

Control Process for secondary packaging

– A quality verification of corrugated cardboard for distribution of liquid food in developing countries

Lisa Berggren & Mattias Flink

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Master Thesis, Technology Management – No. 207/2010
ISSN 1651-0100
ISRN LUTVDG/TVTM2010/5207/SE
Printed in Sweden
Wallin & Dalholm AB
Lund 2010

Control Process for secondary packaging

Quality is not an act. It is a habit.

Aristotle 384BC-322BC, Greek philosopher and scientist, student of Plato and teacher of Alexander the Great.

Acknowledgements

Lund 2010-05-30

First and foremost, we would like to thank our three supervisors, Annika Olsson, Ulf Paulsson, and Claes Wallin-Klevås, for their valuable guidance and advice throughout the working process, and providing us with essential information. They have been contributing and inspiring us to the work presented in this Master Thesis, giving us feedback and support when needed.

Also, special thanks go to Henry Malmqvist for his effort with illustrating pictures, and to Anne Vien, for her advice and correction of the English language.

Without the people mentioned above, we would have had major problems with completing this Master Thesis.

Lisa Berggren and Mattias Flink

Abstract

- Title:** Control Process for secondary packaging
– A quality verification of corrugated cardboard for distribution of liquid food in developing countries
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- Supervisors:** Annika Olsson, Ph.D., Associate Professor, ETP, Packaging Logistics,
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- Claes Wallin-Klevås, Development Engineer at Carton Economy,
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- Problem discussion:** In the past three decades, food packaging technology has undergone rapid change and the interest for packaging performance has increased. In developing countries, the main focus is to drive down the prices, resulting in primary packaging that often requires a greater need for a stronger secondary packaging than other countries. Yet at the same time, it is seldom that the primary and secondary packaging come from the same supplier. Since the suppliers of secondary packaging in most cases are in the same country as where the product is packed, quality awareness is often less since it is a developing country. Moreover, leaks have been found along the distribution way, and a need to ensure the quality of secondary packages is requested.
- Purpose:** To contribute to knowledge within corrugated cardboard and processes to control the secondary packaging in developing countries. The aim is to develop a process to verify quality and performance of the incoming boxes of corrugated cardboard for dairies and other distributors of liquid food. In addition, this is implemented by an actor in a business relationship formed by two different suppliers.

Control Process for secondary packaging

Objectives

- Identify critical factors needed to create a control process that will verify the initial performance of the secondary package of corrugated cardboard while arriving to the customers in developing countries, i.e. the dairies.
- Create a control process for the incoming corrugated cardboard.
- Look into the triad relationship between primary package supplier, secondary package supplier, and the customer, to create an implementation plan on how the control process shall be integrated within the customer's daily work.

Method:

The approach consisted in a presentation of the current situation of secondary package and its role in developing countries. The authors also collected deeper information, primarily through interviews, both internally and externally and through literature and article collections that has been narrowed down and applied to the case study of Tetra Pak. The authors have mainly used a system approach together with influences from the actor-based perspective, using the hermeneutic theory to describe the experienced situation.

Conclusion:

In many developing countries the cost perspective together with product safety is the only essential drivers. Although quality could be seen as a given driver, many of the customers looking into the whole supply chain still have problems working with quality practically. The outcome of this Master Thesis shall therefore be seen as a tool to help customers to improve their business and together work for a competitive supply chain by eliminating package deformation caused by fragile secondary packages. Critical factors were identified and an implementation plan for the process was established in the work.

Keyword:

Secondary package, corrugated cardboard, packaging performance, control process, developing countries, triad business relationship, implementation.

Sammanfattning

- Titel:** Control Process for secondary packaging
– A quality verification of corrugated cardboard for distribution of liquid food in developing countries
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- Handledare:** Annika Olsson, Ph.D., Docent, ETP, Förpackningslogistik, Lunds Tekniska högskola
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- Claes Wallin-Klevås, Utvecklingsingenjör, Carton Economy, Packaging Solutions, Tetra Pak i Lund
- Problemställning:** De senaste tre årtionden har förpackningsbranschen genomgått en snabb förändring, och intresset för förpackningsprestanda har ökat. I utvecklingsländerna handlar det mycket om att pressa priserna, varav primärförpackningen ofta kräver ett större behov av en stark sekundärförpackning än övriga länder, samtidigt som de två olika förpackningarna sällan har samma leverantör. Då leverantören av sekundärförpackning nästan alltid befinner sig i samma land där produkten packas, är ofta kvalitetsmedvetenheten mindre då det är ett u-land. Samtidigt har läckage återfunnits längs distributionsvägen, och ett behov av att säkerställa kvaliteten på sekundärförpackningarna finns.
- Syfte:** Att bidra till kunskapen inom wellpapp och processer för att kontrollera sekundärförpackningar i utvecklingsländer. Syftet är utveckla en process för att kontrollera kvalitet och prestanda på den inkommande distributionslådan av wellpapp för mejerier och liknande distributörer av flytande näring. Dessutom ska detta implementeras hos en aktör i en affärsrelation bestående av två olika leverantörer.

Control Process for secondary packaging

Mål

- Identifiera kritiska faktorer för att skapa en kontrollprocess som kommer att kontrollera den ursprungliga prestandan av sekundärförpackningen av wellpapp när den anländer till kunderna i utvecklingsländerna, d.v.s. mejerierna.
- Skapa en kontrollprocess för att kontrollera den inkommande wellpappen.
- Se över den triangulära relationen mellan primärförpackningsleverantör, sekundärförpackningsleverantör och kunden, för att skapa en genomförandeplan för hur kontrollen skall integreras i kundens dagliga arbete.

Metod:

Tillvägagångssättet har bestått i en presentation av den rådande situationen vad gäller sekundärförpackningar och deras roll i utvecklingsländer. Författarna har vidare samlat djupare information, främst via kvalitativa intervjuer, både internt och externt och via litteratur- och artikelinsamling som sedan smalnats av för att appliceras på en fallstudie av Tetra Pak. Författarna har här främst använt sig av ett systemteoretiskt perspektiv tillsammans med influenser av det aktörsbaserade synsättet, och det hermeneutiska synsättet för att beskriva den upplevda erfarenheten.

Slutsatser:

I många utvecklingsländer är kostnadsperspektivet tillsammans med produktsäkerhet de enda drivande faktorerna. Även om kvalitet kan ses som en drivande faktor har många av de kunder som vill titta på hela leveranskedjan fortfarande problem att arbeta med kvalitet i praktiken. Resultatet av detta examensarbete skall därför ses som ett verktyg för att hjälpa kunderna att förbättra sin verksamhet och tillsammans arbeta för en konkurrenskraftig distributionskedja genom att minska förpackningsdeformationen orsakad av undermålig kvalitet på sekundärförpackningen. Kritiska faktorer identifierades och en genomförandeplan för processen fastställdes i arbetet.

Nyckelord:

Sekundärförpackning, wellpapp, förpackningsprestanda, kontrollprocess, utvecklingsländer, triangulär affärsrelation, implementering.

Glossary

Product	Liquid food, in this case milk
Customer	The dairy
End-customer	Retailer of milk
Market company	The local sales office working with support and selling towards customers within the organization
Primary package	The package that supports and protects the product
Secondary package	The package that supports and protects the primary package
Tertiary package	The surrounding support to the secondary packages, which can be a large package or a pallet
Packaging system	The system consists out of the primary package, secondary package, and the tertiary package or pallet
Palletizing	The procedure to stack the secondary packages onto the pallet and wrap them in plastic film
Packing pattern	The order in how the primary packages are put in the secondary package
Blanks	Sheets of corrugated cardboard: the arriving secondary package not yet folded as a box
Developing countries	The lower-income countries of the world, most of which are in Africa, Asia, and Latin America

Table of Contents

1	INTRODUCTION.....	13
1.1	BACKGROUND	13
1.1.1	<i>The packaging system</i>	14
1.1.2	<i>Developing countries</i>	14
1.2	PROBLEM DISCUSSION.....	16
1.2.1	<i>The case study problem discussion</i>	17
1.3	OBJECTIVE	19
1.4	DELIMITATION AND FOCUS.....	20
1.5	EXPECTED RESULTS	21
1.6	TARGET AUDIENCE.....	21
1.7	DISPOSITION	22
2	SCIENTIFIC METHOD	23
2.1	RESEARCH APPROACH	24
2.1.1	<i>Analytical approach</i>	24
2.1.2	<i>System approach</i>	24
2.1.3	<i>Actor-based approach</i>	25
2.1.4	<i>Interpretation methods</i>	25
2.1.5	<i>The research approach of this Master Thesis</i>	25
2.2	THEORETICAL APPROACH.....	26
2.2.1	<i>The theoretical approach of this Master Thesis</i>	27
2.3	RESEARCH STRATEGY	27
2.3.1	<i>Qualitative method</i>	27
2.3.2	<i>Quantitative method</i>	28
2.3.3	<i>Case Studies</i>	28
2.3.4	<i>Method Combination</i>	28
2.3.5	<i>The research strategy of this Master Thesis</i>	29
2.4	DATA COLLECTION.....	29
2.4.1	<i>Primary sources</i>	29
2.4.2	<i>Secondary sources</i>	29
2.4.3	<i>Interviews</i>	30
2.4.4	<i>The data collection of this Master Thesis</i>	30
2.5	WORKING PROCESS	31
2.5.1	<i>Phase 0 – Pre study</i>	32
2.5.2	<i>Phase 1 - Problem Identification</i>	32
2.5.3	<i>Phase 2 – Empirics and literature study</i>	33
2.5.4	<i>Phase 3 – Development</i>	33
2.5.5	<i>Phase 4 - Verification</i>	34
2.6	CRITICISM OF SOURCES.....	34
2.6.1	<i>Validity</i>	34
2.6.2	<i>Reliability</i>	34
2.6.3	<i>Objectivity</i>	35
2.6.4	<i>Generalization</i>	35
2.6.5	<i>Validity and generalization of this Master Thesis</i>	35
2.7	METHOD ASSESSMENT	36

Control Process for secondary packaging

3	THEORETICAL FRAMEWORK.....	37
3.1	CHOICE OF THEORY.....	37
3.2	SUPPLY CHAIN MANAGEMENT.....	37
3.2.1	<i>System thinking within the Supply chain</i>	40
3.2.2	<i>Process definition</i>	40
3.2.3	<i>Business relationship</i>	43
3.3	PACKAGING PERFORMANCE	47
3.3.1	<i>The packaging system</i>	47
3.3.2	<i>Regular Slotted Container</i>	48
3.3.3	<i>Corrugated cardboard</i>	48
3.3.4	<i>Test methods</i>	51
3.3.5	<i>Packaging choice</i>	57
3.3.6	<i>Sampling</i>	58
3.4	QUALITY.....	59
3.4.1	<i>Process control</i>	61
3.4.2	<i>Quality system</i>	64
3.4.3	<i>Cost of poor Quality</i>	68
3.5	ARE WESTERN BUSINESS MANAGEMENT TOOLS APPLICABLE IN DEVELOPING COUNTRIES?	69
3.6	ANALYSIS METHODS	70
3.6.1	<i>Gap analysis</i>	70
3.6.2	<i>Root cause analysis techniques</i>	71
4	THE SECONDARY PACKAGE FOR BEVERAGE INDUSTRY	73
4.1	INTRODUCTION TO THE BEVERAGE INDUSTRY	73
4.2	PACKAGING PERFORMANCE IN DEVELOPING COUNTRIES.....	75
4.2.1	<i>Vietnam</i>	76
4.2.2	<i>China</i>	77
4.2.3	<i>Kenya</i>	77
4.2.4	<i>Egypt</i>	78
4.2.5	<i>Standards in developing countries</i>	78
4.3	SECONDARY PACKAGING SUPPLY CHAIN	79
4.3.1	<i>Customer</i>	79
4.3.2	<i>Primary packaging supplier</i>	80
4.3.3	<i>Secondary packaging supplier of corrugated cardboard</i>	80
4.3.4	<i>Transport & Distribution</i>	82
4.3.5	<i>Retailers & Consumers</i>	82
4.4	BUSINESS ENVIRONMENT IN DEVELOPING COUNTRIES	83
4.4.1	<i>The economy</i>	83
4.4.2	<i>The average knowledge level</i>	84
5	TETRA PAK	85
5.1	COMPANY PRESENTATION.....	85
5.1.1	<i>Background</i>	85
5.1.2	<i>Carton economy</i>	86
5.1.3	<i>Carton economy portfolio</i>	86
5.2	THE SECONDARY PACKAGE IMPORTANCE FOR TETRA PAK'S PACKAGES	87
5.2.1	<i>Tetra Pak's specifications and recommendations</i>	87
5.2.2	<i>McKee model</i>	87

Control Process for secondary packaging

5.3	BUSINESS RELATIONSHIPS WITHIN THE TETRA PAK BUSINESS	88
5.3.1	<i>The relationship between Tetra Pak and the dairy</i>	88
5.3.2	<i>The relation between the dairy and their supplier for corrugated cardboard</i>	89
5.4	CURRENT SITUATION WITHIN TETRA PAK'S CUSTOMER	90
5.5	COST OF WASTE	93
5.5.1	<i>Cost units</i>	93
5.6	CALCULATIONS AT TETRA PAK	94
5.7	INDIRECT SAVINGS	94
6	ANALYSIS	95
6.1	MANAGING THE SUPPLY CHAIN MANAGEMENT.....	95
6.1.1	<i>Customer knowledge within SCM</i>	95
6.2	PROCESS MAPPING OF THE MAIN PROCESSES AT CUSTOMER SITE.....	96
6.2.1	<i>Process identification</i>	97
6.2.2	<i>Machine</i>	98
6.2.3	<i>Method</i>	98
6.2.4	<i>Man Power</i>	98
6.2.5	<i>Materials</i>	98
6.2.6	<i>Measurement</i>	98
6.2.7	<i>Mother Nature</i>	99
6.2.8	<i>The identified gaps</i>	99
6.2.9	<i>Critical factors for the control process</i>	100
6.3	DEVELOPMENT OF THE CONTROL PROCESS	104
6.4	IMPLEMENTATION OF CONTROL PROCESS	105
6.4.2	<i>Implementation and problem handling model</i>	110
7	CONCLUSIONS & RECOMMENDATIONS	111
7.1	RESULTS.....	111
7.2	DISCUSSION	112
7.2.1	<i>Empirical findings</i>	112
7.2.2	<i>Theoretical findings</i>	113
7.3	CONCLUSIONS	113
7.4	RECOMMENDATIONS FOR FURTHER STUDIES.....	114
8	REFERENCES.....	115
8.1	BOOKS.....	115
8.2	ARTICLES	117
8.3	ELECTRONIC.....	122
8.4	INSPIRATIONAL LITERATURE FOR THE PRE STUDY	123
8.5	INTERNAL COMPANY DOCUMENTS	126
8.6	INTERVIEWS	126
9	APPENDIX	127
9.1	APPENDIX 1 - QUESTIONS USED DURING INTERVIEWS AT TETRA PAK	127
9.2	APPENDIX 2 - QUESTIONS USED DURING INTERVIEWS AT SCA.....	129
9.3	APPENDIX 3 – CONTROL PROCESS.....	131
9.4	APPENDIX 4– CHECKLIST CONTROL PROCESS.....	135
9.5	APPENDIX 5 - QUICK GUIDE	136

1 Introduction

This chapter will describe essential information about the background to this Master Thesis, but also give important prerequisites for the reader. Furthermore, objectives, delimitations and target groups are presented.

1.1 Background

Packaging logistics is a very important issue for companies all over the world, no matter what line of business they are working in. They need to understand how different parts of the supply chain interact to manage the expectations of the packaging performance.¹ The main objective in all food and beverage distribution is to transport the product as cost-effectively as possible, and at the same time retain the maximum quality of the product.²

The changes in global patterns of food production, international trade, and public expectations for health protection have created an increasingly demanding environment in which our food system operates³. The quest for constant cost reduction within the industry may though not risk the safety of the food. Today, the responsibility for food safety is shared by everyone involved with the food, from production to consumption and ensuring food safety is a fundamental public health concern⁴. According to World Health Organization (WHO), food borne and waterborne diarrheal diseases together kill about 2.2 million people annually⁵. In order to maintain consumer confidence in food supply, in both domestic and international markets, a significant challenge is to pursue a political environment that promotes economic development.⁶

With today's advanced distribution system, all kinds of products are available in most parts of the world. This would not have been possible without effective and functional packaging engineering knowledge.⁷ Even though distribution of packages occurs all over the world, the level of distribution system and packaging technology differs widely from one country to another. The level of packaging and distribution in a country is strongly dependent on its degree of industrialization. In a simple agricultural economy, only minimal or even no packaging is required for food consumed more or less locally. However, urbanized societies have a stronger reliance on distribution systems, to supply pre-packed food on a national scale in the quantities and qualities needed.⁸ With a growing urbanization in developing countries, they are now also facing challenges within the area of distribution and packaging.

In cases where the secondary package only plays a role in providing a solution to secure logistical movement, storage and protection of the primary package, it is mostly seen as an irritating additional cost. This is still very common in developing countries compared to more

¹ Jönson, G., 2005

² Tetra Pak web page, 2010-01-29

³ World Health Organization, 2006, Food and Agriculture Organization of the United Nations

⁴ The Food and Agriculture Organization of the United Nations web page, 2010-03-02

⁵ World Health Organization web page, 2010-03-02

⁶ World Health Organization, 2006, Food and Agriculture Organization of the United Nations

⁷ International Trade center, 1998, Africa Adapting Packaging to Meet Market

⁸ International Trade center, , The role of packaging in the distribution system

Control Process for secondary packaging

developed countries where the secondary package is also used for advertising, building brand to create a corporate identity for bringing a product to market.⁹

In the cost-conscious supply chain it can be difficult to motivate investments in secondary packaging, since it appears to add no extra value to the product. In the majority of purchases, the consumer would neither know that secondary packaging has been used nor, therefore, appreciate the protective role it has played to get the product safely to the retailer.¹⁰ Today many companies try to minimize or even get rid of the secondary package to reduce cost. This on the other hand, requires a strong developed distribution system and a rigid primary packaging so that it can reach the consumer in good condition.¹¹

The most common material used in secondary packaging for beverages worldwide is corrugated cardboard¹², but plastic film, carton board with laminates, and plastic or paper moulded containers are also used. In the decision making of secondary packaging one must always ensure that cost considerations do not outweigh the ability of the package to fulfill its function¹³. Due to the price, supply, and rigidity of corrugated board, it is mainly used in developing countries as secondary packaging material for beverages.¹⁴

1.1.1 The packaging system

A package is usually used with the purpose to protect, preserve, and communicate the product. But the purpose with the packaging is not only to protect the product from external influences but also to protect the environment from the product itself. The packaging that is in direct contact with the product is called primary package. To further protect and provide easy handling, the primary packages are stacked into another bigger package called secondary package. This package is often to be exposed to most of the influences throughout the distribution. To facilitate the distribution, several secondary packages are assembled onto a pallet. The pallet holding the primary and secondary packages is defined as a tertiary packaging. The whole assembly of all these packages is called a packaging system. The system is shown in Figure 1¹⁵.

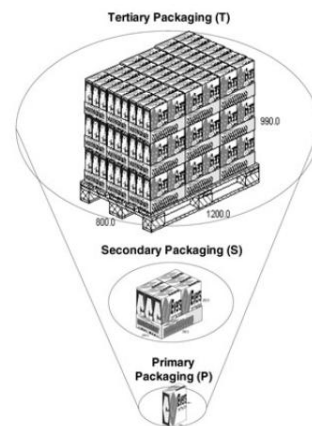


Figure 1 - The packaging system.

1.1.2 Developing countries

A huge difference between developed and developing countries is the environment where the package is used. Most developing countries lie in tropical or sub-tropical zones, and thus climate, especially heat and humidity, is an important secondary influence on packaging

⁹ Giles, G., 1999

¹⁰ Giles, G. 1999

¹¹ Giles, G. 1999

¹² SCA presentation, 2010-03-18, Mariestad

¹³ Giles, G. 1999

¹⁴ Interview Package Engineer B, Tetra Pak, 2010-02-18

¹⁵ Hellström, D. and Saghir, M. 2007

Control Process for secondary packaging

parameters.¹⁶ This should be considered in the development of packaging specifications.¹⁷ Different packaging performance criteria are therefore needed in different geographical areas and for the different types of packages and packaging systems.¹⁸ The importance of this environmental information cannot be emphasized enough. This information is the basis for packaging requirements and if not developed with the right conditions, the package will fail in distribution even though the design goals were met.

