"/>				
The secondary package should reduce theft and manipulation of product	<input type="checkbox"/>				
Information Carrier	<input type="checkbox"/>				
The secondary package should facilitate identification of the product	<input type="checkbox"/>				
The secondary package should inform other actors in the supply chain	<input type="checkbox"/>				
The secondary package should prevent goods from being misplaced	<input type="checkbox"/>				
The secondary package should inform about contents	<input type="checkbox"/>				
Handling Efficiency	<input type="checkbox"/>				
The secondary package should be easy to fill and seal	<input type="checkbox"/>				
The secondary package should be easy to open, empty, close, and reseal	<input type="checkbox"/>				
The secondary package should be easy to grab and stack	<input type="checkbox"/>				
The secondary package should be stable	<input type="checkbox"/>				
The secondary package should be easy to clean	<input type="checkbox"/>				
The secondary package should be designed to fit different products	<input type="checkbox"/>				

Fel! Formatmallen är inte definierad.

Weight and Volume Efficiency	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should not enclose unnecessary amount of air	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should not be stronger than necessary	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Right Quantity and Size	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary packages should be easy to group into one unit for handling and transportation	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should support use of multipacks	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should fit into pallets and store shelves	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Marketing	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should attract attention	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should reinforce the product image	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Environmental Issues	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should be produced with minimal energy consumption	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should not consist of environmentally harmful materials	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should consist of minimal amount of packaging material	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should be designed to minimize waste	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package material should be recyclable	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Cost	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package should be cheap	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<input type="text"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Other (please add any requirements you think are missing)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<input type="text"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<input type="text"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

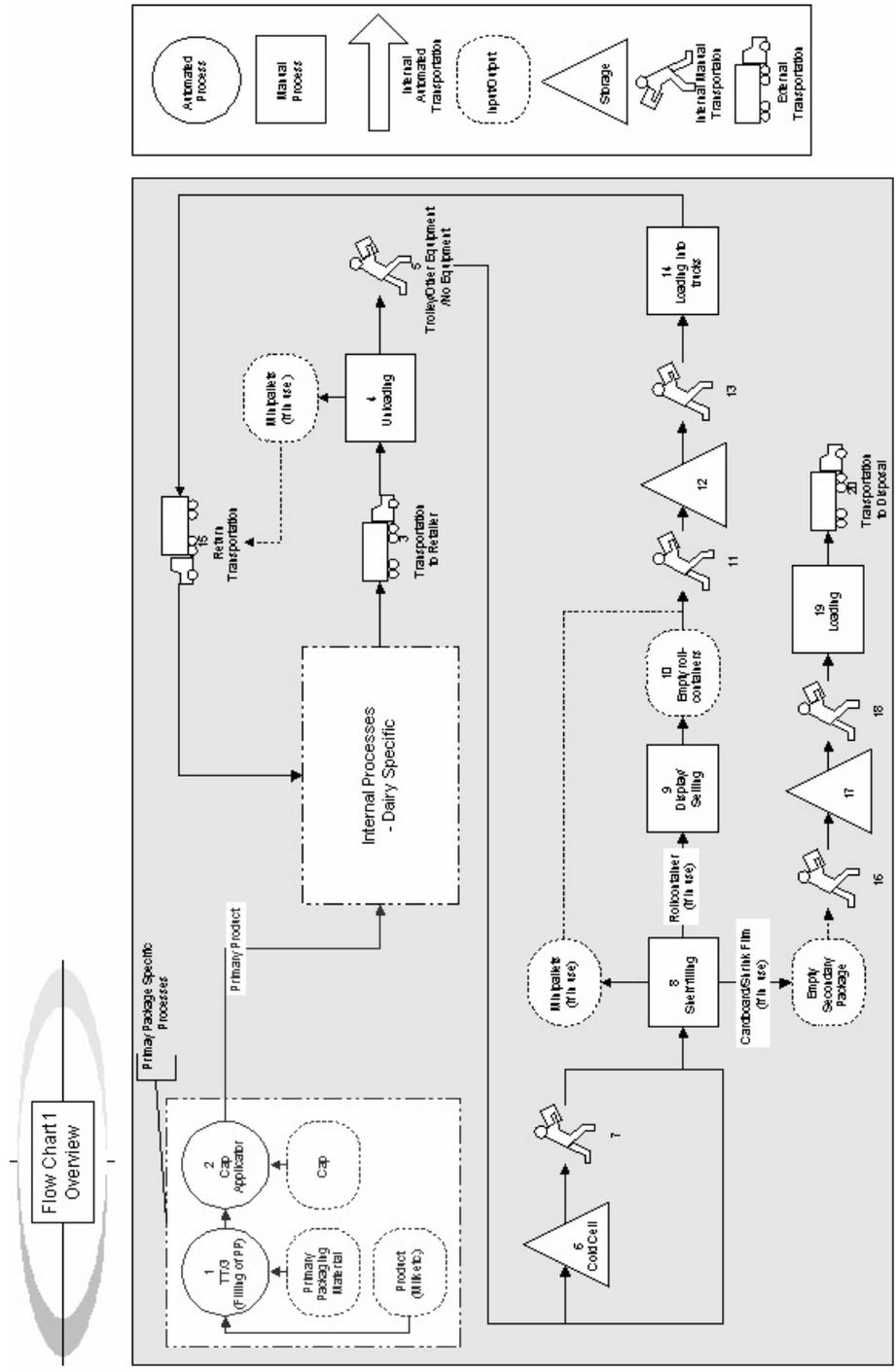
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Packaging Scorecard - Current Situation					
Company Name					
Contact Name					
Title					
Phone					
E-mail					
<p>Instructions Grade each question from 1 (disagree) to 5 (completely agree) depending on how you perceive that the existing packaging system performs. It is important that you only consider the secondary and tertiary package during the scoring.</p>					
	Disagree 1	Partly agree 2	Agree 3	Certainly agree 4	Completely agree 5
Product Protection	<input type="checkbox"/>				
The secondary package reduces damage of the product	<input type="checkbox"/>				
The secondary package reduces theft and manipulation of product	<input type="checkbox"/>				
Information Carrier	<input type="checkbox"/>				
The secondary package facilitates identification of the product	<input type="checkbox"/>				
The secondary package informs other actors in the supply chain	<input type="checkbox"/>				
The secondary package prevents goods from being misplaced	<input type="checkbox"/>				
The secondary package informs about contents	<input type="checkbox"/>				
Handling Efficiency	<input type="checkbox"/>				
The secondary package is easy to fill and seal	<input type="checkbox"/>				
The secondary package is easy to open, empty, close, and reseal	<input type="checkbox"/>				
The secondary package is easy to grab and stack	<input type="checkbox"/>				
The secondary package is stable	<input type="checkbox"/>				
The secondary package is easy to clean	<input type="checkbox"/>				
The secondary package is designed to fit different products	<input type="checkbox"/>				