Still today, many countries in Africa have controlled economies, and there may thus be strict controls on imports of packaging and its raw material. This often results in materials being substituted, often of lower quality. As a consequence, the packaging performance worsens and the cost effectiveness decreases.¹⁹

Especially in Africa, but also in other developing countries, the equipment may be out-dated machineries with inadequate capacity and not designed to process more modern materials. This also obstructs the availability and range of materials supplied to the cardboard box supplier. The supply of good material gets even more critical because of the limitation of mechanical handling in the supply chain in developing countries. This fact contributes to harsher environmental exposure of the packaging system, risking both health and safety of the packaging and its content.²⁰

In many developing countries, the price is a very important issue and a key factor for decision making of packaging.²¹ In Africa, where the majority of the population lives at minimal income levels, standards of packaging convenience and appearance may be sacrificed to reduce cost. This usually brings other problems along the way. Not prioritizing quality often results in package system deformations in the distribution chain in one way or another.²²

According to research made by both Tetra Pak²³ and Lansmont²⁴, package deformations may occur from any type of event, but are in most cases received during handling operations. Of course not all packages are handled the same way, even when carried or transported over the same route. This strengthens that a certain inherent variability with the manner in which packages are handled exists, but could also imply that the package performance of the secondary package could be of varying quality.

Environmental exposure of the packaging system is therefore a challenge in both developed and developing countries. However, in developed countries there are different computerized models for calculating different kinds of stress, stiffness and other hazards on the package both as individual units and as pallet or mixed loads.²⁵

Since the way of distribution in developing countries are often simpler, the secondary package becomes even more important for the primary packages. The secondary and

¹⁶ International Trade center, 1998, Africa Adapting Packaging to Meet Market

¹⁷ Giles, G., 1999

¹⁸ International Trade center, 1998, Africa Adapting Packaging to Meet Market

¹⁹ International Trade center, 1998, Africa Adapting Packaging to Meet Market

²⁰ International Trade center, 1998, Africa Adapting Packaging to Meet Market

²¹ Interview Package Engineer B, Tetra Pak, 2010-02-18

²² International Trade center, 1998, Africa Adapting Packaging to Meet Market

²³ Interview Package Engineer B, Tetra Pak, 2010-02-18

²⁴ Lansmont Corporation web page, 2010-03-02

²⁵ Giles, G., 1999

Control Process for secondary packaging

primary packages are often transported by trucks, cars, and on bicycles on bumpy gravel roads. In less industrialized countries, the secondary packages may be manually loaded and unloaded several times in one day, being thrown in the air from person to person by local workers, which demand certain strength and quality from the package. Sometimes, pallets are not used for the distribution of the packages; therefore, the secondary packaging might act as a pallet, making it even more exposed to risks.²⁶

1.2 Problem discussion

According to Dominic (2005), the understanding of packaging within the supply chain and how it contributes to establishing of logistic networks has become very important to meet customers demand. He highlights the lack of ability from the packaging industry to meet customer's demand (pull) and requests upper management to seek the role as network integrator.²⁷ In the past three decades, food packaging technology has undergone rapid change and the interest for packaging performance has increased. According to Sonneveld (2010), adding value in the food supply chain through the development of partnership relations between the packaging industry and packaging users seems to be the philosophy for the new millennium.²⁸ Also, the interest of the entire supply chain has increased in most industries because of the savings and quality improvements that can be made by looking into the whole chain from production to consumption. Therefore, many companies have continuously improved their products by involving the entire value chain in their business model to reach customer satisfaction.²⁹ (Figure 2³⁰)

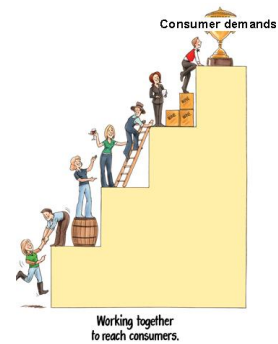


Figure 2 - Consumer demands

Most customers are responsible for the choices of the secondary package, although the primary package supplier gives recommendations on the parameter criteria. Many customers return to the primary package supplier when the primary packages aren't durable enough, even if it might be due to their choice of the secondary packaging. Nevertheless, it is difficult for the primary package supplier to know whether the problems occur due to their primary packaging or their customers' secondary packaging. Certain specifications have been set for the quality of the corrugated cardboard. However, it is hard to tell whether these specifications are sufficient or not. Also, the primary package supplier does not know whether these specifications are being met by the customer or the suppliers for cardboard, since few or no controls are usually made.³¹

Even if controls were made, both the primary package supplier and their customer would have difficulties in analyzing and judging the reliability of the test if it is not performed in an

²⁶ Tetra Pak internal video documentation from Kenya, Vietnam and Egypt

²⁷ Dominic, C., 2005

²⁸ Sonneveld, K., 2010

²⁹ Lummus, R. and Vokurka, R., 1999

³⁰ Figure 2, URL:

http://www.pir.sa.gov.au/_data/assets/image/0012/120441/Pic_4_Consumer_Demand_illust.jpg
2010-03-05

³¹ Interview Development Engineer A, Tetra Pak, 2010-01-25

Control Process for secondary packaging

environmental chamber. This is due to the fact that sampling and conditions greatly affect the accuracy and repeatability of test results.³²

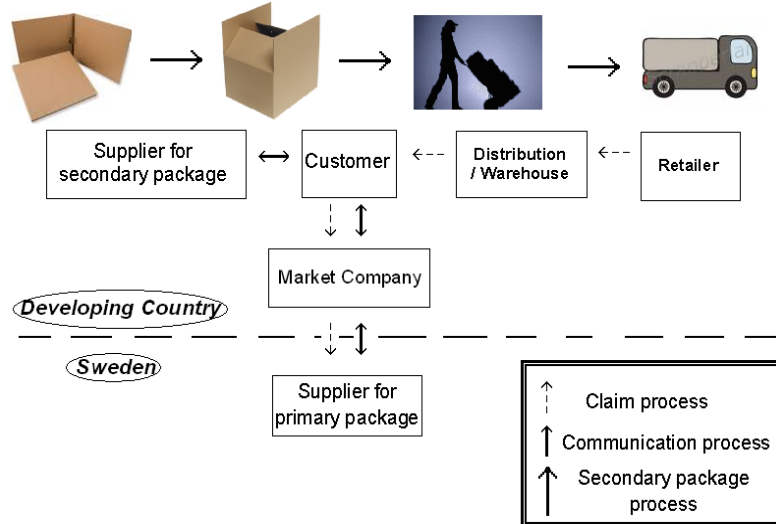


Figure 3 -The different processes for secondary packaging, claims, and communication

Tetra Pak is one of the companies that are interested in developing their knowledge in how the secondary packaging is affecting their product, but also how they can help their customers to control and improve the secondary packaging performance. In this way, Tetra Pak can create a better relationship with their customers and hopefully allow them to grow with their customers.

Because of the great need of simplified standards or control processes in developing countries, this Master Thesis focuses on the secondary packaging of the Carton Economy Product Portfolio. Today, the Carton Economy Product Portfolio includes the low-cost alternatives within the Tetra Pak Product Portfolio. These packages are also the most sensitive to external forces due to its form and minimal material usage³³ in order to keep the price low so that customers in developing countries can afford them. The Carton Economy Product Portfolio includes the Tetra Fino Aseptic (TFA), Tetra Classic Aseptic (TCA), and the Tetra Wedge Aseptic (TWA) packages.

1.2.1 The case study problem discussion

The case study is made at Tetra Pak in Lund where Tetra Pak and their customer have experienced that it is hard to retain the original quality of the secondary package within the site and during the distribution. ³⁴ Through Tetra Pak’s earlier studies and investigation of claims, deficiencies have been found in both the dairy during incubation, and also in the distribution to warehouses and consumers.³⁵ This problem increases the risk that several of

³² Schueneman, H., Paper and corrugated paperboard, Westpak

³³ Tetra Pak internal web page, Orbis, 2010-01-29

³⁴ Tetra Pak internal web page, Orbis, 2010-01-29, varies surveys made in different developing countries by Tetra Pak

³⁵ Internal video documentation from customers in Kenya, Vietnam, Egypt and Iran, Tetra Pak

Control Process for secondary packaging

the primary packages are being deformed and tossed before they even reach the customers.³⁶

The deformations have been identified through a product waste of the package system (both the primary and secondary packages), which means that it is difficult to determine whether the problem has occurred through tough handling or by the poor package performance of the system.³⁷

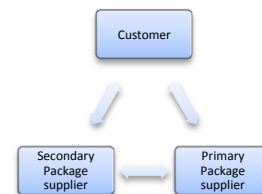
Today, Tetra Pak Carton Economy performs controls on some customers' processes to obtain measurement data and information about the packaging deformations that occurs in the dairy. This is done in order to increase the understanding of the reason to packaging deformation.³⁸ The data collection was strongly welcomed by the dairy, which shows that they are willing to find ways to identify and minimize package deformations that lead to waste product.³⁹

Tetra Pak Carton Economy and Tetra Pak market companies have repeatedly visited their customers, where it has been noted that there are several shortcomings in both the management of packaging systems and a lack of troubleshooting the causes of packaging deformation. To reduce problems caused by the management of packaging systems on site, they would need to replace hand labor with machines. However, in many developing countries, a switch from hand packing to machine is not economically defendable due to the cheap labor. Whether the customer is using manual or automatic packing line, it is important to educate and create understanding of the secondary package performance to the dairy personnel to avoid disruptions in production.⁴⁰

Tetra Pak Carton Economy has provided recommendations to their customer about the handling of packages, which in turn have shown improvements. However, there is still a lack of dealing with the troubleshooting to the cause of the package system deformation. Tetra Pak has tested their primary packages, but has not been able to find any reason for why there would be a leakage as long as the packages are handled as recommended.⁴¹ Therefore, Tetra Pak calls for a solution to control the initial performance of the secondary package when it arrives to the dairy. This is done in order to get a better control of the quality that enters the distribution chain.

By implementing such a process, one aims to reduce the number of claims, but also to create an understanding for the customer on how the performance of the secondary package influences on the packaging system.⁴²

Figure 4 - The triangular relation between the two suppliers and their customer.



³⁶ Tetra Pak internal web page, Orbis, 2010-01-29, varies surveys made in different developing countries by Tetra Pak

³⁷ Internal video documentation from customers in Kenya, Vietnam, Egypt and Iran, Tetra Pak

³⁷ Tetra Pak internal web page, Orbis, 2010-01-29, varies surveys made in different developing countries by Tetra Pak

³⁸ Interview Project Manager B, Tetra Pak, 2010-04-15

³⁹ Interview Package Engineer B, Tetra Pak, 2010-02-18

⁴⁰ Interview Development Engineer A, Tetra Pak, 2010-02-19

⁴¹ Interview Package Engineer B, Tetra Pak, 2010-02-18

⁴² Interview Development Engineer A, Tetra Pak, 2010-02-19

Control Process for secondary packaging

By creating an understanding, Tetra Pak believes that the number of package deformations can be reduced within the dairy. The customer will then lower their waste and thereby be more cost effective. If the control process shows that the secondary package does not fulfill TP's recommendations, a stronger secondary packaging may be the solution to the packaging deformations. This may also result in cost savings further down in the supply chain.⁴³

1.3 Objective

The objective of this Master Thesis has been divided into three different parts.

- Identify critical factors needed to create a control process that will verify the initial performance of the secondary package of corrugated cardboard while arriving to the customers in developing countries, i.e. the dairies.
- Create a control process for the incoming corrugated cardboard.
- Look into the triad relationship between primary package supplier, secondary package supplier, and the customer, and to create an implementation plan on how the control process shall be integrated within the customer's daily work.

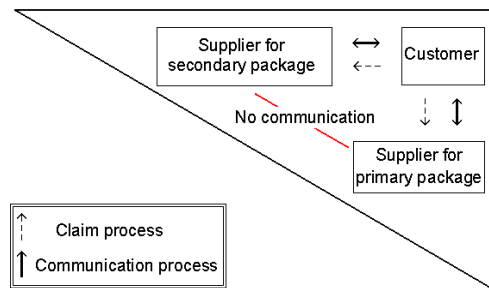


Figure 5 - The triad relationship

⁴³ Interview Development Engineer A, Tetra Pak, 2010-02-19

Control Process for secondary packaging

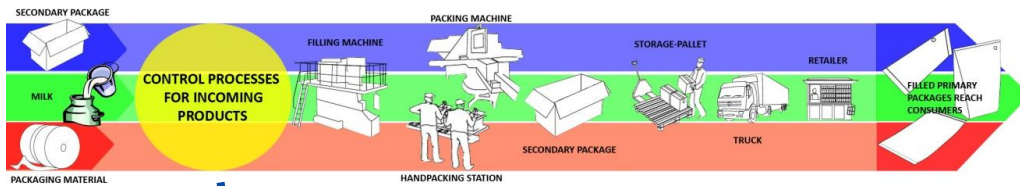
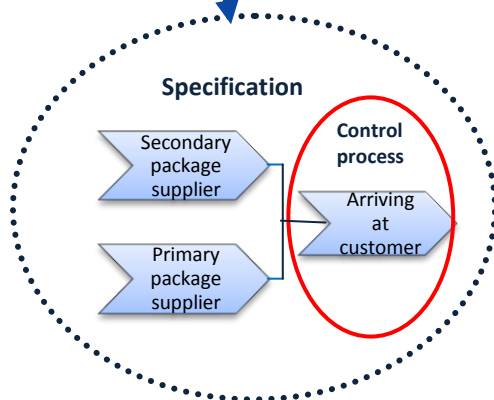


Figure 6 - Where is the control process introduced?



The purpose of the control process is to minimize the variation in performance of the secondary package that enters the distribution chain. It strives to prevent the deformation of secondary package and reduce the amount of wasted liquid food. The impact objective of the control process is for Tetra Pak's customers to increase their knowledge within packaging performance and quality, in order to achieve a more satisfied consumer. This allows the customers to expand their business, which in turn allows Tetra Pak to ensure and increase their business to existing customers of packaging material and filling machines.

1.4 Delimitation and focus

This Master Thesis focuses on the importance of secondary packaging within the distribution for liquid foods in developing countries. It also focuses on these countries' ability to improve controls for packaging performance. In many developing countries, workers pack all primary packages into the secondary packages by hand. Therefore, this Master Thesis will only include Regular Slotted Container (RSC) of corrugated cardboard, since these are the most frequently used for hand-packing and also the most common for secondary packaging boxes worldwide^{44,45}. The focus on developing countries has been chosen since many international standards are hard to apply on businesses within these countries and therefore many international companies have difficulties with implementing control processes. In this Thesis, a case study of Tetra Pak will be conducted with a focus on their customers in Vietnam since the problem has been clearly identified there. Since this is a general problem in developing countries and more related to company size than countries, studies in China, Egypt and Kenya will be made in order to broaden the situation. The complementary studies have been

⁴⁴ International Trade Centre, Technical notes on the use of corrugated paperboard boxes, Export Packaging Note No. 13

⁴⁵ Montague, M., Corrugated Packaging 101, Wexar Packaging Inc.

Control Process for secondary packaging

chosen due to the differences within the countries' economic situation and different company sizes. Hence, this Master Thesis's result will be applicable to both small and large companies.

To control the initial performance of secondary packages, this report will look into the key components that are the most essential for the secondary package performance. Since packaging manufacturing in most cases is a local business, the package material will depend on the country's natural resources. Although we have chosen not to look into the different pulp properties, we will investigate the final performance and features of the package. This delimitation is made because it is the end performance of the package that determines how well the package fulfills its purpose. Therefore, this Thesis will focus on the secondary packaging performance of the final box, and exclude research of different materials.

The transportation between the secondary package supplier and the customer has very little impact on the package since it is still only a blank, and it is not exposed to any external loads. Stores have a small impact compared to other external forces during the production and distribution. Consequently, we will not look into these processes; we will only focus on the initial performance of the box, according to the picture below. Finally, the distribution center will be excluded due to the fact that the majority of the customers deliver directly to the retailer without using a distribution center.

1.5 Expected results

This Master Thesis results in a control process that will be implemented in a triangular business relationship. The Thesis includes three different results:

- Recommendations of test methods for corrugated cardboard packages
 - Identification of critical key factors
- Control process
 - A secondary package check manual and a checklist will be developed. These will be used by the customer to control the performance and increase the understanding of the importance of secondary packaging.
- Recommendations for an implementation plan
 - How to implement a process in a triangular relationship.

1.6 Target audience

The target audience of this Master Thesis is mainly the Academia where it can be an inspiration for further studies and thereby of interest for students, professors and researchers. The Master Thesis will also be a contribution to the work at the department of Packaging & Distribution Solutions at Tetra Pak Carton Economy and those within Tetra Pak who find interest within this subject. It could also be of interest for Tetra Paks's customers, the personnel working at the dairy factories and their suppliers. Since the Master Thesis gives a concrete example of a control process, it can be of interest to all companies within the liquid food industry or having problems with secondary package performance in developing countries where standards are difficult to implement.

1.7 Disposition

Chapter 1 - Introduction

The introduction intends to describe the problem background. Furthermore the problem background ends up in the problem discussion which then leads to the research purpose. The introduction also clarifies the delimitation and presents the sponsoring company in short terms.

Chapter 2 - Scientific Method

In the Methodology chapter the scientific research method and this master thesis's chosen approach are presented to give the reader an understanding of how the research was conducted. The chapter also discusses the difficulties of the selected model and source criticism in order to view the understanding of the difficulties affecting reliability and validity of this master thesis.

Chapter 3 - Theoretical Framework

The theoretical framework describes different tools that have been used throughout the research to identify both the current situation but also new opportunities and methods for improvements of control process at Tetra Pak's costumers. Furthermore, this chapter gives the reader a material and engineering understanding of the secondary package

Chapter 4 - The secondary packaging for beverage industry

This chapter gives the reader an understanding of the present situation and the difficulties in localizing the cause to packaging deformation. The authors have also used this chapter to present and explain the distinctions made in this report.

Chapter 5 - Company presentation

In this chapter the authors present the company, Tetra Pak, where the case studies have been conducted.

Chapter 6 - Analysis

The theoretical framework is applied to the empirical and the contemporary situation. The comparison results in a process development of existing process and a control process of the secondary packaging at the dairy are analyzed.

Chapter 7 - Conclusions and recommendations

The final chapter presents a solution to the purpose of the report and a discussion around the relevance of the study and how the chosen method affected the study's reliability and validity is carried out.

2 Scientific method

The scientific method describes the possible approaches the study uses to achieve the purpose stated in the first chapter. The methods chosen are further discussed and their validation is also considered.

There are many different ways to perform scientific research; the most common way is to evaluate a suitable methodology for the question formulation. In order to do so, it is important to have great knowledge and criticism for the different methods, but also to clarify the authors own opinion and values to obtain an objective and trustworthy Master Thesis. Depending on the researchers' view of knowledge, the findings of the study are only as good as the method of investigation that was used to obtain them⁴⁶. The goal with the paper is to find answers to the research questions that meet the purpose of the research objectives. To do so, the working process is structured after the traditional research process model⁴⁷. In this Master Thesis the authors have made minor modifications to the traditional research process model to suit their case.