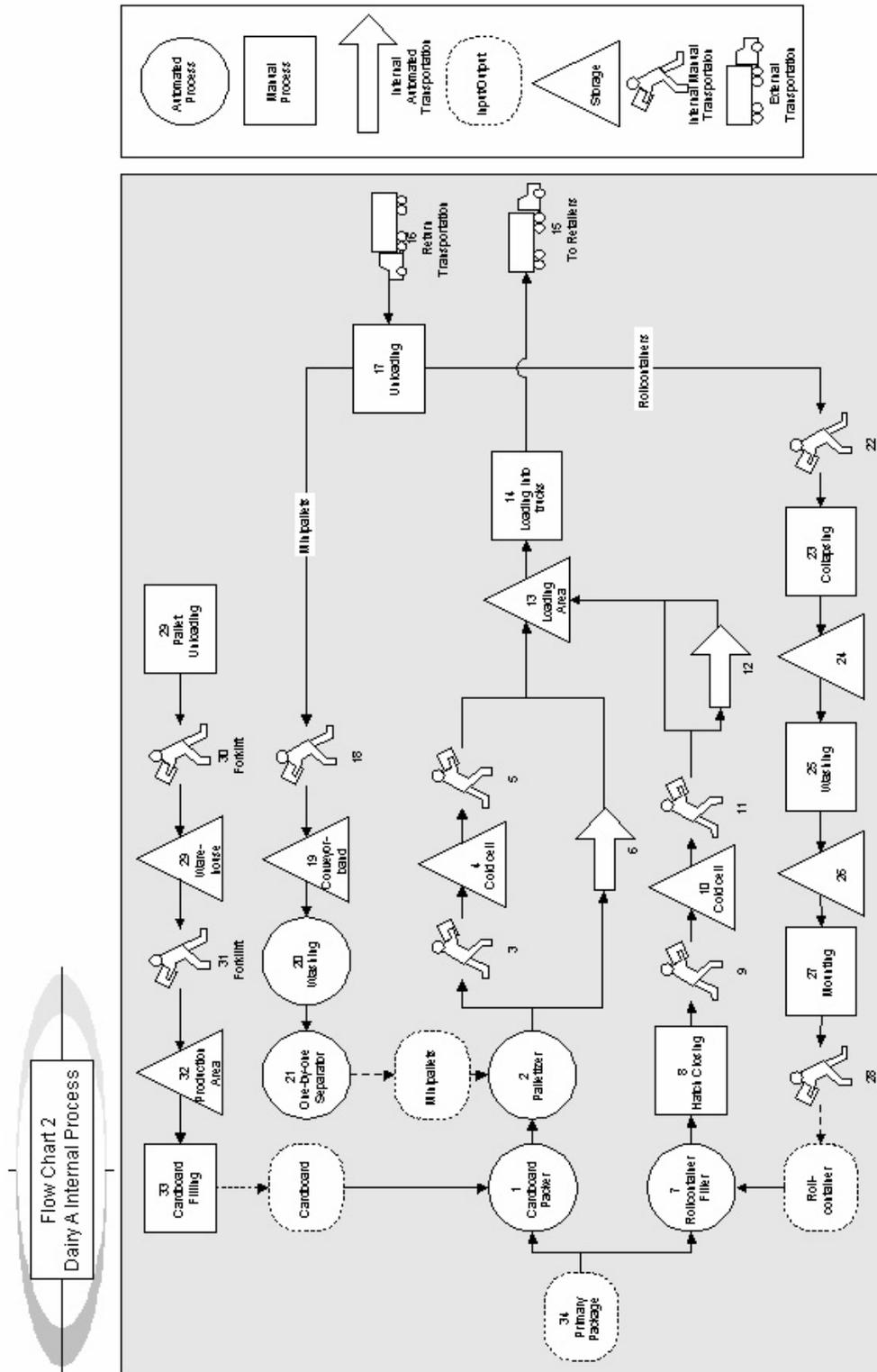
Fel! Formatmallen är inte definierad.