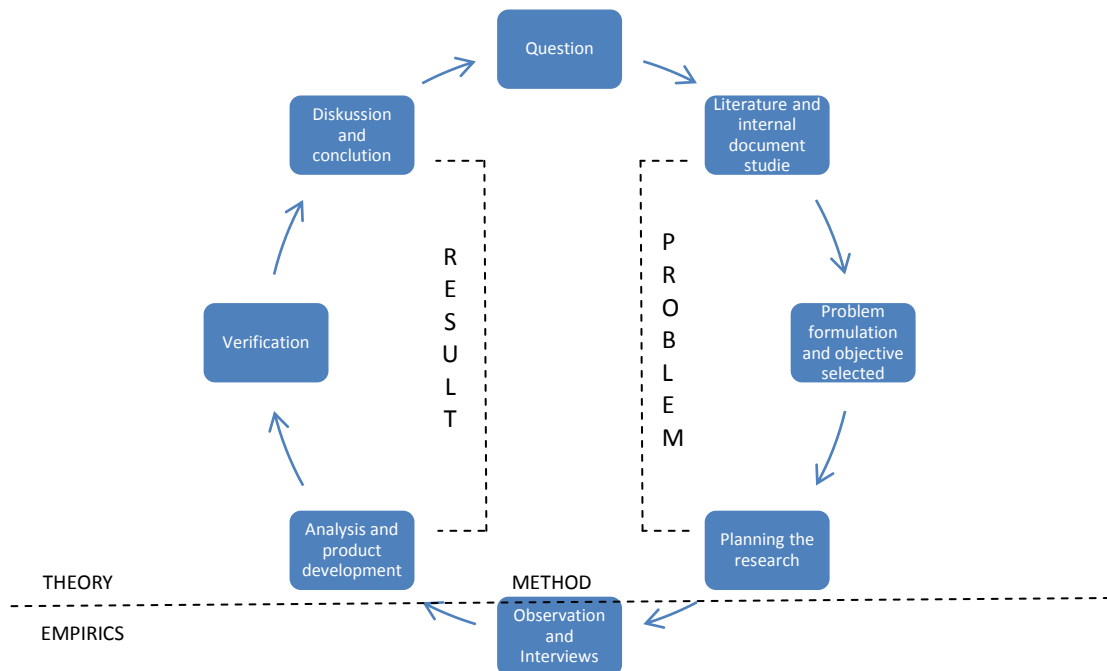


Figure 7 - Modification of the traditional research process model⁴⁸

Methodology is a very broad concept which can be described as a tool for finding the solution to the problem and to come up with new knowledge. All approaches can be described as methods. However, there are certain methods that are more durable than others, and are also more suitable for some kind of problems. It is customary to divide studies into four categories depending on the available knowledge and information of today; explorative, descriptive, explanative and normative, whereas the methods are usually divided

⁴⁶ Gray, P. et. al., 2007

⁴⁷ Backman, J. 2008

⁴⁸ Backman, J. 2008

into qualitative and quantitative processes.⁴⁹ An explorative data analysis approach is used when there is little knowledge available in the area. Therefore hypotheses are tested in order to form a better understanding of the area of interest. A descriptive approach does not explain, but describes the relationships within the area of interest. The next type of method, explanative, both describes and explains the area of interest and strives to achieve a deeper knowledge in the area. The last method, normative, is used when some knowledge already exists and the authors aim to develop advice and improvements within the area of interest.⁵⁰

2.1 Research approach

There are also different ways of research approach on how to tackle the problem, i.e. assuming theory which then tries to apply to what you've observed. This is called a deductive approach. Also, you can first observe, and then draw similarities and create new theories that describe the phenomena that we've studied, even called an inductive research. The scientific theoretical traditions of positivism, systems theory, phenomenology and hermeneutics can together with the Kuhn cycle describe the different steps in scientific development. Depending on the objectives the authors have with their study, different aspects can be considered.⁵¹

2.1.1 Analytical approach

Looking at ease and demanding the model to be clear and precise, the approach is seen from an analytical perspective.

This approach has been developed through the Western thinking and is based on a positivist science. Positivism requires that knowledge is empirically provable, namely that a scientific claim is only true if it corresponds to reality⁵². Therefore feelings, values and political statement, etc. cannot be verified with this model and according to this approach they are not belonging to the scientific realm.^{53,54}

2.1.2 System approach

The system approach is grounded on a system which is made up of several parts. The idea of system theory is not to focus on individual objects in isolation, but to see everything in context and understand the big picture. The essence of the approach is that each element must be known, since the elements interact with each other and can therefore affect the whole, both positive and negative. Systems theory is a useful method for analyzing the flows of various kinds, both within systems and between systems and external parties. The approach method is often used to organize and plan activities, by studying different processes and cycles. However, caution must be taken to distinguish what level of the system the authors are studying in order to maintain focus and collect relevant data. Systems theory can be seen as a development of positivism and hence the requirement for rationalism, measurability and comparability.^{55,56}

⁴⁹ Holme, I. and Solvang, B., 1997

⁵⁰ Björklund, M. and Paulsson, U., 2003

⁵¹ Wallén, G., 1996

⁵² Wallén, G., 1996, p.38

⁵³ Wallén, G., 1996

⁵⁴ Holme, I. and Solvang, B., 1997

⁵⁵ Wallén, G., 1996

2.1.3 Actor-based approach

A person's view of knowledge, epistemology, is strongly connected to the persons view upon the world. To truly understand the situation of how the organization works, the authors have according to this approach to see the business through the eyes of the employees. The focus lies on the individual operator and how a system's elements characteristic creates the entirety⁵⁷. This approach can be seen as the opposite to the other two approaches since this approach believes in hermeneutics and advocates for a distinction between the methods of natural science and of social science.⁵⁸ The actor-based approach is not just a way of thinking, clarity and multi-views, it also puts demands on creativity and unpredictability.⁵⁹

2.1.4 Interpretation methods

Hermeneutics is derived from the biblical text and interpretation and, can be seen as complementary to the positivist traditions. The approach is the way to interpret the meanings of texts, symbols, documents, experiences, etc. The method exchanges between part perspective and holistic approach and the attention to contradictions in the interaction. The theory can also be seen as a general theory of communication and understanding. Phenomenology is based on Husserl's philosophy, rooted in speculation about consciousness, self consciousness, intentionality and "phenomena". The approach is based on experience and is more or less integrated with the hermeneutic theory.

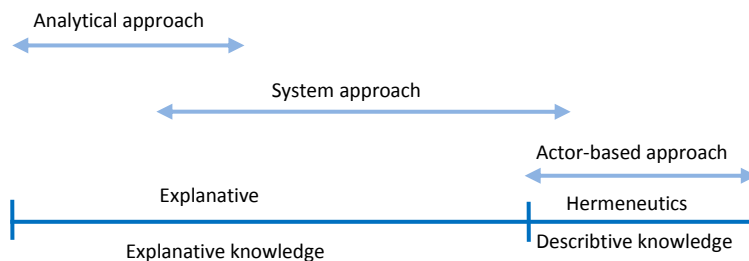


Figure 8 - The relationship between the methods of natural science and of social science.⁶⁰

2.1.5 The research approach of this Master Thesis

The purpose of this Master Thesis is to investigate how a secondary packaging control process can be developed and how this will contribute to an organizations performance. The authors will look at existing processes and analyze the interaction between them. Defining what affects the processes will be made by looking at the observed area through a broader perspective including the supply chain and the business relationships between the two suppliers and their customer. The authors have therefore chosen the system approach to help them keeping a holistic view that allows them to explain the relation and interactions within the system of processes as objectively as possible. However, the Master Thesis may include some influences from the actor-based approach, using the hermeneutic theory to

⁵⁶ Holme, I. and Solvang, B., 1997

⁵⁷ Holme, I. and Solvang, B., 1997

⁵⁸ Arbnor I. and Bjerke, B., 1994

⁵⁹ Björklund, M. and Paulsson, U., 2003

⁶⁰ Arbnor I. and Bjerke, B., 1994

Control Process for secondary packaging

describe the experienced situation, both from an external and internal view. This will help to create a better understanding of how the triad business relationship affects the supply chain performance and in the end it will also address to the consumer's level of satisfaction.

Since some knowledge within the area of interest already exists, the authors have chosen a combination of two study methods, explanative and normative. The authors will describe the situation of today but also seek deeper for information that can develop a deeper understanding of what influences Tetra Pak's customers' choice of secondary packaging and how this in turn affects the profitability of Tetra Pak's customer, the dairies. The authors also strive to find new knowledge and combine this with existing knowledge in order to present suggestions for improvement and develop the control process.

2.2 Theoretical Approach

The selection of theory is significant since it may influence not only the topic of the research, but the findings as well. Generally, there are two approaches, deductive and inductive. Deductive aims to start with investigating existing theory and then apply it to the observation⁶¹. This is made by creating a hypothesis beyond the available knowledge from existing theory and then verifying it empirically. The approach takes into consideration that theoretical models cannot be examined directly in reality because they often contain simplifications. Therefore, creating different model conditions for how the observed case relates to the theory is essential for this approach⁶².

The inductive approach on the other hand begins with the discovery, often from a specific case and after completing the observation and data collection the information is sorted into a concept or generalization⁶³. Usually, the researcher has no prior knowledge of the abstraction; instead he or she would build new theory after observing and analyzing the observations. This approach gives a gradual understanding to behavior and is a simple, straightforward approach for deriving findings in context of qualitative data analysis.⁶⁴ However, there are scientists who question this approach since they believe that the theory quickly goes empiric and misses out of scientific basis within the results. Of course there are opponents who believe that the inductive approach gives the opportunity to build new theory,⁶⁵ but to build new theory requires a process for data analysis which in this case means to analyze results by fitting curves to data points. Therefore the approach can be divided into two different processes, interpolation (fitting a line or relationship between data points) or extrapolation (extend a line or pattern beyond the range of the data).⁶⁶

If the authors change level of abstraction, between induction and deduction throughout the research, the method is called abduction.⁶⁷ Abduction can be used in order to help the authors to expand their understanding of both theory and empirical phenomena and the relationship between them. Instead of following a certain number of planned research activities, according to a standardized concept, abduction will allow the authors to constantly

⁶¹ Gray, P. at el. 2007

⁶² Wallén, G., 1996

⁶³ Gray, P. at el., 2007

⁶⁴ Thomas, D., 2006

⁶⁵ Wallén, G., 1996

⁶⁶ Gray, P. at el., 2007

⁶⁷ Björklund, M. and Paulsson, U., 2003

Control Process for secondary packaging

move 'back and forth' from one type of research activity to another and between empirical observations and theories.

When conducting a case study, one of the main difficulties can be how to handle the interrelation of the many elements involved during the research. But by not following a predetermined way of research steps, the authors allows to develop theory with focus on the empirical insights that can be more suitable for the context of the case.⁶⁸

2.2.1 The theoretical approach of this Master Thesis

An abductive approach method has been chosen in this Master Thesis, which means that a combination of inductive and deductive pattern is used. This, we have selected because the current situation is very faintly investigated and therefore require the authors to switch between abstraction levels and combine empirics with theory regularly to both describe and explain the system to be considered. Since this Master Thesis begins with identifying the root causes to secondary packaging deformation of a specific case, the research will mostly be of inductive characteristic. After observations and information gathering, the collected knowledge will be sorted into a concept of a secondary packaging performance control process. When an understanding of the situation is created, theory will be studied and models will be modified to fit the problem of area of interest.

The theory in this Master Thesis will be used as a supporting tool for the development of the control process and implementation plan. Different theories will also help us to sort out and structure both the research process and the collected information in an organized manner.

2.3 Research strategy

The various methods have their strengths and weaknesses and it is important to be aware of them to receive a sustainable and well-founded study. In this master thesis both qualitative and quantitative methods are used for gathering information and investigating a certain case study.

2.3.1 Qualitative method

The qualitative method can be divided into five different approaches, direct observation, participant observation, informant and respondent interviews and analysis of the sources.⁶⁹

It might be difficult to give an exact definition of what a qualitative method is. According to *Qualitative research in information management*⁷⁰, the best way to understand what is meant by qualitative research is to determine what it is not. For instance, it is not procedures that predominantly rely on statistical analysis. Neither is it a procedure that relies on a set of gathered data. The strength of qualitative data lies more in its rich description. The findings should mainly answer to the questions *how* or *why*? This means that communication between the researcher and the research field/person is important to get the most out of such a method. When it comes to qualitative methods, it is often the analysis itself that is the difficult part. The information is often large and not very lucidly. The analysis can be

⁶⁸ Dubois, A. and Gadde, L-E., 2002

⁶⁹ Holme, I. and Solvang, B., 1997

⁷⁰ Glazier J., Powel, R., 1992

performed in different ways. One way is to choose certain central themes that one would like to highlight, or one could start with certain dictums and try to build up a total understanding out of the material. Even computers programs are used to analyze the data.⁷¹

2.3.2 Quantitative method

The quantitative method is a scientific research technique that is used for gathering quantitative data, which is anything that can be measured. Normally it is used to verify if a certain hypothesis is true or not. In order to do this one will make a survey, measure or weigh something.

It is easy to misinterpret these quantifications; just because something can be described in numbers doesn't necessarily mean that it is truer. If one wants to use the information that has been gathered, it is vital that it is not too big, since it will then be difficult to survey the material. One of the greatest advantages with the quantitative method is that it is rather easy to systemize the raw material. An information matrix has to be created that shows the values of each respondent to each variable. When this has been done a certain loss will always be obtained, thus before analyzing the data one has to be sure if there is a pattern in the loss or if certain age groups have chosen not to reply. The result of this survey may have major consequences on what one state based on the gathered data.⁷²

2.3.3 Case Studies

Case studies are one of several ways to do research and can be used for both generating and testing hypotheses. A case study can be used as a research strategy, where the empirical inquiry is a description or investigation of a scenario within its real life context. Case studies can be based on both qualitative and quantitative methods and are nowadays often used in problem-based learning to answer the questions that address "how" and "why" in unexplored research areas.

A single-case study can deeply describe the reality of a phenomenon, by contrast to multiple-case studies that provide a stronger and more robust theory building since the propositions are more deeply grounded in varied empirical evidence. Thereby only using a few additional cases can significantly affect the quality of the developed theory.⁷³

2.3.4 Method Combination

Since the qualitative and quantitative methods have different advantages and disadvantages, a combination of them both is preferable. The quantitative method has its greatest strength in explaining and describing various phenomena through the use of statistics to get an average view. However, the qualitative method gives us a simple view of the whole picture and goes deeper in order to create an understanding of the individual and unique case.⁷⁴

⁷¹ Björklund, M. And Paulsson, U., 2003, Holme, I. and Solvang, B., 1997

⁷² Björklund, M. And Paulsson, U., 2003, Holme, I. and Solvang, B., 1997

⁷³ Eisenhardt, K. and Graebner, M., 2007

⁷⁴ Holme, I. and Solvang, B., 1997

2.3.5 The research strategy of this Master Thesis

Due to its methodological character, this Master Thesis will be conducted as a case study at Tetra Pak, focusing on literature cases from Vietnam, Kenya, China and Egypt. The authors have chosen this approach since there is little documented work about how the secondary package affects business in developing countries, but also due to the limited access to other cases. With these cases, the authors are given a real-world example of the challenges in this Master Thesis. To increase the credibility, a combination of quantitative and qualitative methods will be used. Including more than one research approach within the general confines of a case study is seen by many as a vital strategy capable of enhancing the efficiency and the credibility of a research study. Our goal is to identify links and patterns within our area of interest and eventually modify models or methods to describe and organize a solution for eliminating unwanted waste.

Much of the information studied is a qualitative and secondary data, but we will also use quantitative methods to gain a more thorough understanding of the situation through the primary data.

2.4 Data collection

In order to collect relevant information during the investigation a theoretical basis of knowledge is a prerequisite. Often, the availability and scope of data is limited and thus, some boundaries are required to make the data reliable. Condition of generalizing is central in scientific studies. It is essential that the authors highlight the reality that exists for the investigation and what other conditions, like theoretical, methodological as well as empirical, affect the result⁷⁵.

2.4.1 Primary sources

Primary data includes data that the author himself has gathered, often through observations, interviews, or surveys, in order to form an analytical framework of the research. While gathering of raw data, it is vital to bear in mind that the collectors use themselves as a measuring instrument; therefore the observation is conducted by his point of view as well as in the interviews and written questionnaires. For that reason, the authors need to be aware of their own preconceptions and values to keep an objective perspective. A way to facilitate objectivity is to use different sources within the data collection. The advantage of primary data, as long as it is scientifically conducted, is that the writer can better understand the values that have influenced the outcome than using secondary data.⁷⁶

2.4.2 Secondary sources

Secondary data is information gathered for earlier studies and purpose. It is thereby important to analyze for what purpose the earlier information was collected and by whom.⁷⁷

⁷⁵ Wallén, G., 1996

⁷⁶ Befring, E., 1998

⁷⁷ Befring, E., 1998

2.4.3 Interviews

Interviewing is often a good and efficient way to collect information. The interview will most likely give a greater insight, and expand our understanding of the problem. A scientific interview is not performed in the exact same way as a media interview. The big difference is that a scientific interview doesn't address to spectators⁷⁸. Thus it doesn't have to be as conceivable and entertaining. Another important aspect is that when a scientific interview is being performed, you have to stay critical to both your methods, and also to the interviewee's answers. Hence, a good way to prevent insecurity in information is to interview several people, resulting in a wider perspective to draw general conclusions from. A survey can in some cases also be seen as an interview, although two people aren't talking. The questions are more closed, and the interviewee is often given a few answers in advance to choose between. Interviews are basically divided into three parts – structured, unstructured, and semi-structured. A structured interview is good to apply on a big group of people, where one often wants to quantify a hypothesis. The structured interview reminds of a survey, where the interviewee has a certain number of answering alternatives. Therefore the results are easy to display statistically. A clear disadvantage with this method is that it isn't flexible since the questions cannot take into account the unpredictable, nor do they allow any discussion⁷⁹.

When one is using the unstructured method, the questions don't need to come in a special order, and it is up to the interviewer to formulate the substantial questions and gradually change them throughout the interview. The questions are to be so called *open questions*, meaning that the interviewee is able to answer the questions how he or she wishes, for instance from personal experiences⁸⁰. This method is also called a qualitative interview since one gets information about qualitative aspects.

The semi-structured interview is a mix between the two other methods. The questions have a framework of topics to be explored yet it allows the interviewer to bring up new questions depending of the interviewee's answer. A semi-structured or an unstructured interview are prefer when a qualitative interview wants to be obtained

When it comes to asking different types of questions, these are often divided into two categories – open-ended and closed-ended. The open-ended questions refer to an unstructured interview, where the interviewee is allowed to answer very broadly, whereas the closed-ended questions are very strict, often asked to clarify facts. The more the questions are leading, the more delimited will the answers become and the interviewee will have difficulties in coming up with own reflections. At this point, the interview is leaving its purpose and won't be an exploring process. Therefore a closed-ended question of the leading type should be used with care. Although it might work well in the end of an interview, since it has got a stopping effect on it as the answer is very limited.⁸¹

2.4.4 The data collection of this Master Thesis

The data collection of this Master Thesis has mainly been carried out through qualitative methods such as interviews. A qualitative method is more suitable for this paper since a deeper analyze is to be done, at the same time as the goal for the authors is to get a general

⁷⁸ Jacobsen, J., 1993

⁷⁹ Jacobsen J., 1993

⁸⁰ Patel, R. and Davidson, B., 2003

⁸¹ Jacobsen J., 1993

Control Process for secondary packaging

and objective picture of how today's conditions are. The interview questions have been highlighting certain areas at the same time as they give the interviewee some freedom to develop and answer the question. The questions are considered to be semi-structured since they also allow the interviewer to further develop or change the questions depending on the answer from the interviewee. The gathered data was analyzed altogether and the authors tried to create a general picture of the situation.

The supervisors' advice and recommendations when it comes to potential literature and data bases have been very important throughout the data collection. A massive literature study was carried out and information was gathered from Tetra Pak's internal database, but mainly from the university database and by studying literature from the central libraries. Professors within the subject at LTH were also an important factor to retrieve information, not only via interviews but also through their own dissertations and papers.

However, a quantitative method in the shape of a survey was also used in order to contact the market companies within Tetra Pak and get their point of view.

2.5 Working process

For the convenience of the reader, the authors have chosen to describe the working process through five different phases, according to Figure 9.

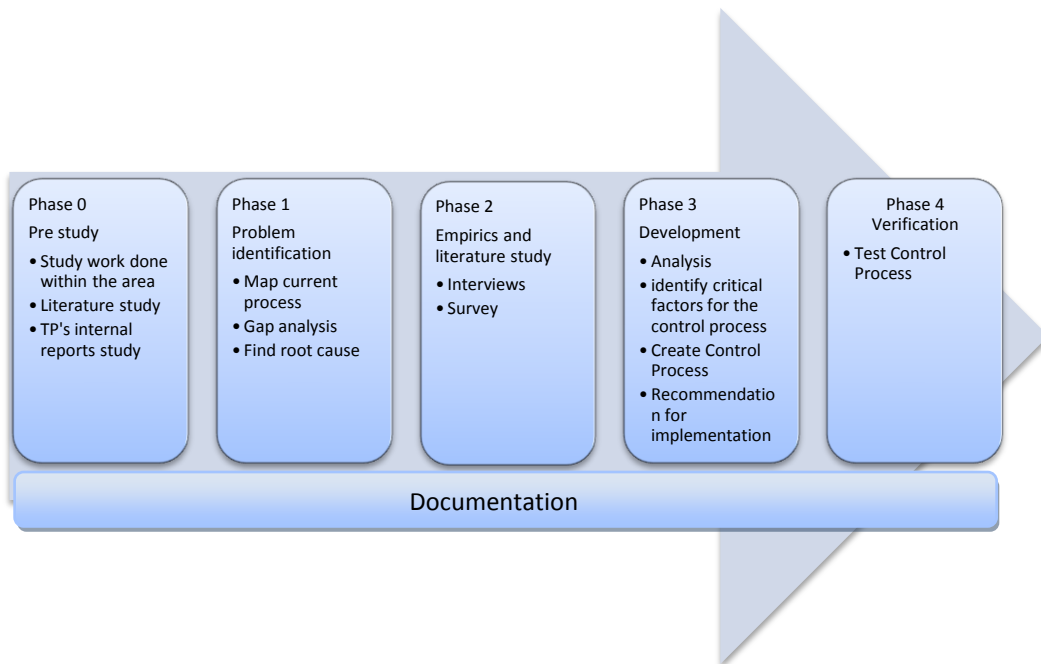


Figure 9 - The working process of this Master Thesis.