Weight and Volume Efficiency	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package does not enclose unnecessary amount of air	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package is not stronger than necessary	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Right Quantity and Size	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary packages are easy to group into one unit for handling and transportation	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package supports use of multipacks	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package fits into pallets and store shelves	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Marketing	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package attracts attention	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package reinforces the product image	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Environmental Issues	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package is produced with minimal energy consumption	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package does not consist of environmentally harmful materials	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package consists of minimal amount of packaging material	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package is designed to minimize waste	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package material is recyclable	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Cost	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The secondary package is cheap	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<input type="text"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Other (please add any properties you think are missing)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<input type="text"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<input type="text"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

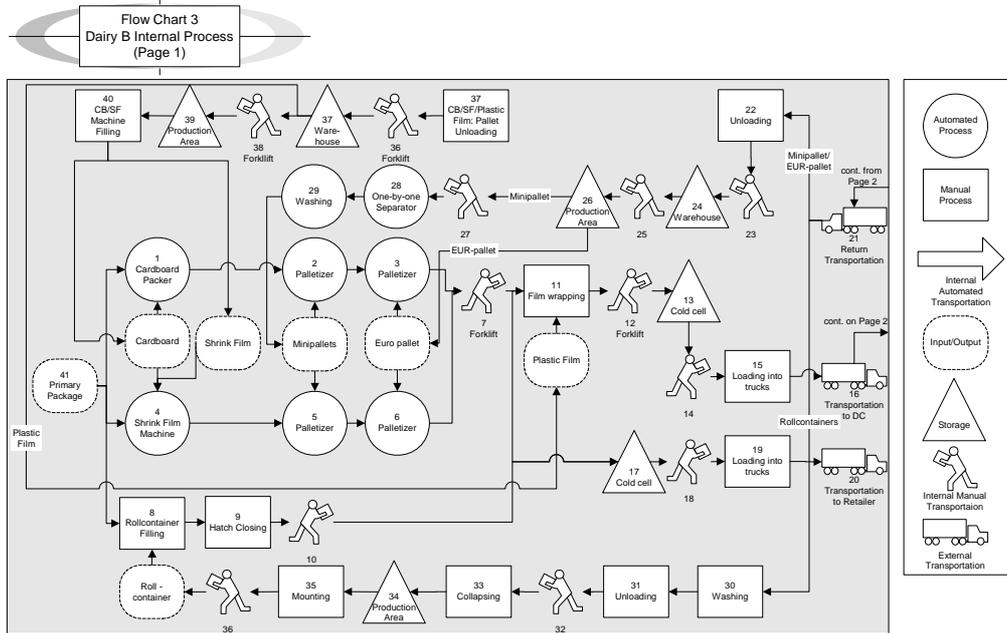
Appendix E – Flowchart



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Appendix F – Results from Packaging Scorecard

Answers: PSc - General Requirements																		
	Client A					Client B					Client C							
	Production Resp.	Marketing Director	Key Account Mgr 1	Key Account Mgr 2	Truck Driver	Average*	ProdMaint.&Serv. Mgr	Production Mgr	Purchasing Mgr	Transport Mgr	Dist. Log. Mgr	Average*	Prod. & Mark. Mgr	Production Resp.	Cold Cell Resp. (DC)	Truck Driver	Average*	
PP		5	4		5	4,5	3	5	5		5	4,5		5	3	5		4,3
1	5	5	4	3	5	4,3	3	5	5	5	5	4,6	5	5	3	3	5	4,0
2	1	1	1	1	5	1,0	2	3	4	2	1	2,4	5	5	4	1	3	3,8
IC		3	3		4	3,0	2	5	5		2	3,5		4	5	3		4,0
1	2	4	4	5	4	3,8	1	5	5	3	3	3,4	5	5	3	3	3	4,0
2	3	4	3	5	3	3,8	1	5	4	3	3	3,2	5	5	2	3	3	3,8
3	3	3	4	5	4	3,8	1	5	4	3	2	3,0	5	5	3	5	3	4,5
4	2	3	2	5	2	3,0	2	3	5	3	1	2,8	5	5	5	5	3	5,0
HE		4	4		5	4,0	3	5				4,0		5	5			5,0
1	1	3	5	5	5	3,5	1	5	3	5	1	3,0	5	5	3	5	5	4,5
2	3	3	5	5	4	4,0	1		3	5	1	2,5	5	5	2	5	5	4,3
3	5	5	5	4	5	4,8	3	5	5	4	3	4,0	5	3	4	3	5	3,8
4	5	5	5	4	5	4,8	4	4	5	4	4	4,2	5	2	4	4	5	3,8
5	3	5	5	4	5	4,3	1		4	5	4	3,5	5	1	4	4	2	3,5
6	4	3	4	3	4	3,5	3		3	3	4	3,3	2	1	2	5	2	2,5
7	5	5	3	4	4	4,3	1		5	3	1	2,5	3	1	2	5	5	2,8
8	5	5	4	5	5	4,8	3	3	5	3	1	3,0	3	3	3	5	3	3,5
WAVE		4	4		5	4,0	3	5				4,0		5	5			5,0
1	5	4	1	5	4	3,8	3	5	3	4	5	4,0	3	5	4	4	5	4,0
2	4		3	3	5	3,3	3	5	3	4	4	3,8	3	5	2	5	5	3,8
RQAS		5	5		4	5,0	3	5			5	4,3		4	5			4,5
1	5	5	5	5	4	5,0	3	5	5	4	4	4,2	5	4	4	5	5	4,5
2	3	3	4	3	4	3,3	3	3	4	4	2	3,2	2	1	4	3	3	2,5
3	4	5	2	4	4	3,8	3	5	5	4	1	3,6	4	5	4	5	5	4,5
M		5	2		5	3,5	1	5	5		3	3,5		5	4	1		3,3
1	2	5	3	5	5	3,8	1	5	4	3	2	3,0	3	5	2	1	3	2,8
2	2	5	3	5	5	3,8	1	3	5	3	2	2,8	3	5	2	1	3	2,8
EI		5	4		5	4,5	3	5	5		5	4,5		5	5			5,0
1	5	5	4	3	5	4,3	1	5	5	5	5	4,2	5	5	4	3	5	4,3
2	5	5	5	5	5	5,0	1	5	5	5	5	4,2	5	5	5	5	5	5,0
3	5	5	4	4	2	4,5	2		5	5	5	4,3	5	2	4	5	5	4,0
4	5	5	5	4	5	4,8	1	5	5	5	5	4,2	5	5	5	5	5	5,0
5	5	5	5	5	5	5,0	2	5	5	5	5	4,4	5	2	5	5	5	4,3
C		5	5		5	5,0	3	5	5		5	4,5		5	5			5,0
1	5	5	3	3	5	4,0	1	5	5	5	5	4,2	5	5	3	3	5	4,0

* based on respondents from the dairy only

Answers: PSc - Current situation

Client A	Cardboard					Rollcontainer			
	Production Resp.	Marketing Director	Key Account Mgr 1	Key Account Mgr 2	Truck Driver	Production Director	Marketing Director	Key Account Mgr1	Key Account Mgr2
PP		5	4		5		5	4	
1	5	3	3	1	5	5	5	4	1
2	1	1	2	3	3	1		1	1
IC		3	3		4		3	1	
1	3	2	3	1	5	5	5	2	2
2	2	2	4	1	4	5	5	1	2
3	2	2	3	4	4	5	5	3	2
4	2	2	3	3	4	5	5	1	2
HE		4	4	3	3		4	4	
1	2	4	5	3	3	2	4	1	3
2	3	4	5	3	4	3	4	2	2
3	3	2	3	3	2	2	4	4	2
4	4	3	5	3	2	5	4	4	3
5	3	2	4	1	2	5	3	4	2
6	2	1	3	2	2	5	3	1	1
7	5	1	4	2	2	5	5	5	2
8	3	1	3	5	4	5	4	3	3
W A W E		4	3		5		4	4	
1	5	4	3	5	5	5	3	1	3
2	5		2	3	5	5	3	3	3
R Q A S		5	4		5		3	5	
1	5	3	3	3	4	3	3	5	3
2	2	2	3	3	2	4	2	1	3
3	5	1	3	2	4	5	1	4	3
M		5	3		5		4	3	
1	4	1	4	2	5	4	4	1	1
2	4	1	4	3	5	4	4	1	1
E I		5	4		5		5	4	
1	2	1	4	3	2	5	4	2	2
2	5	5	4	3	5	5	1	2	3
3	2	3	5	3	1	5	2		3
4	2	1	4	3	3	5	2	5	2
5	5	5	4	5	5		5	2	3
C		5	4		5		5	5	
1	2	1	2	1	3	2	3	3	1