2.5.1 Phase 0 – Pre study

In order to bring us into the work, we began our study to look into similar projects undertaken in the field to get a better picture of the problem. The authors also studied several books within research methodology to get a thorough picture of what a study requires, but also to find out how the most appropriate way to reach the purpose should be conducted. A project plan was created in order to structure the work and to get a basic knowledge of the purpose to the research.

2.5.2 Phase 1 - Problem Identification

When the authors created a picture of how they wanted to proceed with the research, they continued scheduling interviews and questionnaire surveys. Their supervisor was an important person in order to get information about suitable and competent personnel within Tetra Pak that are to be interviewed. Moreover, a survey about secondary package routines and controls were sent to various market companies in developing countries, i.e. China, Kenya, and Vietnam. After having conducted more interviews, the authors realized that they wanted a secondary package supplier's point of view in order to get hold of their knowledge. Therefore they got in contact with the big corrugated cardboard supplier, SCA, in Mariestad. The advantage with having an outsider's point of view is that it is often very neutral and objective. The information from the visit and interview, but also from studying several internal reports within Tetra Pak, gave the authors a good picture of the customers' problems and the type of deformation that occurred. Conversely, the authors began to realize that the knowledge of corrugated cardboard is not always very developed. The authors therefore decided to ensure and evaluate the test methods available today and combine them with theory and the case of adjustments between the developed and developing countries. In order to find potential improvement areas within the customers' working process, as well as the triad relationship and supply chain, a gap analysis was made.

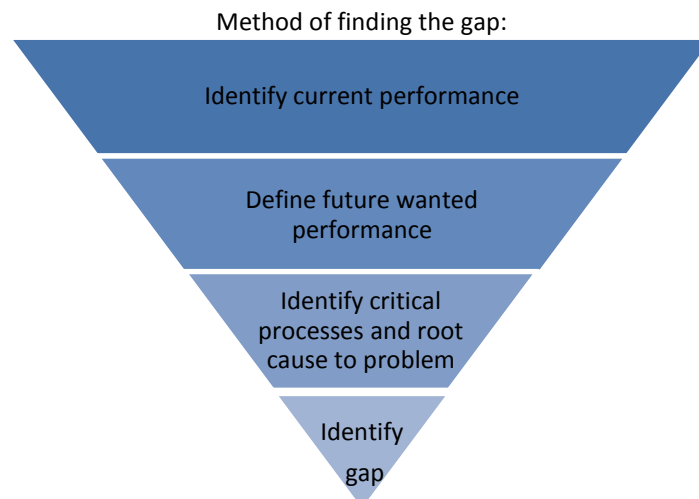


Figure 10 - Working process for gap analysis

2.5.3 Phase 2 – Empirics and literature study

As point of departure, the authors took an approach of an overall theoretical framework consisting of three different models or theories, but during the research process they continue to scan, select and discard theoretical perspectives as this framework is confronted with empirical information.

Within the study area, there is much secondary data within Tetra Pak, and there is obviously a difficulty in sorting the information effectively and ensure that relevant information is fully included in the research. There is also a lot of external information about corrugated cardboard. However, there are still a lot of unanswered questions within the area that affects the outcome of this Master Thesis. The difficulties are mainly addressed to the uncertainties in handling of living material and the complexity of factors that directly or indirectly affect the material performance. The authors have therefore beyond the theories of corrugated cardboard used theories about how to control variation and how to work with quality within an organization.

Since Tetra Pak works a lot with Six Sigma the authors started with looking for improvement tools within this area. However, it turned out through interviews with specialists within Six Sigma that this method might be too advanced for developing countries. Instead they recommended the authors to look into Lean or Quality management, where Lean seems to be a more suitable method due to the simplicity. Since the customer need a method for verification of a suppliers output of production the authors continued with their study of total quality management literature. The theories have been conjunct with empirics from different customer sites in developing countries. Since Tetra Pak has started to collect data about packaging deformation from certain customers, the authors found it suitable to choose some of these customers. They know that the customer had problems with packaging deformation and the authors could receive statistics of how many packages that got deformed. The authors have through secondary data analyzed three cases in the countries Kenya, Egypt and Vietnam. The authors have chosen these cases since the customers due to their size and location have reached different knowledge within the area of quality. In Egypt the knowledge is good but the measurement of performance for reaching customer satisfaction is still mostly based on financial goals. In Kenya the interest in performance measurements has radically increased. However, they have a limited supply of both machines and materials due to the economy and political situation. Vietnam on the other hand has customers who are growing very fast, and due to their expansion, they are also experiencing a negative change in packaging performance. Customers in Vietnam have already requested a solution for testing the secondary package quality and it is therefore of great interest for this Master Thesis.

2.5.4 Phase 3 – Development

Throughout the working process a lack in control and work routines slowly emerged. After identifying a gap, the authors based their work the fishbone diagram and the five whys to find root causes to the secondary package deformation. The fishbone diagram states the six major factors that can find the root cause to a variation in quality. The method also gives an alternative to add two other factors; Mother nature (environment) and Measurement (inspections) depending on what the specific case looks like. Since the authors find these two very essential for the current case those have also been added. The five whys method is a rather simple, but efficient method that the authors used during their work, striving to ask oneself the question “*why?*” five times. By asking this question one will eventually find an

Control Process for secondary packaging

answer, combined with the information gathered through the interviews, that develops a process and a result that the authors believe will decrease the variation in packaging performance.

2.5.5 Phase 4 - Verification

The ultimate way of making a verification of the authors work would be to go to one of the studied countries, and actually try the control process together with employees at the site. However, this couldn't be made, but an alternative by letting employees at Tetra Pak verify the control process in another developing country, Nigeria, was made in connection with a business trip. This verification is being made right now, and any feedback has not yet been retrieved.

Before the control process was sent to Nigeria, people involved and with experience from the sites in developed countries gave their feedback on the result. Moreover, an outside secondary package specialist from China has verified the control process, and also gave his feedback to the authors. The feedback resulted in minor modifications of the control process.

2.6 Criticism of sources

The choice of research methodologies has got deep impact on the accuracy of the findings. When performing a research, the author can never be certain that the techniques used will allow her/him to see objectivity. The position of post-positivism⁸² will always be a challenge in models of scientific inquiry. The most important canons of scientific inquiry are validity, reliability, objectivity and precision. Keeping a critical perspective entail looking beyond the obvious and seek for other possibilities.

2.6.1 Validity

Validity aims to evaluate how well the measurement has been done, that is how close the concept is to the evidence. Being aware of the gap between the measured result and reality helps us to understand how well our findings describe the situation. A high validity will be achieved by using several different references of information and data. Moreover, a critical test and a thorough processing of the information are important for the validity.

2.6.2 Reliability

Since scientific knowledge has to be cumulative, the research has to be conducted in such a way that the outcome can be repeated with the same result. To achieve replication, the study has to be created with reliable measurement tools. In order to increase the reliability, consideration should be taken to the amount of interviewed persons, but also whether these persons have got an objective view or not. The reliability will be guaranteed by having similar questions when interviewing that control that the answers are perceived correctly^{83, 84}.

⁸² Post-positivism differs from positivism by arguing two things: firstly that the observer and the object observed cannot be completely separated and as a result, secondly, there is no common shared reality.

⁸³ Holme, I. and Solvang, B., 1997

⁸⁴ Wallén, G., 1993

2.6.3 Objectivity

When writing a Master Thesis there is always a risk that the researchers own values and opinions will intrude into the outcome of the study. Ideally, independent researchers would arrive at identical findings while given the same condition and purpose. To increase objectivity, we seek the views of all, not only with whom we agree. An increased objectivity will be assured by no factual errors or biased collection of sources when referring to sources. By seeking evidence we will challenge our theories, and by using a number of sources, we can verify the information we receive and guard against a subjective perspective on our research result. Triangulation will be used, which means that the single case will be investigated with many different methods to ensure a wider perspective and increase the validity. For instance, the authors have combined interviews together with surveys and literature studies.⁸⁵

2.6.4 Generalization

Throughout the research it is essential to keep a level of generalization. By keeping a general perspective to the subject the result within the Master Thesis will be useful and addressed to a larger amount of people outside the selected study area. For a result to be general it is has to be applicable in other areas or processes in one way or another. The result will therefore be thoroughly discussed by the authors in order to explain to the reader the risks and adaptations that should be taken into account in the general case.⁸⁶

2.6.5 Validity and generalization of this Master Thesis

The aim of this research is to find how to measure, control and assure the quality for the secondary packaging before it enters the packing line. Later on an implementation plan will be developed, as a base to gain a good result at the customer's site and that is applicable in to the rest of similar organizations with secondary packaging quality problems within developing countries. This means that the process for implementing new process components to the existing working traditions has to be evaluated in order to understand the effect they have on the customers' business. This will also give the authors greater knowledge for the challenges their product has to face when the result shall be generalized. However, improved quality is a goal for most companies within the packaging industry and the control process, recommended manuals, working guideline, and the Quick guide, will probably be useful tools for other companies as well. Even with or without adjustments to fit the specific process. In this paper, the best way to validate the control process was for the authors would be to test in at a site in one of the studied countries. Unfortunately, this opportunity never came up, and due to a limited time table, the real validation was never made. Nevertheless, the control process is currently being validated in Nigeria by two employees at Tetra Pak. This is a good way in order to improve and make a verification of the work.

A possible risk when performing many interviews within one company as in this case, is that the result won't come out as objective as desired, and maybe more external interviewees could have changed the result. Moreover, a study of another company with a similar situation could have been beneficial for the result in this Master Thesis.

⁸⁵ Holme, I. and Solvang, B., 1996

⁸⁶ Patel, R. and Davidson, B., 2003

2.7 Method assessment

When starting with this Master Thesis the authors had no previous knowledge of working, neither within Tetra Pak nor within the packaging industry. Therefore the authors have been able to see the business without having well-established prejudices. In addition, the author had to spend a lot of time studying and trying to get a picture of the packaging beverage industry in order to take on the mission. Furthermore, the authors are well aware of not focusing too strongly on the empirical pre-study within Tetra Pak before investigating a more general perspective of the area of interest through literature study and external interviews. This in order to avoid being too influenced by existing theories within tetra Pak and thereby, limiting our findings and ability to see new patterns and create a more general control process of a general interest.

By reading articles the authors have been able to create as far as it is possible an objective view of the situation and by using articles within the area the authors have tried to generalize their case to a more general situation. This is made in order to give the Master Thesis a broader audience so that the findings also can be of interest for the general reader.

In order to critically observe the situation at Tetra Pak, the authors have chosen to use triangulation. By combining the different kind of methods the authors hope to conduct their Master thesis in a more neutral manner. Since the findings are connected to certain cases, the reinterpretation of the result can only be seen as an indicator, when applied to other situations. Making the findings more general has to be done with great caution, the authors have therefore decided to hold a discussion about their findings in intent to highlight possible inadequacies and risks with a generalization.

3 Theoretical framework

The theoretical framework gives the reader a fundamental review of theories that are the foundation for the report and its analysis.

3.1 Choice of theory

The theoretical framework is compiled for the understanding of the concept of quality and the packaging performance of corrugated cardboard. Firstly, an introduction to the supply chain is compiled with the purpose to provide the reader with knowledge about the structure of a supply chain and the importance of business relationship within that chain. Later on, a literature review of the packaging performance and test methods are presented and finally the aspects of quality and control methods are introduced to the reader.

In this chapter the authors also give the theoretical background to the analysis methods used in this Master Thesis and how western theories can be applied in developing countries.

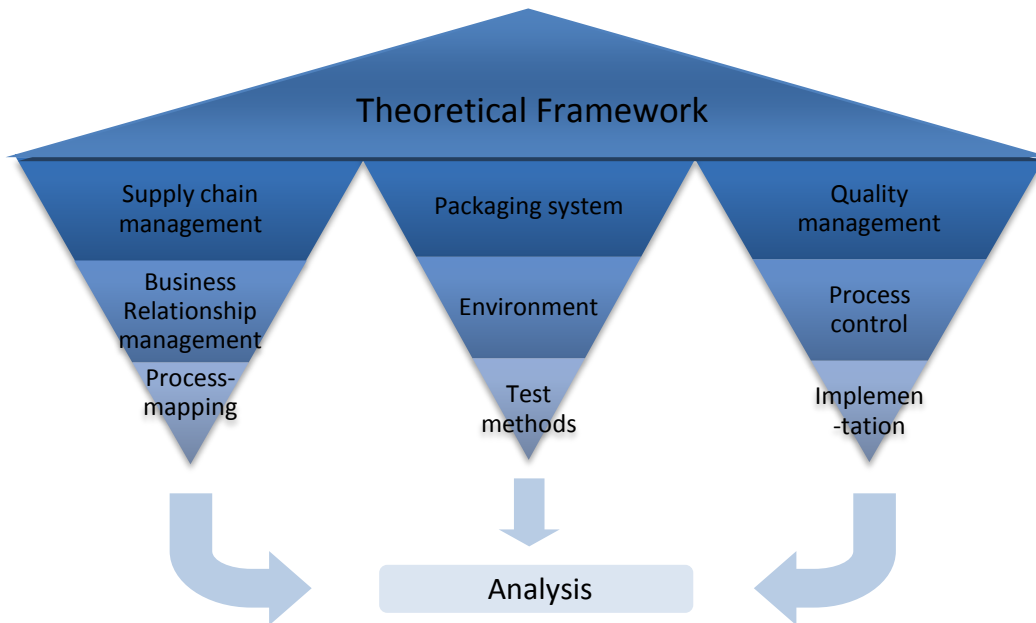


Figure 11 - Theoretical Framework

3.2 Supply chain management

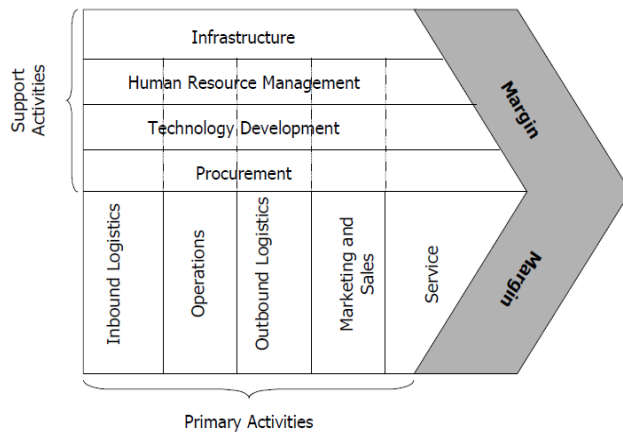
In the supply chain, there is a close relationship between packaging and logistics since they affect each other in several ways.⁸⁷ In order to create better conditions for packaging logistics in the supply chain many different types of business relationships have been developed. During the last few decades, business relationships have gone from traditional single exchange transactions to become a more long-term dyadic or even triadic business

⁸⁷ Lumsden, K., 2006

Control Process for secondary packaging

relationship.⁸⁸ Developing strategic relationships across businesses generates an increasing need of management in the value chain. Nowadays, the dyadic business relationship is turning into a triad business relationship including two organizations connected by a third organization. To manage the logistics and to create processes that enhance the single organization as well as the entire value chain has increased the demand for skills and knowledge both within value and supply chain management. The differences between the two concepts are becoming more diffuse since they get more and more integrated with each other.

The value chain was presented in 1985 by Michael Porter and was a part of his competitive advantage theory. The value chain can be described as the consumer's point of view of the product creation and delivery. In every step of the product creation, customer value shall be added to the product. The value chain primarily focuses on the internal activities and relationships, and the value network describes the external, but in a daily manner the value chain is used for describing both internal and external.⁸⁹



Porter 1985

Figure 12 - The value chain

After the development of the value chain, the focus on each relationship grooved and potential development was seen in terms of external integration. The supply chain concept was developed and linked together different businesses value chains. The Council of Supply Chain Management Professionals today defines supply chain management as planning and management of all activities and integrates supply and demand management within and across companies.⁹⁰

It can also be described as *“the management of the total flow of distribution channel from supplier to the ultimate user.”*⁹¹

Today, supply chain management is known as the third generation supply chain management that includes value creation from the customer's point of view⁹². This result in the two

⁸⁸ Meier, R. et al, 2004

⁸⁹ Johnson, G. et al., 2008

⁹⁰ The Council of Supply Chain Management Professionals web page, 2010-04-19

⁹¹ Mentzer, J., 2001, p.9

Control Process for secondary packaging

concepts; supply chain and value chain now are integrated and sometimes referred to as supply/Demand chain, SDC.⁹³

Since the market becomes more global, the competition has moved from being a single company concern to become a challenge for the entire supply chain versus other supply chains.⁹⁴ Supply chain activities can be grouped into strategic, tactical, and operational levels. At the strategic level, the company management makes decisions for the overall corporate strategy. On the Tactical level, business decisions are made and measurement tools are used to meet the overall corporate strategy, which the strategic level has made. Decisions at this level are made each day in businesses and affect how the products move along the supply chain.⁹⁵

Operational decisions are made with awareness of the strategic and tactical decisions that have been adopted within a company. These higher level decisions are made to create a framework within the company's supply chain operation and to the best competitive advantage. The operational decisions compared to the others are made more often, as frequent as many times a day. The day to day operational decisions ensure that the products efficiently move along the supply chain achieving the maximum cost benefit.⁹⁶

When building up a business relationship, a company can choose to collaborate on one or more levels. At the strategic level, the collaboration is in terms of market positioning and strategies to reach the goal. At the tactical level, the collaboration includes co-ordination and design of procedures, instrument and tools to improve and easier plan the day-to-day activities. At the operational level the companies can find advantages by integrating the operational planning of manufacturing, inventory management and transportation processes.⁹⁷

Supply chain management has been characterized as a strategic management concept, which can give an interdependency to reach competitiveness and profitability of the individual company as well as the entire supply chain.⁹⁸

There are mainly four different system levels of supply chain management mentioned in literature; the internal supply chain, the dyadic relationship, the external supply chain and the inter-business network embracing. All the different approaches describe different issues within the supply chain management.⁹⁹

⁹² Feller, A., 2006

⁹³ Dominic, C., 2005

⁹⁴ Meier, R. et al., 2004,

⁹⁵ Becker, J. et al., 2004

⁹⁶ Becker, J. et al., 2004

⁹⁷ Becker, J. et al., 2004

⁹⁸ Håkansson, H. and Persson, G., 2004

⁹⁹ Håkansson, H. and Persson, G., 2004

Control Process for secondary packaging

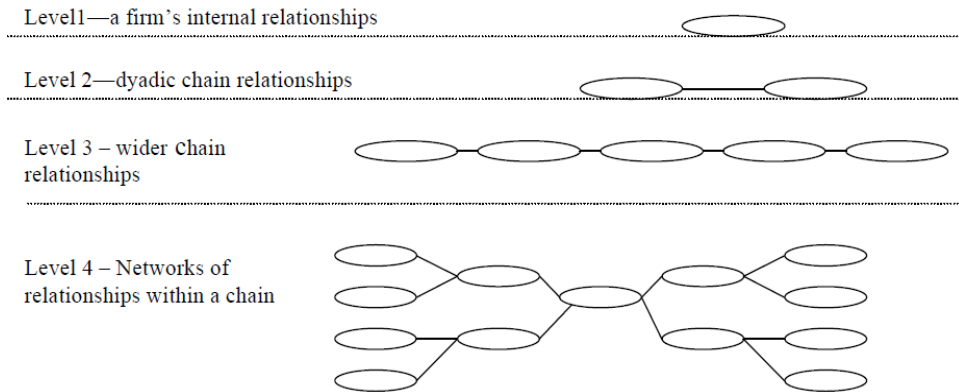


Figure 13 - Four levels of relationships in the supply chain¹⁰⁰

3.2.1 System thinking within the Supply chain

The system thinking is essential in the process approach. Various processors are interdependent and affect one another. To achieve success on a long-term basis, system thinking has to be used to understand the overall view. A system is usually defined as *"a variety of components that together form a whole, whose properties reflect the whole rather than the individual components"*.¹⁰¹

A system perspective can be adopted if the organization considers the whole chain performance instead of only measuring performance internally. Many studies have been made on internal relationship interaction and some has been made in the aspect of interaction between supplier and customer.¹⁰² However, there is still a lot to study regarding the triad business relationship using the systems perspective, and when doing so, the importance of processes increases.¹⁰³

3.2.2 Process definition

A process can be defined as a chain of activities that transform inputs into outputs while creating value for customers¹⁰⁴. A process shall be both clearly defined and measurable. Processes help to repeat certain activities to reach a pre-determined result. Processes also facilitate the understanding and visualization of the whole value chain. Describing the business in terms of processes provide a better customer focus and by anchoring the process orientation within the organization, every employee can better understand their role in the quality improvement work.¹⁰⁵ According to Kaoru Ishikawa, the next process is your customer, using intern customers increase the customer focus. Process orientation means that all activities shall be looked at the customer point of view, while flow charts help to understand how the work shall be done.