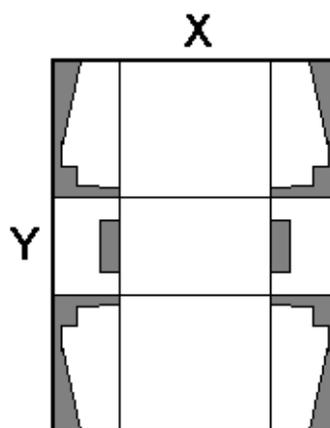
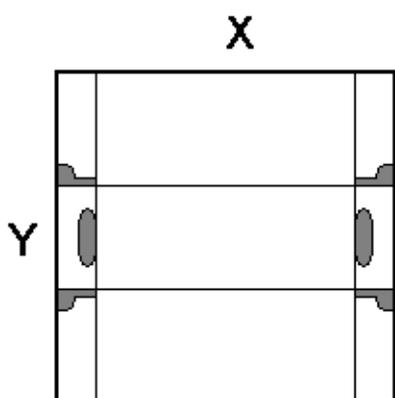
Answers: PSc - Current situation

Client B

	Cardboard					Rollcontainer					Shrink film with cardboard divider			
	ProdMaint.&Serv.Mgr	Production Mgr	Purchasing Mgr	Transport Mgr	Distr. Log. Mgr	Maint & Develop Mgr	Production Mgr	Purchasing Mgr	Transport Mgr	Distr. Log. Mgr	Maint & Develop Mgr	Production Mgr	Purchasing Mgr	Transport Mgr
PP	3		5		5	3	3	5		5	3	5	4	
1	3	2	5	3	2	5	3	4	3	5	3	5	5	3
2	1	2	4	3	1	2	2	5	3	2	2	2	5	3
IC	2	5	4		5	2	4	5		2	2	5	4	
1	3	3	4	3	2	3	3	5	5	4	3	5	4	5
2	3	3	5	3	2	3	3	5	5	5	3	5	4	5
3	3	3	4	3	1	3	3	4	5	5	3	5	5	2
4	3	3	5	3	1	3	3	4	5	1	3	5	5	5
HE	3	5			4	3	2	5		4	3	5	5	
1	3	5	4	3	2	3	3	5	1	3	3	5	5	3
2	3	5	4	3	4	3	3	4	1	3	3	3	5	3
3	3	5	4	2	3	3	2	5	1	2	3	5	5	5
4	2	2	5	2	2	3	2	4	1	5	3	5	4	3
5	1	1	5	5	1	1	2	5	1	5	3	3	4	5
6	3	2	5	3	1	3	5	5	3	5	3	3	5	3
7	1	2	5	3	2	3	3	5	3	5	1	3	5	5
8	3	3	5	2	1	2	3	5	3	2	3	5	5	5
W A W E	3	5	4		4	3	2	5		5	3	5		
1	3	5	4	3	5	3		5	1	1	3	3		5
2	3	2	4	3	5	3		5	3	3	3	3		5
R Q A S	3	5	5		5	3	2	4		5	3	5		
1	3	2	4	5	5	3	3	4	2	5	3	5		3
2	3	2	4	3	1	1		5	3	5	3	3		3
3	3	3	5	3	3	2	1	5	2	2	3	5		5
M	1	5	4	5	4	2	3	5		5	1	5		
1	3	3	4	2	2	1	2	5	3	2	1	5		5
2	3	3	5	2	2	1	2	4	3	2	1	5		5
E I	3	5	4	3	5	3		5		5	3	5		
1	2	3	4	3	5	1	2	4	4	3	2	5		3
2	3		5	3	5	1	3	4	4	5	1	5		3
3	2	3	4	3	4	1	3	5	4	1	2	3		2
4	3	3	5	3	5	1	3	5	4	5	3	3		2
5	3	5	5	3	5	3	3	5	4	5	2	5		3
C	3	5	4		5	3		5		5	3	5		
1		2	4	2	5	1	2	5	5	2	3	2		2

Answers: PSc - Current situation						
Client C		Prod. & Mark. Mgr	Production Resp.	Cold Cell Resp.	Cold Cell Resp. (DC)	Truck Driver
Client C						
PP		5	5	5	3	
1		5	5	3	3	5
2		3	4	4	1	3
IC			5	5		
1		3	4	3	5	1
2		5	5	3	2	2
3		5	4	3	2	3
4		2	4	5	4	3
HE			5	5		
1		5	5	3	1	3
2		5	5	3	1	3
3		5	4	4	5	2
4		5	5	4	5	5
5			5	4	1	2
6		5	5	2	5	2
7		3	2	2	1	2
8		5	5	3	5	3
W A W E			5	5		
1		5	5	4	1	5
2		5	5	3	3	5
R Q A S			4	5		
1		5	4	4	5	3
2		1	5	4	5	3
3		5	5	4	5	5
M			3	4		
1		2	3	3	3	2
2		2	3	3	3	2
E I			3	5		
1		5	1	3	4	3
2		5	4	5	5	3
3		5	5	4	5	3
4		5	2	5	2	2
5		5	1	5	5	3
C			3	5		
1		5	3	3	1	3