¹⁰⁰ Collins, R. and Sun, X., 2009

¹⁰¹ Ljungberg, A. and Larsson, E., 2001, p. 47

¹⁰² Collins, R. and Sun, X., 2009

¹⁰³ Hammer, M., 2001

¹⁰⁴ Ljungberg, A. and Larsson, E., 2001

¹⁰⁵ Blomqvist, R. et al, 1996

Control Process for secondary packaging

The processes can be divided into a hierarchy model, as shown in Figure 14, where the main process is the process within the company that adds value to the product for an external customer. The main process can then be divided into sub-processes performed in a function or department within the company, and these are in turn composed of activities. Each activity can later on be divided into different operations/working tasks.¹⁰⁶

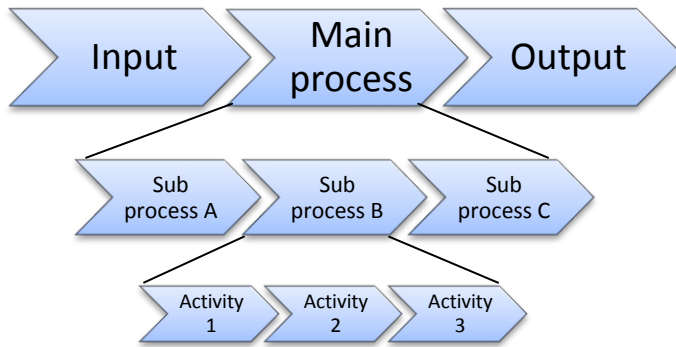


Figure 14 - Process hierarchy model

3.2.2.1 Process mapping

According to Juran¹⁰⁷, the first step in gaining control over an organization is to know and understand the basic. Process mapping can be used in a representative way for the organization to reach self-assessment. The approach helps the organization's employees to better understand their and other roles and how these affect each other. Process mapping can therefore be used as a learning tool for the overall operations and the basics of control that concern the customer directly.¹⁰⁸

Process mapping is usually done within the organization, which does not fully take into account the customer's requirements, in this Master Thesis, the consumer's requirements. Therefore, it is important to consider the entire supply chain in the process mapping or first specify the customer's requirements¹⁰⁹. Companies who want to maximize their productivity or who are experiencing production and output related problems can use process mapping to improve their processes. Process maps can be broadly divided into two types: true maps of what actually happens in the organization and maps of what ought to happen.¹¹⁰

Basically there are two different ways of performing a process map. One way of doing it is to use IT implementation based on information flow, also known as engineering approach. This method was developed by The United State Air force in 1970 and is still very useful when adding computer-aided systems into an organization. However, the method does not take into consideration the value-adding perspective of activities.¹¹¹ Instead, the business approach can be used in terms of flowcharts which help companies to follow a systematic

¹⁰⁶ Sandholm, L., 2006

¹⁰⁷ Juran J., 1988

¹⁰⁸ Keller, P. and Jacka, M., 1999

¹⁰⁹ McGrath and MacMillian, 2000

¹¹⁰ Winch, G. and Carr, B., 2001

¹¹¹ Winch, G. and Carr, B., 2001.

Control Process for secondary packaging

approach in managing their business. The business approach mapping method is one of the most basic and common methods of process mapping and can be seen as a reviewing tool that takes into account the actual working processes. The method also helps the business by mapping out the standards that must be reached and, most importantly, the impact of processes has on the business' customers.¹¹² Process maps, also called Flowcharts, can be seen as a graphical representation that help the organization visualize the series of activities that has to be met in order to accomplish a business goal. The flowchart helps decision makers and employees to visualize and understand the processes within the organization and allows them to realize why some of their processes are highly effective and why others are not working optimally.¹¹³

Process mapping can be done in four major steps; Process Identification, Information gathering, Interviews and map design, and analysis. Process identification is where a full understanding of all the steps of a process is recognized. Information gathering is the identification of activities, risk and key controls in a process. To increase the understanding through the point of view of individuals related to the process, the third step includes interviews and designing the map. Finally, the map gets analyzed to see what improvements can be made to run the business more effectively and efficiently.¹¹⁴

By analyzing the map created, a visual check can identify control breakdowns and inefficiencies, including bottlenecks and unproductive utilization of resources. This helps the organization understand why a job is done rather than how it is done. In this analysis, one looks into every step in a process to identify if each step adds value to the product from the customer's point of view. An examination of each step is done to determine whether it is necessary for the business or not.¹¹⁵

3.2.2.2 Customer satisfaction

In this Master Thesis the definition of customer-focus will be described through the traditional western thinking. This is done due to the lack of well developed business models and analyzed customers need in developing countries. Also, the customer-focus is not seen as essential in developing countries as in developed countries. The reason for this is mostly based on the limited economic and political conditions. In order to apply business theories from developed countries to developing countries, the authors will account for various applications such studies carried out between the developed and developing countries later in this Master Thesis.

Customer satisfaction can be defined as the state of mind that customers have after experiencing a company's product or service to which the customer's expectations have been met or exceeded. By achieving customer satisfaction, the customer becomes loyal to the company and will most likely repurchase the product or service again. According to Cacioppo, a 5-percent increase in loyalty can increase profits by 25%-85% and a very satisfied customer is nearly six times more likely to be loyal and to repurchase and/or recommend your product than a customer who is just satisfied. Therefore, defining and understanding

¹¹²Jacka, M. and Keller, P., 2009

¹¹³Anjard, R., 1996.

¹¹⁴ Jacka, M. and Keller, P., 2009

¹¹⁵ Jacka, M. and Keller, P., 2009

Control Process for secondary packaging

the customer needs can help any company to identify new product or service opportunities. It can also help the company to improve their processes and achieve quality improvements on issues that are most important to the customer.¹¹⁶

Many organizations get into difficulties through an inappropriate vision of customers and their needs, it is therefore essential to put the interest of customers first. Many researchers consider a customer focus to be the most fundamental aspect of corporate culture, since customer focus is critical to business profitability, a necessary antecedent of competitive advantage and a hallmark of successful business.

In developing countries, like Nigeria, where markets are fragmented and buyers' power is low, customer needs are less well understood, so a customer emphasis should have a greater impact on performance. According to Nwokah and Maclayton, customer focus has a direct link with sales growth in food and beverage organizations in Nigeria. The major findings from their study was that customer-focus contributes to business performance of the food and beverages organizations in Nigeria through some moderating variables such as government policies, firm size, expansion, new product development, innovation, diversification organizational politics and employees' esprit de corps.¹¹⁷

3.2.3 Business relationship

During the last two decades, there have been many empirical studies carried out within the field of how industrial markets generally look like. These studies have mainly shown that industrial markets are characterized by the survival of long-term customer and supplier relationships.¹¹⁸

During this time, major changes have occurred in the context and structure of supply networks and business relationships. Earlier, the optimal solution for purchasing according to the buyer's opinion was "freedom from dependence", which means that the buyer could choose from a great range of different sources, most likely choosing the supplier providing the lowest price.¹¹⁹ Today several companies have realized the benefit of having fewer suppliers with involving relationships to reach a positive effect on quality.¹²⁰ However, these relationships have over time become more complex and vary with regard to content and process aspects.¹²¹

A company's products can be seen as the output of a given structure of activities within the company and the input of other company's structures of activities. Therefore the connections established among suppliers and other actors, are crucial for the result of the specific products. This means that the performance of a supply chain depends not only on the conditions of a single company's involvement, but largely on the way its activities and resources are related to those of other supply chains.¹²²

¹¹⁶ Cacioppo, K., 2000

¹¹⁷ Gladson N. and Maclayton, D., 2006

¹¹⁸ Holmen, E. and Pedersen, A.-C., 2000

¹¹⁹ Gadde, L-E. and Håkansson, H., 1994

¹²⁰ Hagberg-Andersson, Å., Åhman, S. and Kock, S., 2000

¹²¹ Holmen, E. and Pedersen, A.-C., 2000

¹²² Gadde, L-E., Håkansson, H., 2001

Control Process for secondary packaging

Business relationships occur for the purpose of pursuing reciprocally beneficial goals and interests.¹²³ The value creation that arises through the cooperation is what makes a business relationship meaningful¹²⁴. The essence of a mutual business relationship is that both parties are more compensated from the benefits that arise from the collaboration than that of the independency. However, creating mutual goals that influence performance satisfaction positively can be difficult due to the differences in ethical and moral values between the companies involved.¹²⁵

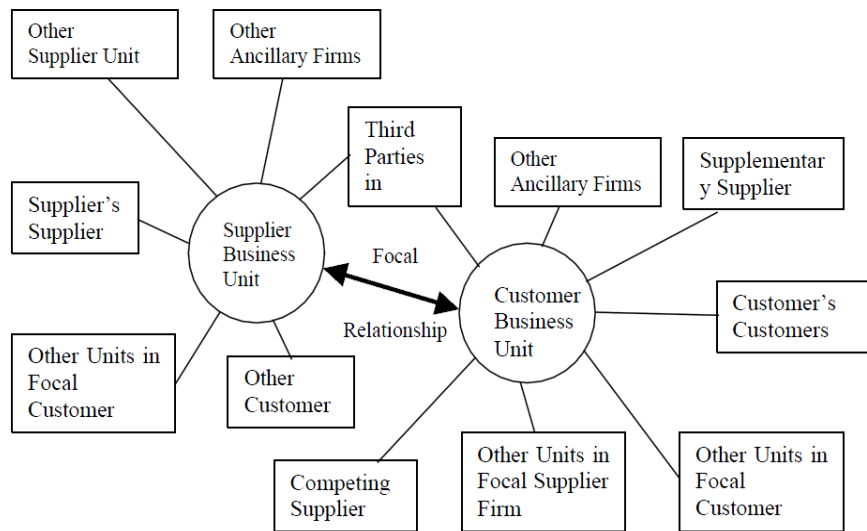


Figure 15 - Connected relations for organizations in a dyadic relationship within a network.¹²⁶

While examining the literature of business relationship, discoveries can be made regarding changes in the recently made research approach, from studying dyadic buyer-supplier relationships to examining such dyadic business relationship in the context of other relationships the participating organization may have. These studies have shown that business relationships do not exist in isolation; they are connected to a network through direct and indirect relationships. This implies that in addition to characterizing direct dyadic relationships between buyers and suppliers, the studies have shown that single relationships also are affected by and affect upon other indirect relationships, such as between suppliers.¹²⁷

Together these relationships create a triadic buyer-supplier-supplier relationship. However, the relationships between suppliers cannot be contemplated without considering the interaction between the buyer and each of the suppliers.¹²⁸

¹²³ Batt, P., 2000

¹²⁴ Håkansson, H., and Snehota, I., 1995

¹²⁵ Batt, P., 2000

¹²⁶ Anderson, J. et al, 1995, p. 3

¹²⁷ Holmen, E. and Pedersen, A.-C., 2000

¹²⁸ Choi, T. and Wu, Z., 2009.

3.2.3.1 The triad business relationship

How a company should interact with other companies brings to the forefront the importance of the relationships within a wider network. For a company that is part of the supply chain, the interaction with the other companies in the same supply chain is a critical factor for success. Some relationships are easy to recognize as important while other relationships can be harder to locate the actual importance and its impact on profit. Because of this sub optimization is common within a supply chain with multiple companies. Companies along the supply chain have different developments and skill. Therefore it can be hard to cooperate sometimes due to the different perceptions of improvements. However, in many of today's supply chains there are many companies held together in a non voluntary relationship by a third party. The interconnection has therefore become very important in order to deliver a good final product to the consumer.¹²⁹ In most literature today, the relationship of customer and supplier is well studied and there are many different models for managing this relationship. However, supplier relationship with their customer's other suppliers, i.e. a triad, is less developed and more difficult to manage.

Through earlier studies, different triads have been identified by investigating the possible relationships consisting of strong, weak, or absent ties among the three actors involved. Usually it is not enough to just consider dyadic relationships within the triad since this refers to the forbidden triad which hardly ever occurs. Given that there is one, Granovetter believes that the three actors are connected in some way or another even if the ties are very weak.¹³⁰

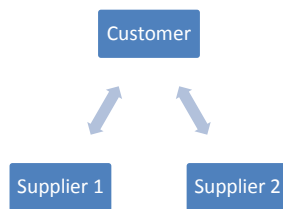


Figure 16 - The forbidden triad¹³¹

According to Blankenburg's study of triad relationships within the industrial networks of Swedish companies, she recommends four different modes of managing connections within a triad relationship, depending on what type of interaction and information exchange that can be observed between the focal relation and the third party.¹³²

¹²⁹ Ford, D. et al., 2003

¹³⁰ Granovetter, M., 1973

¹³¹ Granovetter, M., 1973, Picture at p. 1363

¹³² Blankenburg, D. and Johanson, J., 1992

Control Process for secondary packaging

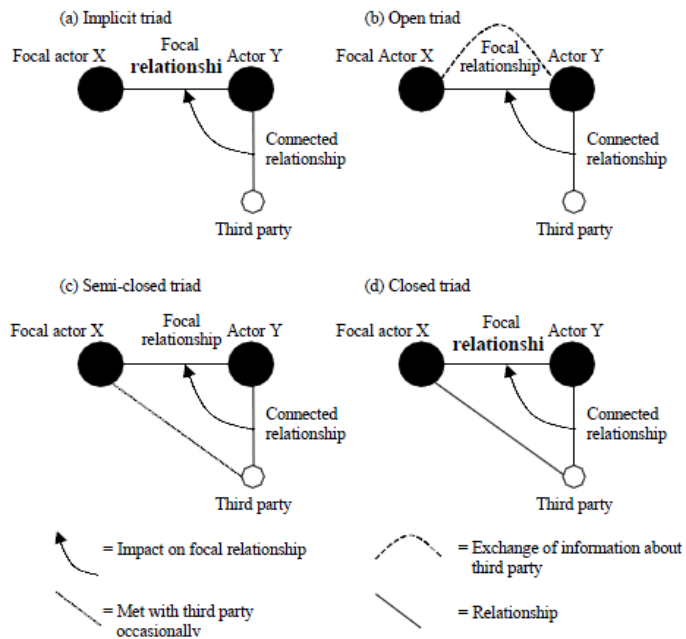


Figure 17 - Four ways of managing triad relationships¹³³

Major business relationship has been founded, regardless the industry, to be connected through five different interdependencies; technology, social relations, administrative routines and systems, knowledge and legal ties.¹³⁴

¹³³ Blankenburg, D. and Johanson, J., 1992. Picture: p. 10

¹³⁴ Ford, D. et al., 2003

3.3 Packaging Performance

In this chapter we have chosen to investigate different test methods that can be performed to analyze the performance of the secondary package, but also to look into the impact from the climate. The test methods discussed in this chapter are international standard test methods. The most common test methods have been chosen and are not to be considered the only one existing. The test methods are used worldwide although the equipment is less advanced in developing countries.

3.3.1 The packaging system

A package is usually used with the purpose to protect, preserve, and communicate the product. But the purpose with the packaging is not only to protect the product from external influences but also to protect the environment from the product itself. The package that is in

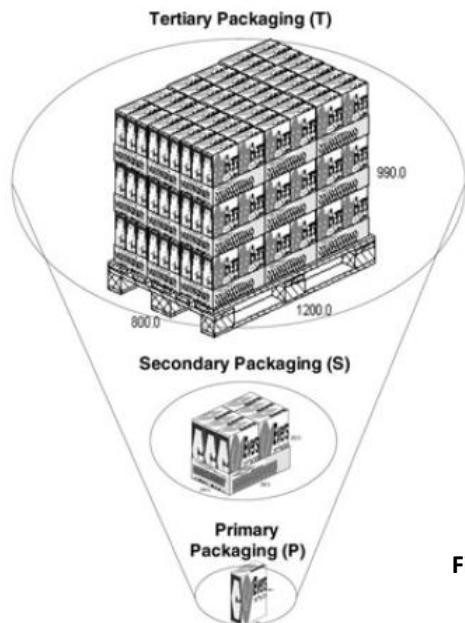


Figure 18 - The packaging system

direct contact with the product is called primary package. To further protect and to provide easy handling, the primary packages are stacked into another bigger package called secondary package. This package is often to be exposed to most of the influences throughout the distribution. To facilitate the distribution, several secondary packages are assembled onto a pallet. The pallet with its primary and secondary packages is defined as a tertiary packaging. The whole assembly of all these packages is called a packaging system. The system is shown in Figure 18.¹³⁵

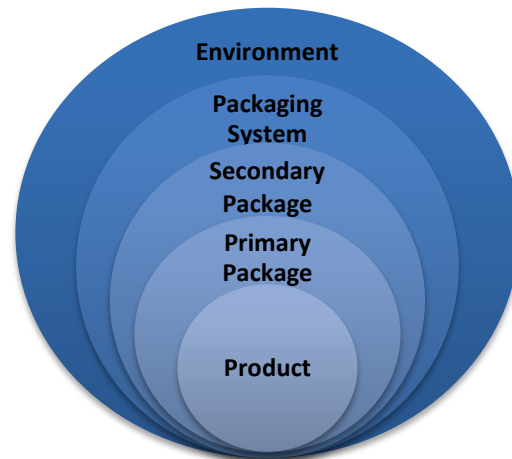


Figure 17 - Different shells affecting the product

¹³⁵ Hellström, D. and Saghir, M., 2007

3.3.2 Regular Slotted Container

A regular slotted container (RSC) is the most commonly used version of a corrugated cardboard box. This means that all flaps are of equal length and are suppose to meet when closed. The content in the box is protected by one corrugation on the sides and two thicknesses on the top and bottom.¹³⁶

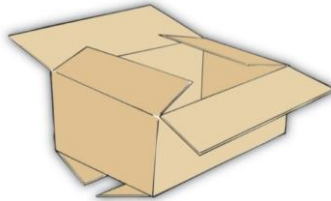


Figure 19 - Regular Slotted Container¹³⁷

3.3.3 Corrugated cardboard

Corrugated cardboard is composed by two different components; the liner and the fluting (corrugated medium) as shown in Figure 20¹³⁸.

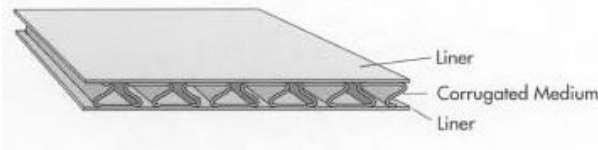


Figure 20 - The structure of corrugated cardboard¹³⁹

Corrugated cardboard exists in different configurations, up to triple-wall. The most common version of a RSC box is made out of two liners and one flute, also called single-wall, shown in the middle in Figure 20. The number of liners can vary from one to four, and the layers of fluting are therefore up to three. The flute profile determines the thickness of the corrugated cardboard, and can be almost half a centimeter thick. Normally, the thicker the fluting, the stiffer the corrugated cardboard, but it also leads to a higher material cost.¹⁴⁰

The general importance of the liner is to give strength and stiffness to the corrugated cardboard, whereas the fluting connects the two liners and stabilizes and protects the content from shocks.¹⁴¹

The most important raw material in corrugated cardboard is paper. All different papers are made of cellulose fibers that are extremely small. During the pulp process the fibers hook up together with the fiber fragments and the paper is being made.