Appendix G – Energy Consumption Calculations



Cardboard Tray Dairy A

Nbr of TTs:	8 pcs
CB height (H):	0,002 m
Density:	222 kg/m ³
Energy cons:	14,5 MJ/kg

$X=308+154=$	0,462 m
$y=154+2*237=$	0,628 m

Area= $X*Y=$	0,290 m ²
Area/TT= $0,036$	m ²

$V=Area*H=$	0,580 dm ³
$V/TT=$	0,073 dm ³

Mass:	0,124 kg
Mass/TT:	0,016 kg

Energy Cons:	1,798 MJ
Energy Cons/TT:	0,225 MJ

Cardboard Tray Dairy B

Nbr of TTs:	12 pcs
CB height (H):	0,002 m
Density:	245,9 kg/m ³
Energy cons:	14,5 MJ/kg

$X=458+2*84=$	0,626 m
$y=237*2+152=$	0,626 m

Area= $X*Y=$	0,392 m ²
Area/TT= $0,033$	m ²

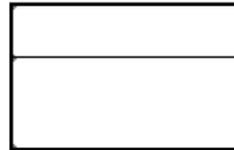
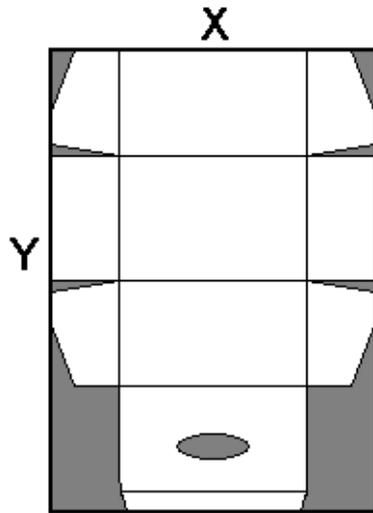
$V=Area*H=$	0,784 dm ³
$V/TT=$	0,065 dm ³

Mass:	0,172 kg
Mass/TT:	0,014 kg

Energy Cons:	2,494 MJ
Energy Cons/TT:	0,208 MJ

Note: Figures are not according to scale.

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Cardboard WA Box Dairy C

Nbr of TTs: 10 pcs
 CB height (H): 0,002 m
 Density: 271,6 kg/m³
 Energy cons: 14,5 MJ/kg

$X=383+156=$ 0,539 m

$y=2*237+2*156+44=$ 0,83 m

$Area=X*Y=$ 0,447 m²

$Area/TT=$ 0,045 m²

$V=Area*H=$ 0,895 dm³

$V/TT=$ 0,089 dm³

Mass: 0,186 kg

Mass/TT: 0,019 kg

Energy Cons: 2,697 MJ

Energy Cons/TT: 0,270 MJ

Shrink Film Solution Dairy B

Nbr of TTs: 12 pcs
 CB height (H): 0,004 m
 CB Density: 166,8 kg/m³
 Energy cons CB: 14,5 MJ/kg
 Energy cons Plastic Film: 34,9 MJ/kg

$Area=(450*(154+239))=$ 0,177 m²

$Area/TT=$ 0,015 m²

$V=Area*H=$ 0,707 dm³

$V/TT=$ 0,059 dm³

Mass CB: 0,118 kg

Mass Plastic film: 0,03 kg

Total mass: 0,148 kg

Mass CB/TT: 0,010 kg

Mass PF/TT: 0,003 kg

Energy cons CB: 1,711 MJ

Energy cons Plastic Film: 1,047 MJ

Total Energy Cons: 2,758 MJ

Energy cons/TT: 0,230 MJ

Note: Figures are not according to scale.

Appendix H – General Req. Average Scores

Ranking for each criterion based on total average general requirements scores for the three dairies, excluding the general area criteria.

Pos.	Criteria	Area	Score
1	The secondary package material should be recyclable	Environmental Issues	4,80
2	The secondary package should consist of minimal amount of packaging material	Environmental Issues	4,58
3	The secondary package should be produced with minimal energy consumption	Environmental Issues	4,48
4	The secondary package should not consist of environmentally harmful materials	Environmental Issues	4,40
4	The secondary package should be designed to minimize waste	Environmental Issues	4,40
6	The secondary package should be ergonomically designed	Handling Efficiency	4,25
7	The secondary package should reduce damage of the product	Product Protection	4,20
8	The secondary package should be easy to grab and stack	Handling Efficiency	4,17
9	The secondary package should be stable	Handling Efficiency	4,15
10	The secondary package should be cheap	Cost	4,13
11	The secondary package should prevent goods from being misplaced	Information Carrier	3,92
12	The secondary packages should be easy to group into one unit for handling and transportation	Right Quantity and Size	3,90
13	The secondary package should not be stronger than necessary	Weight and Volume Efficiency	3,88
14	The secondary package should reinforce the product image	Marketing	3,85
15	The secondary package should not enclose unnecessary amount of air	Weight and Volume Efficiency	3,83
16	The secondary package should inform other actors in the supply chain	Information Carrier	3,82
17	The secondary package should support use of multipacks	Right Quantity and Size	3,65
18	The secondary package should facilitate identification of the product	Information Carrier	3,63