¹³⁶ Schueneman, H., Paper and corrugated paperboard, Westpak

¹³⁷ Figure:http://www.interplas.com/product_images/Regular-Slotted-Big.jpg 2010-05-05

¹³⁸ Rosaler, R., 2002

¹³⁹ Figure:http://www.inouting.com/public/pen/How_corrugated_cardboard_is_made_A_finished_pie
[e_of_corrugated_cardboard.jpg](http://www.inouting.com/public/pen/How_corrugated_cardboard_is_made_A_finished_pie)

¹⁴⁰ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁴¹ Svenska Cellulosa Aktiebolaget, SCA Packaging Sweden AB, 2009

Control Process for secondary packaging

The more the paper has been processed, the stronger is the paper. The fibers bind

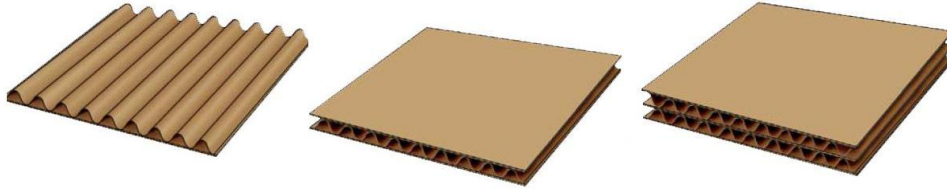


Figure 21 - Different configurations of corrugated cardboard; one-side, single-wall, and double-wall

themselves together when the water has disappeared, and dries in the paper machine. Thus, one doesn't need to add any kind of glue to create the bonding between the fibers. The size of the fibers also affects the strength; typically the paper gets stronger as the fibers get longer. In Scandinavia, really long and strong fibers can be found thanks to the climate and vegetation where spruce and spine are two trees that supply a really good paper quality. In warmer countries, the paper is often made from trees with shorter fibers, but also from sugar canes and rice.¹⁴² Since the material differs from country to country, international standards for corrugated cardboard do the same.¹⁴³

3.3.3.1 Flute Orientation

Corrugated cardboard packages are usually made with the flute direction running vertically. This provides better stacking strength on the vertical direction. However the fluting direction can be horizontal. In the case of horizontal fluting direction, the packages should be stacked, stored and transported lying on their side. This will provide the packages with the greatest strength, when the fluting is orthogonal to the compressive forces, and such packages are typically end-opening. Most recent tests under tight laboratory conditions and pre-conditioning of the packaging showed a 50% difference in strength between a corrugated cardboard box with vertical fluting versus horizontal fluting.¹⁴⁴

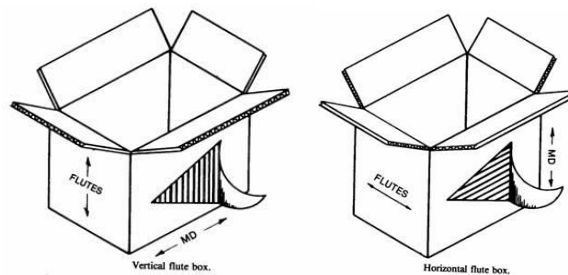


Figure 22 - Different directions of the fluting

3.3.3.2 Printing on corrugated cardboard packages

Printing on the outside of a box can cause damage, since it can reduce the strength of a corrugated cardboard just as efficiently as a die cut hole can. This is done by the pressure from the printing rollers needed to obtain a good print, which will crush the structure of the fluting and thereby weakening the board. A study made by Colgate Palmolive Peet Company

¹⁴² Svenska Wellpappföreningen, 1996

¹⁴³ Russell, P., Talk Packaging, 2010-05-13

¹⁴⁴ Russell, P., Talk Packaging, 2010-05-13

Control Process for secondary packaging

shows that a corrugated cardboard package starts losing compression strength when printing exceeds 20% coverage.¹⁴⁵

3.3.3.3 Size of the corrugated box

It is important to control the dimensions of the package so it can fit properly into the chosen packaging pattern and onto the pallets. If the secondary package is designed too large there will be overhang, which most likely will lead to secondary package deformation.¹⁴⁶

3.3.3.4 Climate impact

Since corrugated cardboard is made out of a hydroscopic material, it will have very different strength properties at different humidity levels. For almost all standard testing, conditions of 23°C and 50% Relative Humidity (RH) are required. In addition, the corrugated cardboard should be held at 39°C and 30% RH for 24 hours to allow the paper to stabilize before testing. This phase is called preconditioning, which makes the paper transition from a dryer state to standard conditions.

This helps ensure that the required humidity conditions of the corrugated cardboard can be reached in a minimum period of time.¹⁴⁷

As can be seen in Figure 23¹⁴⁸ the air during preconditioning actually contains more water than during standard conditions, even though it is supposed to be "drier". The importance here is that it is the experienced humidity that affects the corrugated cardboard. This can be explained

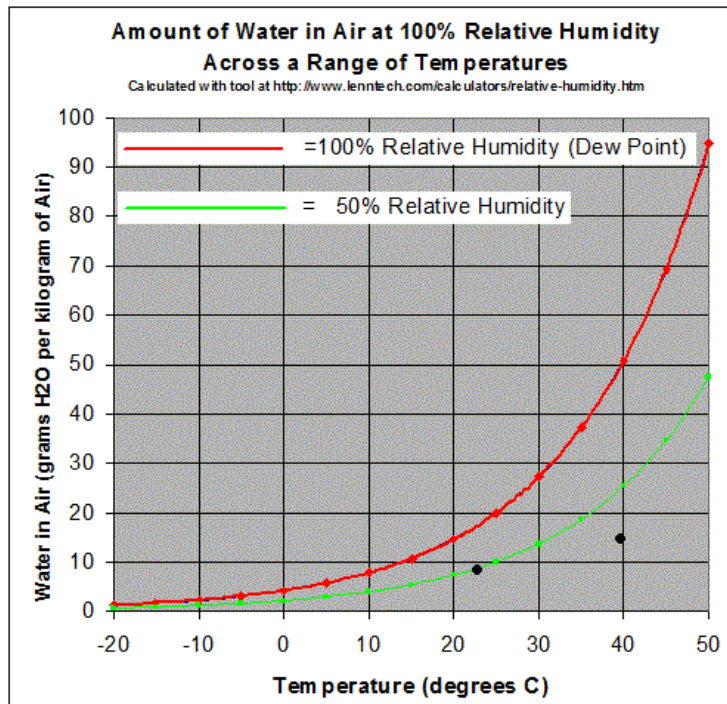


Figure 23 - The possible amount of water that can be kept in air at different temperatures

by an example considering two pieces of paper lying outside, one of them in summer time, and the other in winter. The highest absolute air humidity is obtained during summer, whereas the highest RH is obtained during winter. We all know that the piece of paper lying

¹⁴⁵ Russell, P., Talk Packaging, 2010-05-13

¹⁴⁶ Russell, P., Talk Packaging, 2010-05-13

¹⁴⁷ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁴⁸ http://www.conradaskland.com/blog/wpcontent/uploads/2007/07/relative_humidity.png, 2010-05-

Control Process for secondary packaging

outside in winter is wet and has significantly higher moisture content. Therefore it is the RH that is the interesting condition to measure.¹⁴⁹

Generally speaking, the higher moisture content in paper, the lower will the bearing capacity be. As shown in Figure 24, the box compression strength decreases significantly with an increase in relative humidity.¹⁵⁰ At 90% RH, just around 40% of the strength of the box is left. This environmental scenario is not unusual in developing countries, and becomes even harsher during the nights when RH increases. Furthermore, the strength of corrugated cardboard decreases even more when it is brought to an environment that slowly goes from 50% RH to 70% RH, than if it would have been exposed to an environment with 70% RH directly. This phenomena is difficult to explain, but emphasizes that a variation in RH is decreasing the strength of corrugated cardboard even more.¹⁵¹

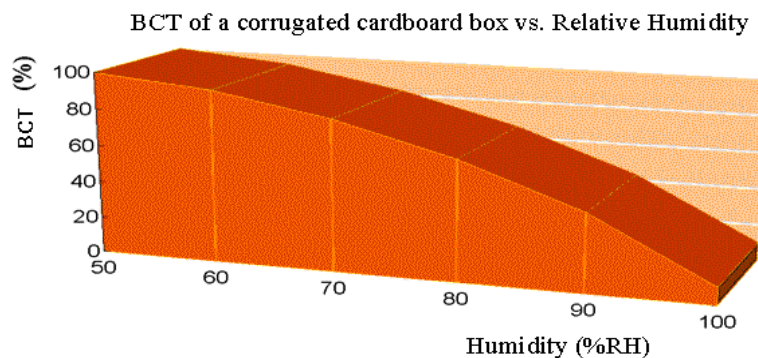


Figure 24 - Displaying the correlation between the BCT and the Relative Humidity¹⁵²

Another test was carried out in Lund and Sundsvall at three constant climates; 50% RH, 70% RH and 90% RH. The boxes were subjected to a normal top-to-bottom compression with a short-term ramp loading in the different environments. The influence of the RH was obvious, and resulted in various results. The short-term ramp loading strength with an average for 10 boxes, starting with 50% RH, resulted in; 3706N, 2879N and 1444N. It can be denoted that the strength at 70% RH is 0.78 times the strength at 50% RH and the strength at 90% RH is 0.39 times the strength at 50% RH. It can also be noticed that the strength at 70% RH is twice the strength at 90% RH¹⁵³. This test corresponds very well with the graph generated by China Package Test Center, and strengthens the difference in performance at different environments.¹⁵⁴

3.3.4 Test methods

As mentioned in the introduction, all the packages within the packaging system are strongly dependent on each other. It is important that all the different packages have a sufficient performance in order for the packaging system to arrive to its customer in a good condition.

¹⁴⁹ Interview with professor at the department of Structural Mechanics, LTH, 2010-04-13

¹⁵⁰ Tetra Pak Test Report Document 2551

¹⁵¹ Interview with professor at the department of Structural Mechanics, LTH, 2010-04-13

¹⁵² China Package Test Center, Tetra Pak Test Report Document 2551

¹⁵³ Gustafson, P.-J. and Nyman, U., 2005

¹⁵⁴ China Package Test Center, Tetra Pak Test Report Document 2551

Control Process for secondary packaging

The secondary package plays a big role when it comes to protecting the primary package. Thus if it is of an inadequate quality, the system will most likely collapse and fail to retain the original quality of the primary package. The difficulty in dimensioning the secondary box is that there are so many factors involved during the distribution that have an impact on it. If the purchase of testing equipment could help ensure the right quality of the secondary packages, the profit potential should be good, bearing in mind that the raw material cost more than 50% of the box itself. From that point of view, the cost of testing equipment is negligible in relation to the profit which it can give.¹⁵⁵

3.3.4.1 Edge Compression Test

The Edge Crush Test (ECT) describes how to determine the edgewise compression strength parallel to the flute of a short column of corrugated cardboard, normally the size 25 x 100 mm. To perform this test, one also needs the equipment in Figure 8. The specimen is placed on its edge between two plane crushers where it's pressed together until collapse. The load is applied with a given loading speed, usually 10-15 mm/min. The maximum load that the specimen can sustain before collapsing is measured and the result is normally given as force per length unit, e.g. kN/m. According to Westpak¹⁵⁶ and Svenska Wellpappföreningen¹⁵⁷, the ECT is the most important quality when it comes to the stack ability of a box, especially when the goods inside it cannot support the load. Also, according to Westpak, the ECT strength of a specimen corresponds to the top-to-bottom compressive strength of a cardboard container.¹⁵⁸

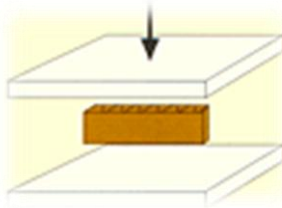


Figure 25 - The equipment of an ECT¹⁵⁹

There is no doubt that the edgewise-compressive strength is one of the most important properties of corrugated cardboard. However, when the ECT was first introduced, one realized that there was a problem in that the specimens were crushed in the ^{end} surfaces. This was a problem since one didn't know whether the method really measured the true edgewise-compressive strength or whether the test result is an indication of how well one has managed to cut a test piece with parallel edges.¹⁶⁰

The reason why one strives to avoid compression failure in the end surfaces is that the real failure never takes place there. Therefore, there are five different ways of performing the test today, where they all try to avoid edge compression failure. In order to decrease the stresses and avoid edge compression failure, the specimen is cut differently and glued. Among all the different ECT-methods, the circular neck-down method is superior in all aspects compared to all the others and is illustrated in Figure 26. This cutting assures that

¹⁵⁵ Markström, H., 1988

¹⁵⁶ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁵⁷ Svenska Wellpappföreningen, 1996

¹⁵⁸ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁵⁹ <http://www.multipakend.com/index.php?topic=9&lang=eng>

¹⁶⁰ Markström, H., 1988

Control Process for secondary packaging

failure will first occur in the middle of the specimen. It is also a very simple cut with two half circles.¹⁶¹

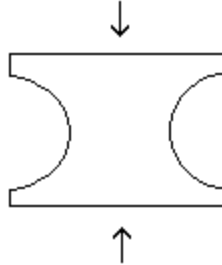


Figure 26 - The FPL neck-down method

The five different methods may give up to a 30% difference in test results, which must be considered unsatisfactory. Altogether, the ECT is useful to compare the edgewise compression strength between different material combinations. Later on, this procedure has also been utilized as a defining characteristic of paperboard material that complies with carrier regulations. It is thus a good method to verify the quality and the composition of the pulp in corrugated cardboard¹⁶².

3.3.4.2 Box Compression Test

When a shipping container is handled and shipped, one of its most interesting functions is its ability to resist stacking loads. The Box Compression Test (BCT) describes how to determine the resistance of the box to compressive forces. The box is compressed between two flat platens which are hydraulically driven, as in Figure 27¹⁶³. The method is generally acknowledged to be that which best corresponds to practical performance in the stacking of corrugated cardboard boxes. Throughout the testing, a recording device is connected in order to plot the load on one axis, and deformations on the other. With the results, one can observe how the material and design of the box behave and whether or not it is a linear deformation¹⁶⁴. A requirement when performing this test is that the compression speed is fixed, normally between 10-13 mm/min. It may seem strange that the speed is specified that accurately, but bear in mind that a corrugated cardboard box is exposed to varying pressures, from short shock loads to more than one-year-long static loads. A box exposed to a static load which is 80-90% of the measured BCT-value will fail after a few minutes.¹⁶⁵



Figure 27 - A BCT is executed

¹⁶¹ Markström, H., 1988

¹⁶² Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁶³ http://wb3.itrademarket.com/pdimage/29/686429_atboxcompressiontester.jpg

¹⁶⁴ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁶⁵ Gustafson P.-J. and Nyman U., 2005

Control Process for secondary packaging

Under a static load which is 60% of the BCT-value, a month may elapse before failure occurs. The compression speed has therefore no relevance for practical loading cases, but is very important for a comparison between different tests. Practical tests have shown that only 20-35% of the measured BCT compression strength can be relied upon, i.e. a safety factor of 3-5 times is required.¹⁶⁶ Nevertheless, the BCT-value has shown itself to be a very important property to describe the performance of a corrugated cardboard box during stacking and transportation. Although, a minimum of five containers should be tested in order to get a reliable result.¹⁶⁷

When the box is continuously loaded to its limit, the box will first buckle out elastically, while the vertical edges of the box remain straight. Then, failure will appear in the corner regions. Afterwards, the box will break through compression failure in the inner liner. The maximum load-bearing ability of the corrugated cardboard box will therefore depend not only on the compression load-bearing ability but also to a great extent, on the ability of the corrugated cardboard to resist buckling, i.e. its bending stiffness. The higher bending stiffness of corrugated cardboard, the higher will its BCT-value become. It should be noted that the BCT is a test that is instantaneous and only lasts for a few seconds.¹⁶⁸

3.3.4.3 Water absorption, COBB

The test method called COBB measures the water absorption rate of the corrugated cardboard specimen. The result is given as the amount of water picked up per unit surface area. The specimen is submerged 10 mm in water and is then under the surface during a certain amount of time. It is important to specify the duration of the test to properly know the absorption rate.¹⁶⁹

This test gives an insight in how much the corrugated cardboard is affected by its environment and climate. For instance, in tropical countries where the air humidity is extremely high, it is important that the material doesn't absorb too much water in order to retain its strength and remain stackable. The less water the material will absorb, the better it will resist to high air humidity. Both ECT and BCT will certainly be affected of the ability to resist water. Nevertheless, the performance is not directly dependent on the COBB value, but the relative air humidity where it is being distributed.¹⁷⁰

¹⁶⁶ Markström, H., 1988

¹⁶⁷ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁶⁸ Markström, H., 1988

¹⁶⁹ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁷⁰ Markström, H., 1988

3.3.4.4 Flat Crush Test

The Flat Crush Test (FCT) measures the resistance of the flutes to crushing applied orthogonally to the surface of the corrugated cardboard under certain conditions. The test is satisfactory for single faced or single-wall corrugated board but should not be used for double wall or triple wall board. With this method, the specimen rests on the rigid support and is tested at a constant strain rate, see Figure 28¹⁷¹. This is supposed to give a good comprehension of the dampening ability of the corrugated cardboard. The FCT is a measure of the flute rigidity of the corrugated board and is strongly dependent on the height of the flute. The higher the FCT value is, the better is the combination of flute formation and the stronger the flute.

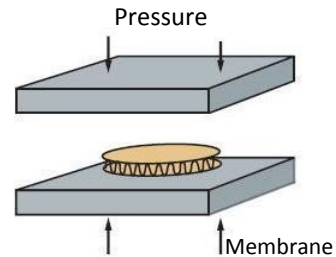


Figure 28 - Flat Crush Test

A low FCT indicates a low strength, leaning, and/or crushed flutes. One must be careful when measuring flat crush resistance to ensure that the measure of resistance adequately simulates the reaction to crushing forces observed during the container's actual use. This method generally does not simulate these conditions¹⁷². Therefore, the correlation may be low between flat crush and the ability of the box to perform in the field. In an investigation carried out at the Finnish Pulp and Paper Research Institute (KCL) in Finland, it was found that the FCT-value was almost unchanged even if the corrugated cardboard was pre-compressed to 60% of its original thickness. On the other hand, a dramatic reduction in the bending stiffness was observed, showing that only 50% of it was left.¹⁷³ When performing the test, the specimen is placed between two rigid platens of a compression test machine and compressed at a constant rate. A minimum of 10 specimens should be used when carrying out the test in order to get a reliable test.^{174, 175}

3.3.4.5 Pin Adhesion Test

This method is used to determine the force required to separate corrugated cardboard between the flute tips of the corrugated medium and its liner board facings. Good adhesion of the corrugated medium to its facings is important in obtaining high quality corrugated boxes. The pin adhesion test provides a means of determining the nature and strength of the bond formed during the combining operation and may be

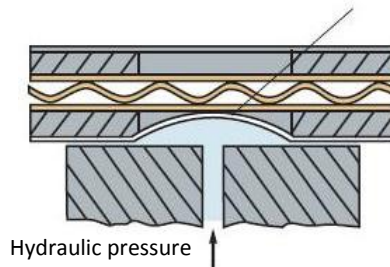


Figure 29 – Burst Strength test

used to detect some manufacturing defects such as poor adhesive penetration, spotty adhesion, and container board with low internal bond strength. The test will measure the force required to separate selectively either the inside or outside facings of corrugated board. The test procedure utilizes a pin adhesion device that when inserted into a given size corrugated board will force the upper or lower facing to be removed from the corrugated medium. The force necessary for this removal is referred to as the pin adhesion value. As

¹⁷¹ <http://www.fardigpackat.se/Upload/Wiki/welltest.jpg>

¹⁷² Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁷³ Markström, H., 1988

¹⁷⁴ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁷⁵ Svenska Cellulosa Aktiebolaget, SCA Packaging Sweden AB, 2009

with all other paper tests, it is important that sampling and conditioning be done according to the required test procedures.¹⁷⁶

3.3.4.6 Burst Strength

Corrugated cardboard is subjected to burst testing just as paperboard is. The test is normally only conducted on single-wall corrugated cardboard since the accuracy of a double-wall is very poor due to the insufficient simultaneous burst of the multiple facings. Triple-wall corrugated board cannot be tested suitably by the burst test method.¹⁷⁷

The test is carried out with a specimen shaped like a disc, placed between two rings and is then charged with a rubber membrane with hydraulic pressure that measures the pressure when bursting. The test is simple and easy to execute but must be recognized that it is subject to serious errors if instrument, diaphragm, and gauges are not properly maintained or if improper procedures are used. It is important that the testing is conducted at standard temperature and humidity conditions and that the box is preconditioned.¹⁷⁸ The Bursting Strength (BS) is a good measure of the uniting ability of a shipping box, but it also gives an indication of the character of the materials used in the manufacture of the box¹⁷⁹. On the other hand, testing the BS gives no direct information regarding the ultimate performance of a design or construction of a finished container. The situations when the BS has its critical importance are during dynamic loads. This could be when the box is dropped or when the content simply wants to burst the shipping box. The BS of corrugated cardboard is equal to the sum of the bursting strengths of the liners and 10% of the bursting strength of the fluting medium. According to *Markström*, one advantage of using BS in the quality control is that defects caused by too high compression forces in the bonding process at the single facer can be exposed. The BS will increase if the grammage increases, and it has therefore been incorrectly assumed that there is a direct relationship between BS and BCT.¹⁸⁰ (Figure 29¹⁸¹)

3.3.4.7 Bending Stiffness

It has long been known that the bending stiffness of the cardboard is one of the most important properties for the attainment of high performance in corrugated cardboard boxes. The bending stiffness of corrugated cardboard is completely determined by the thickness of the board and the ability of the outer and inner liner layers to resist tensile and compression forces¹⁸². Therefore the bending stiffness will change if the board thickness, the raw material type or the grammage of the liners vary. The method is very useful when one wants to compare the quality of the corrugated cardboard before and after the converting process, i.e. when the liner and fluting is being put together. It is rather common with compression damage, such as partly crushed flute profile which is difficult to detect in normal thickness testing. The bending stiffness can be

expressed in a simplified expression as: $S_b \approx 0.5 \times D_L \times T^2$ ¹⁸³

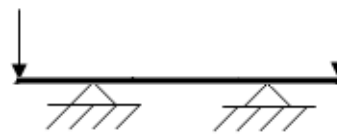


Figure 30 - Bending stiffness

¹⁷⁶ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁷⁷ Markström, H., 1988

¹⁷⁸ Schueneman, H., Paper and corrugated paperboard, Westpak

¹⁷⁹ Svenska Wellpappföreningen, 1996

¹⁸⁰ Markström, H., 1988

¹⁸¹ <http://www.fardigpackat.se/Upload/Wiki/welltest.jpg>

¹⁸² SCA Packaging Sweden AB, 2009,

¹⁸³ Markström, H., 1988

Control Process for secondary packaging

Where D_L = the tensile stiffness of the liner, and T = the thickness of the corrugated board. Since the thickness is squared in this expression it is obvious that a small change in thickness is enough to cause an important change in the bending stiffness. When a bending stiffness test is performed, the fluted layer is subjected to compression forces which, in combination with the sensitivity of the bending stiffness to changes, make the method extremely suitable as a production control test¹⁸⁴.