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19	The secondary package should inform about contents	Information Carrier	3,60
20	The secondary package should be easy to fill and seal	Handling Efficiency	3,58
21	The secondary package should fit into pallets and store shelves	Right Quantity and Size	3,56
22	The secondary package should be easy to open, empty, close, and reseal	Handling Efficiency	3,42
22	The secondary package should be easy to clean	Handling Efficiency	3,42
22	The secondary package should minimize handling	Handling Efficiency	3,42
25	The secondary package should be designed to fit different products (standardization)	Handling Efficiency	3,17
25	The secondary package should attract attention	Marketing	3,17
27	The secondary package should reduce theft and manipulation of product	Product Protection	2,47

Appendix I – Current Situation Average Scores

		Cardboard Average A - B	Cardboard C	Rollcontainer Average A - B	Shrink Film B
Product Protection	<i>Gen</i>	4,42	4,50	4,25	4,00
	<i>1</i>	3,00	4,00	3,88	4,00
	<i>2</i>	1,98	3,00	1,90	3,00
Information Carrier	<i>Gen</i>	3,50	5,00	2,63	3,67
	<i>1</i>	2,63	3,75	3,75	4,25
	<i>2</i>	2,73	3,75	3,73	4,25
	<i>3</i>	2,78	3,50	3,88	3,75
	<i>4</i>	2,75	3,75	3,23	4,50
Handling Efficiency	<i>Gen</i>	3,83	5,00	3,75	4,33
	<i>1</i>	3,45	3,50	2,75	4,00
	<i>2</i>	3,78	3,50	2,78	3,50
	<i>3</i>	3,08	4,50	2,80	4,50
	<i>4</i>	3,18	4,75	3,50	3,75
	<i>5</i>	2,55	3,33	3,15	3,75
	<i>6</i>	2,40	4,25	3,35	3,50
	<i>7</i>	2,80	2,00	4,03	3,50
Weight and Volume Efficiency	<i>Gen</i>	3,75	5,00	3,88	4,00
	<i>1</i>	4,13	3,75	2,75	3,67
	<i>2</i>	3,37	4,00	3,50	3,67
Right Quantity and Size	<i>Gen</i>	4,50	4,50	3,75	4,00
	<i>1</i>	3,65	4,50	3,45	3,67
	<i>2</i>	2,55	3,75	3,00	3,00
	<i>3</i>	3,08	4,75	2,83	4,33
Marketing	<i>Gen</i>	3,90	3,50	3,63	3,00
	<i>1</i>	2,78	2,75	2,55	3,67
	<i>2</i>	3,00	2,75	2,45	3,67
Environmental Issues	<i>Gen</i>	4,25	4,00	4,42	4,00
	<i>1</i>	2,95	3,25	3,03	3,33
	<i>2</i>	4,13	4,75	3,08	3,00
	<i>3</i>	3,23	4,75	3,07	2,33
	<i>4</i>	3,15	3,50	3,55	2,67
Cost	<i>Gen</i>	4,38	4,00	4,67	4,00
	<i>1</i>	2,38	3,00	2,63	2,33

Appendix J – Objective Current Situation Scores

Objective Current Situation Scores set by the authors.

	<i>CB Tray</i>	<i>CB WA Box</i>	<i>Shrink Film</i>	<i>Rollcontainer</i>
Product Protection	3	5	3	5
The sec. package reduces damage of the product	3	4	3	5
The sec. package reduces theft and manipulation of product	2	4	4	2
Information Carrier	4	4	4	4
The sec. package facilitates identification of the product	4	3	5	5
The sec. package informs other actors in the supply chain	4	4	3	3
The sec. package prevents goods from being misplaced	4	4	4	5
The sec. package informs about contents	4	4	3	3
Handling Efficiency	4	4	4	4
The sec. package is easy to fill and seal	5	4	3	2
The sec. package is easy to open, empty, close, and reseal	5	4	3	3
The sec. package is easy to grab and stack	4	4	4	N/A
The sec. package is stable	3	4	3	5
The sec. package is easy to clean	2	2	4	4
The sec. package is designed to fit dif prod (standardiz)	3	3	3	5
The sec package minimizes handling activities	5	4	4	3
The sec. package is ergonomically designed	4	3	3	4
Weight and Volume Efficiency	3	4	4	2
The sec package does not enclose unnecessary amount of air	4	4	4	2
The sec. package is not stronger than necessary	4	4	4	N/A
Right Quantity and Size	4	5	4	3
The sec package are easy to group into one unit for hand and trans	3	5	3	2
The sec. package supports use of multipacks	4	3	4	3
The sec. package fits into pallets and store shelves	3	5	4	N/A
Marketing	4	4	3	2
The sec. package attracts attention	4	4	3	2
The sec. package reinforces the product image	4	5	3	3
Environmental Issues	4	4	4	3
The sec. package is produced with minimal energy consumption	4	3	5	N/A
The sec. package does not consist of environmentally harmful mat	5	5	4	3
The sec. package consists of minimal amount of packaging mat	4	3	5	N/A
The sec. package is designed to minimize waste	4	3	4	N/A
The sec. package material is recyclable	5	5	4	N/A