When performing the bending stiffness test there are normally two different methods to use: the 3-point or the 4-point method. The 4-point method can be seen in Figure 30. It is the most common method used and it also gives the most accurate results. The 3-point method leads to unacceptable test errors due to the shear forces which arise during the bending.¹⁸⁵

3.3.5 Packaging choice

A package that is sized and optimized for the entire supply chain eliminates unnecessary damage that would otherwise occur. However, too high specified requirements of the packaging will not be economically justified. Therefore, it is important to find a balance between cost and performance that suits the studied supply chain, according to Figure 31.¹⁸⁶

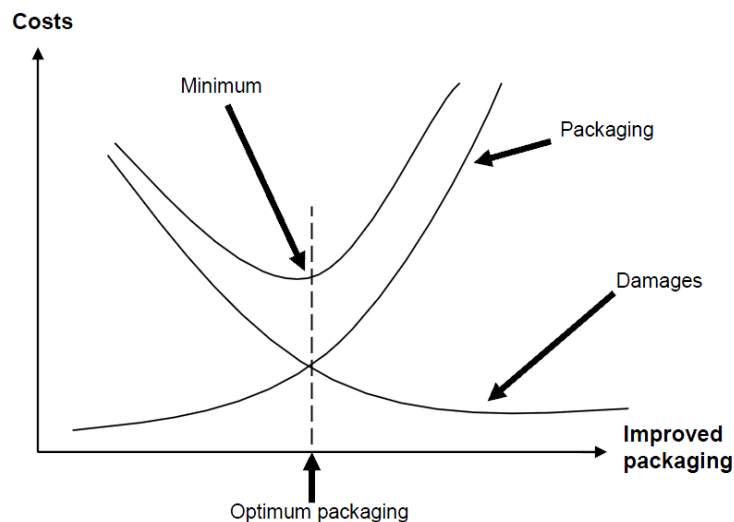


Figure 31 - The theoretical optimum packaging

¹⁸⁴ Kolseth, P., et al, 1987

¹⁸⁵ Markström, H., 1988

¹⁸⁶ Johansson, K. et al, 1996

3.3.6 Sampling

When the batch is delivered to the dairy, several thousand corrugated cardboard blanks arrive at the same time, easily packed and distributed over a day or two. Since it is impossible to test all these blanks, a more efficient way of testing has to be done. By using statistics, an accurate comprehension of the batch's performance can be created. In order to calculate the amount of samples from a testing batch, a one-sided confidence interval of 95% is recommended. Given factors such as the standard deviation and probability of a secondary package failing the test has to be considered and used for the calculations. Together with the amount of corrugated blanks arriving at the customer, an amount of samples can be calculated in order to get a statistical correctitude. However, this has not yet been available for the authors since no statistical data has been presented.¹⁸⁷

According to FEFCO, (European Federation of Corrugated Board Manufacturers), the determination of the total number of individual samples to be taken, as a minimum, from a batch will be determined by the formula:

$$n = N^{1/3}$$

Where: n = total number of individual samples, and N = total number of sheets or cases in the batch.

RECEIVED BATCH SIZE (N)	SAMPLE SIZE (n)
≤ 1000	10
1001-5000	15
5001-10 000	20
10 001-20 000	25
20 001-30 000	30
> 30 000	40

(the minimum in any case will thus be 10, and the maximum 40)¹⁸⁸

¹⁸⁷ Blom, G. et al, 2005

¹⁸⁸ FEFCO, 1984

3.4 Quality

After the Second World War, the interest for quality grew and the notion of quality took a more holistic view as efforts were taken to rebuild and enhance the Japanese industry¹⁸⁹. During the 1970s quality became an important aspect in many companies in developed countries and methods for managing, controlling and assurance of quality were implemented in almost every level of the companies' business¹⁹⁰. However, the definition of quality varies widely and it also has numerous meanings in different situations. According to the International Organization for Standardization, quality can be defined as:

"The degree to which a set of inherent characteristics fulfills the requirements, i.e. needs or expectations that are stated, generally, implied or obligatory" ISO 9000:2000¹⁹¹

According to Bergman and Klefsjö, the word quality was initially used by the roman politician Cicero (106-43 B.C.)¹⁹² Yet, there are recognized researchers within management, also known as gurus that have given their definitions of quality. Some of the well known gurus are; Joseph M. Juran, Edward W. Deming, Philip B. Crosby and Kaoru Ishikawa.¹⁹³ Most of them agree to that quality should be justified in terms of customer satisfaction and specifications.¹⁹⁴ Philip Crosby also highlights the importance of defining quality in order to be able to manage and understand it.¹⁹⁵

In this Master Thesis, quality will be defined as *"The quality of a product is its ability to satisfy, or preferably exceed, the need and expectations of the customers"*.¹⁹⁶

The concept of quality can be divided into five different approaches; Transcendent, Product based, User based, Value based and Manufacturing based.¹⁹⁷ The transcendent approach is built on Platon's view of beauty, which means that the quality lies in the eye of the beholder. The user based view can be seen as a development of the earlier approach, here the quality is not something the buyer can decide on before having it used. The product based view, on the other hand, rests in that quality shall be objectively and exactly measureable in extent to the predetermined desirable characteristics. By this approach, quality is not something the user can determine upon; since quality is something a product inherits.

Manufacturing based approach relates to the fulfillment of tolerances and requirements in production. Finally, the value based view defines quality as a performance at an acceptable cost.¹⁹⁸

¹⁸⁹ Hoyer, R.W., and Hoyer, B.Y., 2001

¹⁹⁰ Sandholm, L., 2006

¹⁹¹ Bergman, B., and Klefsjö, B., 2003

¹⁹² Bergman, B., and Klefsjö, B., 2003

¹⁹³ Black, S. and Porter, L., 1996

¹⁹⁴ Hoyer, R.W., and Hoyer, B.Y., 2001

¹⁹⁵ Crosby, D., 1998

¹⁹⁶ Bergman, B., and Klefsjö, B., 2003

¹⁹⁷ Bergman, B., and Klefsjö, B., 2003

¹⁹⁸ Bergman, B., and Klefsjö, B., 2003

Control Process for secondary packaging

Quality can also be divided into different dimensions, describing possible improvement areas. The quality dimensions for a product for example can be:¹⁹⁹

- Reliability
- Performance
- Maintainability
- Environmental impact
- Appearance
- Flawlessness
- Safety
- Durability

According to this, quality may have different meanings in different cases. Reliability addresses to the measurement of how often problems occur and how serious they are. Performance describes different characteristics that customers desire. Maintainability signifies how easy or hard a problem can be detected, localized and taken care of. Environmental impact, can be both how the product affects its surroundings but also how the surrounding environment impinge on the product. The appearance applies to the aesthetic look of the product, which also concerns the flawlessness of not finding any errors at the time of purchase. After the purchase, safety guarantees that the product causes no damage to person or property and durability ensures that the product can be used, stored and transported without being damaged.²⁰⁰

Nowadays, an increasing number of private as well as public companies and organizations regard quality issues as an integral part of daily operations. This work is often based in what is known as Total Quality Management, TQM. According to Bergman et al., TQM can be interpreted as:

*“a constant endeavour to fulfill, and preferably exceed, customer needs and expectations at the lowest cost, by continuous improvement work, to which all involved are committed, focusing on the processes in the organization”.*²⁰¹

or

“...the integration of all functions and processes within an organization in order to achieve continuous improvement of the quality of goods and services. The goal is customer satisfaction.” by Vincent and Joel (1995)²⁰²

Quality development according to TQM aims at creating an increase in customer satisfaction with a reduction in the amount of resources used. The purpose of quality development is to increase profitability by having more regular customers and at the same time, minimize costs that arise from faults and defects. Generally this is a long-term improvement, however small improvements early in the supply chain can generate large savings along the distribution chain. By constantly making business improvements that enhance the customer satisfaction,

¹⁹⁹ Bergman, B., and Klefsjö, B., 2003

²⁰⁰ Bergman, B., and Klefsjö, B., 2003

²⁰¹ Bergman, B., and Klefsjö, B., 2003

²⁰² Bowen, P.A., 2002, p49

the company will have greater success in expanding their business and enlarge their market share.²⁰³

3.4.1 Process control

In many cases we experience variation we cannot specify. The Japanese quality expert, Kaoru Ishikawa, once said that *we live in a world of dispersions*. Variations can be divided into assignable variation and random variation. There is no clear boundary between these two kinds of causes to variation, what is assignable or not depends on the information received from the process of interest. However, variation in the manufacturing process may be due to many factors, both individual and in combination which makes them hard to locate. Examples of causes in variations can be inhomogeneous incoming material, variation in temperature and humidity, vibrations, and human management.²⁰⁴

3.4.1.1 Types of variation

In order to understand how a process control operates, the reader has to have some knowledge within the principles of variation. Firstly, variation can be divided into sporadic or random.²⁰⁵

The term sporadic variation is normally used for variation of a specific and unusual error or change. This could be errors resulting from human mistakes or changes in material. This kind of variation is most likely to have a clear assignable cause and can therefore be traced and followed through with a preventative action to eliminate the cause of the defect.

The random variation, also known as inherent variation, can be far more difficult to reduce since the root of the cause can be difficult to determine. However, eliminating random variations often have potentially higher rewards than the elimination of sporadic variations. Removing these types of variation often gives the company a competitive edge over its rivals. Before studying the cause of random variation, it is necessary to remove all assignable causes as these will misrepresent the data and lead to misinterpretation.²⁰⁶

In order to overcome the problems that occur due to assignable causes, changes have to be made to the overall process. Many of the assignable causes are often related to negligence in motivation which causes mistakes to happen or one shouldn't cry over spilt milk. However, the root cause often lay in the process system which allows the employee to repetitively and routinely override warning signals. Unless the root cause is tackled, the likelihood is that this common cause will manifest itself again.

The fishbone diagram technique is a useful tool for tracing root causes of assignable variation. According to Deming's work of variation, 94 % of all organizational problems results from random variation in the system. Deming, Juran and Crosby are all convinced that the majority of errors are traceable (according to Juran 80 % and to Crosby 95-100%) and is a result of the management's lack of knowledge within control processes, the human factor, equipment, materials and environment. When dealing with cause identification of random variation, it is usually necessary to isolate a range of variables which may have an impact on observed performance.²⁰⁷

²⁰³ Bergman, B., and Klefsjö, B., 2003

²⁰⁴ Bergman, B., and Klefsjö, B., 2003

²⁰⁵ Pike, j. and Barnes, R., 1996

²⁰⁶ Pike, j. and Barnes, R., 1996

²⁰⁷ Pike, j. and Barnes, R., 1996

Control Process for secondary packaging

These have to be deeply studied and according to Pike et al, this can be done in four stages:

1. Study of symptoms
2. Hypothesizing the cause is commonly achieved through brainstorming and cause and effect charts.
3. Data collection and display using methods such as customer (internal and external) survey, control charts or process mapping.
4. Data analysis using tools like flow charts.²⁰⁸

3.4.1.2 Four categories of quality

The development of quality movement can be divided into four phases where quality management enhances the improvement made before and after production. By analyzing the customer's needs and preferences before production, the company can avoid entering the market with an unprofitable product. The next phase is the quality inspection which aims to check finished products and defect units which will then be scrapped or re-worked. This has for long been the most widely used method for reviewing quality in manufacturing. However, several companies have increasingly begun to review the quality management by introducing quality control, which tries to draw attention to clues that could lead to defective units during production. Quality control was introduced into manufacturing organization because product quality is one of the most important factors that directly affect marketability and customer's satisfaction. Quality control can be divided into two different controls, namely statistic process control, SPC, and statistic quality control, SQC. SPC aims to control the process performance and SQC focus on analyzing variations in manufacturing processes and putting the measurement data into a control chart.²⁰⁹ The SQC aims to identify as many causes to assignable variations as possible and then eliminate them²¹⁰.

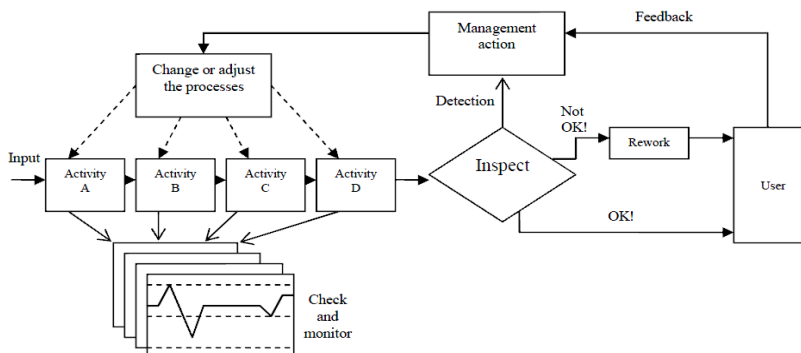


Figure 32 - Process control²¹¹

According to Evans and Lindsay, quality control methods can be used as a elementary tool for daily management of processes but it is also essential for finding problems and working with it continuously to achieve long-term improvements. Thereby having a good quality control system is necessary for manufacturing companies before having any extensive quality management structure. All control systems includes three elements; having a standard or

²⁰⁸ Pike, j. and Barnes, R., 1996

²⁰⁹ Sandholm, L., 2006

²¹⁰ Evans, J.R., and Lindsay, W.M., 2002

²¹¹ Melan, E.H.,1992

Control Process for secondary packaging

goals, do measurements of performance and comparison between results and standards for corrective action. An effective quality control system must have quality policy, mode of procedure and specification on how to perform process control, inspection and testing.²¹²

By being proactive, necessary amendments can be made to avoid later defects, which in the long term lead to cost savings. The preventive work in production over time has led to an increase in understanding of the quality of input goods. Thus, the procedures on how to deal with incoming materials, and measuring instruments and claims have gradually been developed. These tools are a part of the proactive quality system focusing on the arriving control stage of inputs, also known as quality assurance.²¹³

Quality assurance is a main part of the quality control and includes three important factors:

²¹⁴

- The quality policy must be assured in an organization and meet the requirements of the consumer.
- To be able to export, products must meet the requirements of consumers abroad.
- The importance of quality assurance must be known to the top management in the organization and management shall work actively to achieve the goal.

3.4.1.3 *Statistic quality control*

Working with continuous improvements in order to create a learning organization is a must in the TQM philosophy. An emphasis on problem awareness within the organization should be part of the daily work.²¹⁵ When a problem has been identified it can be treated in accordance with the Plan-Do-Check-Action-method, (PDCA-method). The PDCA-method is also called the Control Circle. It is an extension of the Deming's cycle and according to Ishikawa, it is divided into six steps for gaining control.²¹⁶

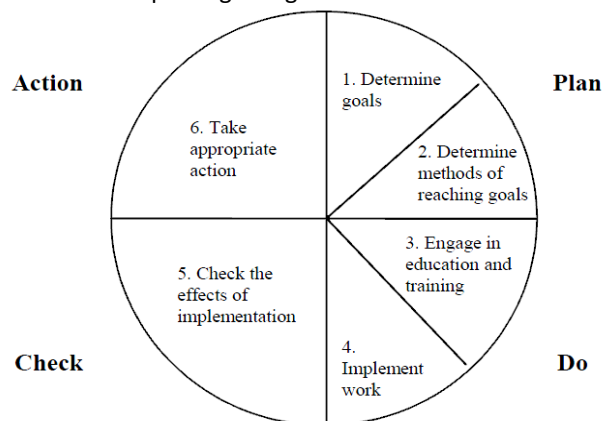


Figure 33 - The PDCA – method

The PDCA-model emphasizes that every problem identified should lead to an improvement within the business. Starting with the planning of the improvement solution (Plan) which

²¹² Evans, J.R., and Lindsay, W.M., 2002

²¹³ Bergman, B., and Klefsjö, B., 2003

²¹⁴ Ishikawa, K., 1985

²¹⁵ Imai, A., 1986

²¹⁶ Ishikawa, K., 1985

Control Process for secondary packaging

then should be implemented (Do), and after implementation the effect should be evaluated (Check). If the evaluation is positive, actions should be taken to make the new change into a standard. According to Imai, under no circumstances should the new standards be seen as the final goal or method. Instead, it should be the start of finding new opportunities for change and improvements.²¹⁷

3.4.2 Quality system

When integrating quality into a business there is a certain need for routines on how to handle different operations. These routines have to include work instructions, measuring tools, parameter specifications and instructions for how to deal with anomalies measurements, default products and claims. Quality system can be defined as:

“the organizational structure, procedures, processes and resources needed for quality implementation of quality management”²¹⁸

The standards are established by the company through the results of measurements and the amount of finished products that come out without defects or as little re-work needed as possible. There are many available systems or certification schemes on the market that helps a company achieve quality within the organization.

3.4.2.1 Performance measurement

Performance measurement is an important element of TQM and for a company to be able to view their business performance.²¹⁹ Measurements are a prerequisite for the company to know how their business works and what they should focus on. Historically, most organizations have measured performance in one way or another, but usually through the financial aspect. However, traditional performance measures, based on financial criteria, provide little support for an organization’s work with quality, because they do not map process performance and improvements seen by the customer perspective.²²⁰ In a successful total quality organization, performance should be measured by the improvements seen from the customer’s point of view as well as by the results delivered to other stakeholders, such as the shareholders. Therefore criteria should include both quantitative and qualitative indicators used to determine the extent to which an activity has taken place, a condition has been met, or a specified level of output or outcome has been achieved.²²¹ There are both different levels and different ways of measuring the company's activities on.