Appendix K – CPEM General Req. Questionnaire

CPEM - General Requirements					
<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> Instructions Grade each criterion from 1 (not important) to 5 (very important) depending on how important you consider the criterion to be. It is important that you only consider the secondary package during the scoring. </div>	Not important	Somewhat important	Important	Very important	Extremely important
	1	2	3	4	5
Production Protection					
Protection of the TT top	<input type="checkbox"/>				
Protection against humidity and water	<input type="checkbox"/>				
Protection against rough treatment	<input type="checkbox"/>				
Avoid exposure of condensation to the TT	<input type="checkbox"/>				
Stability of the TTs in full secondary packages	<input type="checkbox"/>				
Stability of the TTs in half full packages	<input type="checkbox"/>				
Temperature resistance	<input type="checkbox"/>				
Information Carrier					
Printing ability	<input type="checkbox"/>				
Display of contents	<input type="checkbox"/>				
Handling Efficiency					
Simplicity to automatically fill and seal	<input type="checkbox"/>				
Simplicity to pick TTs in the distribution	<input type="checkbox"/>				
Simplicity to grab and carry	<input type="checkbox"/>				
Simplicity to stack	<input type="checkbox"/>				
Simplicity to open and empty	<input type="checkbox"/>				
Minimization of handling activities	<input type="checkbox"/>				
Weight and Volume Efficiency					
Volume efficiency of filled packages	<input type="checkbox"/>				
Minimization of storage space of empty packages	<input type="checkbox"/>				
Right Quantity and Size					
Adaption to EUR-pallets	<input type="checkbox"/>				
Marketing					
Exposure of company logo	<input type="checkbox"/>				
Environmental Issues					
Recycling ability	<input type="checkbox"/>				
Minimization of waste volume	<input type="checkbox"/>				
Other					
Adaption for manual filling	<input type="checkbox"/>				
Simplicity in automatic production	<input type="checkbox"/>				

Appendix L – Overall Satisfaction Calculations

The calculations leading up to the result in the packaging scorecard are extensive and therefore left out. Instead, the repetitive methods of calculation are explained and illustrated by short examples below.

Calculation of a respondent's overall satisfaction

1. List the answers to the general requirements as well as the answers to the current situation for every secondary package affected by the respondent.
2. Form a new column with normalized general requirements for every respondent, i.e. divide every “general requirement”-answer with the sum of all “general requirement”-answers from the same respondent.
3. Form a new score column for every secondary package and calculate how well they suit the respondent's general requirements. This is done by multiplying the normalized “general requirement”-column with the corresponding score for every current solution.
4. Calculate the respondent's total score for every secondary package by adding all the rows in the score column. Transform the score into a percentage by simply dividing the result by the maximum score 5.

<i>Respondent</i>	<i>General Req</i>	<i>Normalized</i>	<i>Cardboard</i>	<i>Score</i>
A	5	0.625 (5/8)	3	1.875 (0.625*3)
	3	0.375 (3/8)	4	1.5 (0.375*4)
Sum:	8	1	Total score:	3.375 (1.875+1.5)
				68% (3.375/5)

In some cases, the respondents have failed to fill in the packaging scorecard completely. An empty box among the general requirements will result in a normalized weight of zero. Hence, that particular criterion will not contribute to the final score. However, when a current situation field is left blank, the normalized weighting for the general requirements has been adjusted to fit the criteria answered by the respondent.

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Calculation of a dairy's total score for a secondary package

For every dairy, choose a secondary package to evaluate.

1. List the general requirement (GR) scores from all respondents at the dairy.
2. Calculate the average GR score by dividing the horizontal sum of all scores by the number of respondents that has answered the question.
3. Normalize the total average GR scores.
4. List the scores regarding the current solution (CS) from the dairy respondents.
5. Calculate the total average CS score by dividing the total score for every criterion by the number of answers.
6. Form a score column where the normalized average GR score is multiplied by the total average CS score.
7. Calculate the dairy's total score for the secondary package by adding all the rows in the score column. Transform the score into a percentage by simply dividing the result with the maximum score 5.

<i>Criteria</i>	<i>Scores (A)</i>	<i>Scores (B)</i>	Average	<i>Norm Average</i>
1	-	5	5	0.625 (5/8)
2	2	4	3	0.375 (3/8)
		Sum:	8	1

<i>Criteria</i>	<i>Current Sol. (A)</i>	<i>Current Sol. (B)</i>	<i>Average</i>	<i>Score</i>
1	5	3	4	2.5 (0.625*4)
2	3	-	3	1.125 (0.375*3)
			Total score:	3.625 (2.5+1.125)
				72.5 % (3.625/5)

Different respondents will probably have different standards of measure for their answers. The adding of the relative weighting of the respondents eliminates this source of error regarding the general requirements.