To succeed within quality measurements, it is recommended to measure both soft and hard elements, and then improvements in quality are often related to the employees’ knowledge and management commitment.²²² To be able to gain higher quality and to plan the manufacturing process in a way that supports the quality, measurements are needed to establish standards.²²³ According to Vroman and Luchsinger, measuring quality is done by

²¹⁷ Imai, A., 1986

²¹⁸ Bergman, B., and Klefsjö, B., 2003, p. 455

²¹⁹ U.S Department of Energy, 1995, 2010-04-27

²²⁰ Department of trade and Industry web page, 2010-04-23

²²¹ Lehman, J., and Myers, I., 1995

²²¹ Lehman, J., and Myers, I., 1995

²²¹ http://download.101com.com/pub/tdwi/images/j_v11n4/strategyfig2.gif 2010-04-27

²²² Bititci, U. and Nudurupati S., 2002

²²³ Juran, J., 1988

Control Process for secondary packaging

setting a value to the output in the crucial process and developing it into quality tools which keeps the level of quality connected to the process of interest.²²⁴

3.4.2.2 Standardization versus adaption strategies

Since quality often affects both upstream and downstream process, it is important that it is self-represented in the supply chain using the same definitions and measurement instruments in order to compare and communicate. There is a range of internationally developed standards today. One of them is the International Standards (ISOs) which can be used worldwide. The international standard for quality, ISO 9000 was based on extensive documentation and was therefore hard to implement, but it has recently become more practically suited to the daily work in various activities. However, the standard ISO 9000 requires the company to have some understanding of the impact that quality checks have on the company's products and profitability.²²⁵ It can therefore be difficult to implement the standard in those companies which have a lower level of knowledge in quality and lack the resources for quality activities. In such cases, the type of standard is not important, but rather the reconstruction of understanding quality and quality impacts. In these cases, it is more appropriate for local adaptations in the form of checklists and basic introduction of documentation. This can be done in many ways such as through various improvement tools in TQM or Lean.²²⁶

Consumers want standards because they inform about the reliability and fitness for purpose of the product.²²⁷ Manufacturers and retailers on the other hand welcome standards, because they; provide clear guidelines on targets that reflect best practice, provide a benchmark that can be used for communicating the specification and characteristics of the product, process, or system involved, and from which improvement can easily be explained and they provide competitive advantage by making it easier, cheaper and more efficient to produce and export products.²²⁸

3.4.2.3 The international Standard organization

The international Standard organization, ISO, has developed over 18,000 International Standards on a variety of subjects. All requirements of the International Standards are generic²²⁹ which makes it suitable for any organization looking to improve the way it is operated and managed, regardless of size or sector.²³⁰ However, the best returns on investment come from those companies that are prepared to implement quality management system throughout the entire organization.²³¹ The standard ISO 9001 is by far the world's most established quality framework, currently being used by approximately 897,000 organizations in 170 countries worldwide. It sets the standard not only for quality management systems, but management systems in general. It helps all kinds of organizations to succeed through improved customer satisfaction, staff motivation and continual improvement. The standards in the ISO family cover specific aspects such as fundamentals in

²²⁴ Vroman, W. and Luchsinger, V. 1994

²²⁵ The international Standard organization web page, 2010-05-05

²²⁶ Interview Professor, PhD, Packaging Logistics, LTH, 2010-04-15

²²⁷ The times 100 web page (A), 2010-05-06

²²⁸ The times 100 web page (A), 2010-05-06

²²⁹ The international organization for Standardization web page (B), 2010-05-05

²³⁰ BSI Standard, 2008, ISO Document ISO/TC 176/SC 2

²³¹ International Standard organization web page, 2010-05-05

Control Process for secondary packaging

vocabulary, performance improvements, documentation, training, finance and economic.²³² The standards only include what requirements a quality system must meet, it does not dictate which and how standards should be met in any particular organization. This leaves great flexibility for implementation in different business sectors and business cultures, as well as in different national cultures. A typical example of documents that us usually included in the Quality management system is a quality policy, a list of quality objectives, a quality manual and other planning documents.²³³ A vital part of developing the quality management system is to plan and deliver training regarding quality issues throughout the organization.²³⁴ In order to get a better overview of the ISO standard, the Quality Management System model based on the Plan-Do-Check-Act improvement cycle can be used. The model shows the quality system requirements which are organized into four sections: Management Responsibility, Resource Management, Product and/or Service Realization; and Measurement, Analysis and Improvement.²³⁵

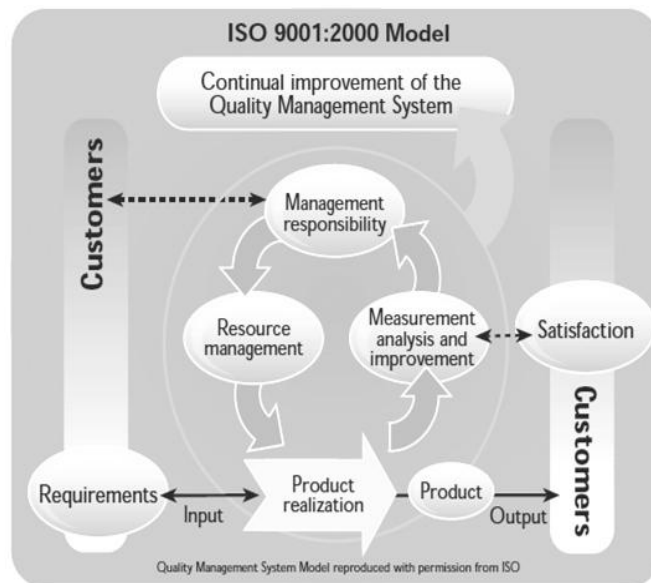


Figure 34 - The Quality Management System Model²³⁶

3.4.2.3.1 The ISTA® Certified Packaging Laboratory Professional program

ISTA created a guideline for selecting and using test procedures and how to get started with a process for improvement of protective packaging effectiveness. The first recommendations are:



²³²International Standard organization web page, 2010-05-05

²³³ The Times 100 web page(B), 2010-05-05

²³⁴ The Times 100 web page(B), 2010-05-05

²³⁵ Kanholm, J., Quality digest web page 2010-05-05

²³⁶ The times 100 web page (A), 2010-05-06

Control Process for secondary packaging

According to the guideline, even a simple lab test can be used if used wisely, and is often preferable to trial and error on field experience. Second recommendation is to find out more about how products move, including the variety of channels used to move the products. However, distribution hazards change and machines for manufacturing and packaging material varies. Therefore continuous review and improvements are recommended. The last advice is to take every opportunity to learn more about your products and distribution.²³⁷

3.4.2.4 Implementation of quality system

To implement a quality management system, an organization will need to find a way to implement the system that agrees with the present business culture. Deming, Juran and Crosby have all developed different methods for implementation of quality. However, in this master thesis, the authors have chosen to look into the Seven-P process, which is built on the three gurus' earlier methods. The implementation of a process in which the business culture will be affected, is not easily achieved. The seven-P process is created to cover the needs for change, organization culture and climate when implementing a new quality process. The seven-P process exists of:²³⁸

1. Positive Commitment
2. Planning
3. Participation
4. Process control
5. Problem identification
6. Problem elimination
7. Performance

3.4.2.5 Change management

Change is about working differently, "work smarter, not harder". To get maximum results from change, it is important to know what should be changed and how it should be changed. By finding new ways of working, procedures, tools and skills, you neither need to add nor cut back on resources.²³⁹

Despite careful planning of quality processes, the initiative can still fail. There are several different reasons to why many organizations fail to implement TQM. The main reasons that the implementation fails are cultural changes, resistance from middle management, lack of appropriate quality measurement and problem-solving techniques.²⁴⁰

In order to make improvements within the organization the leader must understand the theoretical background for the improvement work and how to operate in practices. The leader also needs to be motivated for change and have the courage to realize it. Motivation and courage is developed through an increase of knowledge which increases the willingness to perform a new task.²⁴¹

The change in an organization requires a certain level of education. Training takes place according to Sandholm in four phases. First, a deeper understanding of the quality's impact on the organization's performance, and how the leader can actively work to improve efficiency and profitability are introduced. Second, key personnel are educated about quality

²³⁷ International Safe Transit Association, 2010

²³⁸ Pike, J. and Barnes, R., 1996

²³⁹ Frid, B., 1997

²⁴⁰ Frid, B., 1997

²⁴¹ Frid, B., 1997

Control Process for secondary packaging

and how the organization will work to achieve the desired efficiency and profitability. Thereafter the employees of the various special functions are informed of this to ensure that quality requirements are met in their respective function. Depending on the employees' education level, the methods may be either developed within the function or presented by the managers. Finally, the other employees will be trained in quality, to better understand how it affects business performance and how their role within the company is important in quality work.²⁴²

3.4.2.6 Visual communication

Communication is very important in the work of improving quality. The managers have to be able to communicate both the positive benefits of the process and how the employee should conduct the activities within the process.²⁴³ In developing countries, where the level of writing and reading is not something that can be taken for granted the process can be communicated visually. According to Assistant Lecturer, Ergonomics and Aerosol Technology, LTH, the visual pictures has to be very simple and should be tested on people with similar knowledge as the employees at the customer site. For a person who can read and write, it is very easy to forget important perspectives of those who cannot.²⁴⁴ According to the Communication Manager at Carton Economy, it is hard to know in advance what will work and what will not. Even if some instructions work at one customer it is no guarantee that the same set of instructions will work at another customer.²⁴⁵

3.4.3 Cost of poor Quality

The first person to consider costs in connection to quality issues was Joseph Juran in his book "Quality control Handbook" from 1951. He divided the costs into four parts. Every cost caused internal within the organization before reaching the customer that can be related to product delay, defects or inefficiency should be included in the internal failure costs.

External failure costs, on the other hand, are those costs created by defect products after reaching the customer. To minimize the risk for mentioned costs, prevention activities can be made. The cost for inspections during the production and quality assurance are called appraisal costs.

Prevention costs are those costs related to the implementations of quality systems, education in quality and costs for audits of suppliers.²⁴⁶

Of these four types of costs, the internal failure cost is the easiest to allocate and therefore also the most intentional in business organizations of today. The external failure cost can sometimes be difficult to determine since there might be many actors and therefore different ownerships of activities within chain to the customer. The cost savings made by prevention activities are in many cases only circa figures because expenses for pre-building are often difficult to measure since they do not always have a direct effect.

The approach to quality costs has evolved over the past three decades and begun to move away from the method non-conformity. Earlier we compared the frequency with quality production and we talked about the optimal quality. It was believed then that there was an

²⁴² Sandholm, L., 2006

²⁴³ Sandholm, L., 2006

²⁴⁴ Interview, Professor

²⁴⁵ Interview, Communications Manager, CE Product Communications, Tetra Pak, 2010-04-22

²⁴⁶ Bergman, B., and Klefsjö, B., 2003

Control Process for secondary packaging

upper limit on the product quality and improvement work beyond this was not viable. Today however, we know that the missing knowledge of quality improvement can contribute to further improvement in the quality field. Now known as improvement in the sense of a lack of quality and costs are defined instead as "the costs of defective units, imperfect processes or extended uses sales revenue". The model for the cost of poor quality should contain only two of the previous four parts, internal and external faults charges imposed.²⁴⁷

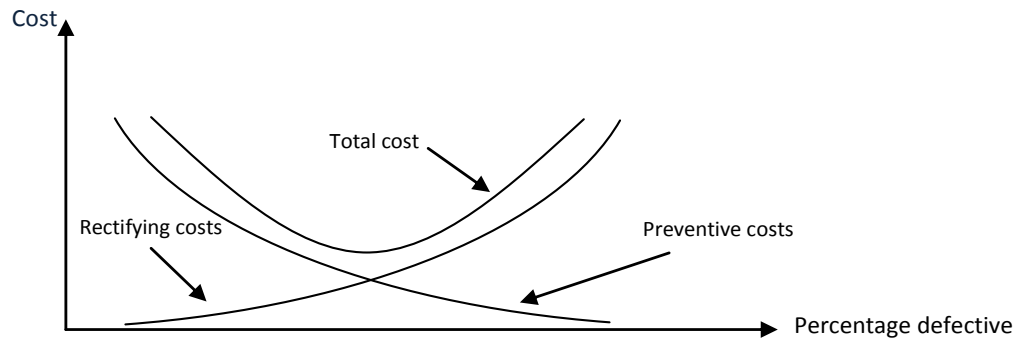


Figure 35 - Wrong view of "quality costs"²⁴⁸

According to the study made by the American Society for Quality showed that already in 1987 companies in the U.S. found the largest potential for improved quality work in the soft parts of the organization. There are many good examples of Japanese successes in the field of quality. According to Pascal and Athos in 1982 the most success will gain those whom managed to create activated participation and commitment of all employees. The same was shown in a study by Harper in 1992, that management's biggest challenge is to create opportunities for employees to engage in daily improvement work.

3.5 Are Western business management tools applicable in developing countries?

There has been very little structural research on organizational effect and change in emerging countries. However, the highly dynamic environment in these countries is very good for testing grounds for new theory, techniques and concepts of business and management.²⁴⁹

It has for long been recognized that culture is a major source of differences in measurement and reporting standards and methods. Because of this it is quite doubted whether existing Western management practices can and will work in emerging markets. One of the theories which have been studied in an emerging country's context, of cause in limited extent, is performance management. Although performance management is relatively unknown in many African countries, the interest in such an improvement tool is growing among African organizations.²⁵⁰

One of the countries in Africa where there has become a growing awareness within using Western theories is Egypt. Many companies had solely relied on financial data, but today

²⁴⁷ Bergman, B., and Klefsjö, B., 2003

²⁴⁸ Bergman, B., and Klefsjö, B., 2003, p. 63

²⁴⁹ De Waal, A., 2007

²⁵⁰ De Waal, A., 2007

Control Process for secondary packaging

there can be sense a trend in willingness within manufacturing organizations to combine financial and nonfinancial measures.

In other countries like Kenya, performance management was traditionally defined as the process of financial control. The mission and strategy are translated into budgets, and the subsequent results get compared with the budgets. Today however, many Kenyan companies are trying to qualify for the ISO standard; they are turning more and more to performance management, especially the BSC.²⁵¹

The overall lack of management skills and expertise often makes it negligible for developing countries to develop complex structures such as sophisticated performance management systems. They therefore concentrate more on introducing and copying tools and systems from the Western world which are not always the best approach due to local circumstances. Nevertheless, there is no question in theory that adopting management practices is a better alternative for an organization than investing limited and scarce resources in efforts which do not amount to much more than 'reinventing the wheel'. Organizations in emerging markets can learn a lot from Western companies which have been wrestling with this issue for over two decades now.²⁵²

However, the poor management practices, bureaucratic inefficiencies, and low productivity levels in many organizations of developing countries create considerable pressure for managers to adopt methods fast and especially ready-to-implement strategies.²⁵³

3.6 Analysis methods

By using the process orientation, causal analysis and other analysis tools, a better understanding of the situation will be examined, measured and changed.

3.6.1 Gap analysis

Gap analysis is a tool which can be used for comparison of a company's actual performance with its future potential performance. The comparison helps the company to identify areas with need for improvements. Usually the present situation is compared to best practices which can be another company with success in the area of interest or theoretical literature. This comparison becomes the gap analysis. (Figure36)²⁵⁴

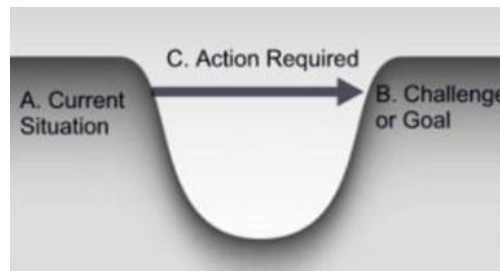


Figure 36 - The gap

²⁵¹ De Waal, A., 2007

²⁵² De Waal, A., 2007

²⁵³ De Waal, A., 2007

²⁵⁴ <http://www.artdavisgroup.com/Images/isogap.jpg> 2010-04-26

Control Process for secondary packaging

According to Winch, G. et al., the gap analysis can be divided into five principle gaps, describing the gap of perception between the products that consumers expected that they would get:²⁵⁵

- Gap between consumer expectation and management's perceptions of consumer expectations.
- Gap between management's perception of consumer expectations and management's translation of those perceptions into product quality specifications.
- Gap between product quality specifications and actual product delivery.
- Gap between actual product delivery and external communications to the consumer about the product.
- Gap between actual product delivered and the consumer's perception of the product.

The gap analysis approach offers both a conceptual framework and a methodology which focuses on the total process of service delivery and on consumer satisfaction.²⁵⁶

3.6.2 Root cause analysis techniques

Root cause analysis is an analytical method used for investigating effects of problems and analyzes the root of the problem. This is done by finding the possible root causes and then determining different possible fields of where to collect information with the goal to finding a solution to the problem.²⁵⁷ The procedure can be described in four steps:

1. Brainstorm possible causes and effects of the problem.
2. Then the causes and effects can be divided into different categories by using the four M's (Methods (process/inspection), Material, Man power, and Machine (technology)) which usually includes the major causes. Furthermore, the four M's can be enlarged with Management, Mother Nature (Environment), Measurement (Inspection), Maintenance and Money power to find the problem. For every major cause there should also be sub contributors identified.
3. The cause and effect diagram can then be drawn as an Ishikawa (fish bone) diagram.
4. For every classification, the effects should be defined.²⁵⁸

This procedure for finding the root cause is just one way of dealing with the complex problem. According to Dr. Anthony Mark Doggett it is nearly impossible to identify the best root cause analysis technique. Different methods are developed for different cases.

²⁵⁵ Winch, G. *et al.*, 1998

²⁵⁶ Winch, G. *et al.*, 1998

²⁵⁷ Kanji, G. K. and Asher, M., 1996

²⁵⁸ Kanji, G. K. and Asher, M., 1996

Control Process for secondary packaging

However, he recognized that certain tools work better for collecting information under certain conditions.²⁵⁹ In this master thesis, three different analysis methods were used; gap analysis, Ishikawa (fault tree analysis) and the five whys.

3.6.2.1 Ishikawa diagram with the five whys

The cause-effect diagram is founded by Japanese Kaoru Ishikawa and also known as the fishbone diagram because of its appearance. The Ishikawa diagram is a tool for breaking down potential causes into more detailed categories. These categories are then organized and divided into factors that help find the root cause.²⁶⁰ These diagrams are commonly used for quality defect prevention and each cause of imperfection is a source of variation. To create the diagram, different categories are used and to easily do this, the 4 M's used in manufacturing (Machine, Method, Material and Man Power) or the 8 P's used in service industry (Product, Price, Place, Promotion, People, Process, Physical evidence and Productivity & Quality) is used as categories.(Figure 37²⁶¹)

To further develop the Ishikawa diagram, the *five whys* technique has been considered and taken into account. It was developed by Sakichi Toyoda for the Toyota Industries Corporation in the 1970s. The five whys strategy solves the problem by finding the root cause through questioning: "Why?" and "What caused this problem?"

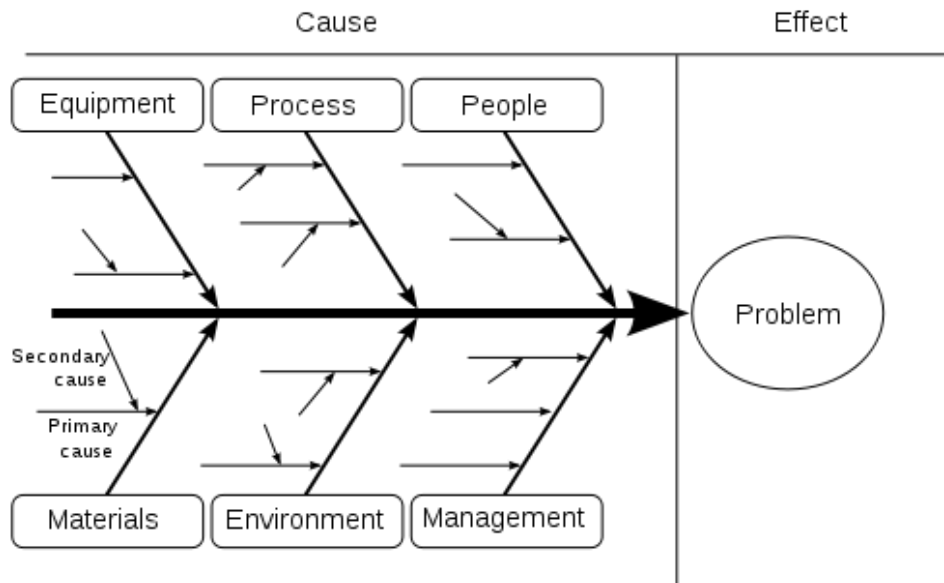


Figure 37 - The Ishikawa diagram

²⁵⁹ Doggett, A., 2004

²⁶⁰ Evans, J.R, and Lindsey, W. M, 2002

²⁶¹ Figure: http://www.charlesconway.com/Articles/Ishikawa_Fishbone_Diagram.jpg, 2010-05-06

4 The secondary package for beverage industry

In this chapter, an introduction to the secondary package industry will be presented. The persons involved in this industry as well as the conditions and processes for secondary packaging will be discussed.

4.1 Introduction to the beverage industry

About seven decades ago, producer and consumer lived relatively close to each other. Whereas today, the goods are often shipped a long way in order to reach the consumer²⁶². To deliver the product they are often packed in a primary packaging which protects it. This pack is usually sold together with the product and is therefore important that the primary packaging is not damaged, because a damaged product does not attract the customer as a whole. For this reason, the secondary packaging is given a greater significance both for the primary packaging appearance and for its durability and ability to protect the product. Secondary packaging contributes to a lower total cost of the packaging of our product distribution, through reduced wastage and fewer damaged goods. However, it is difficult to motivate the customer to pay for it since it's rarely sold to the consumer. Nevertheless, packaging is growing as a competitive tool and an area to reduce costs.

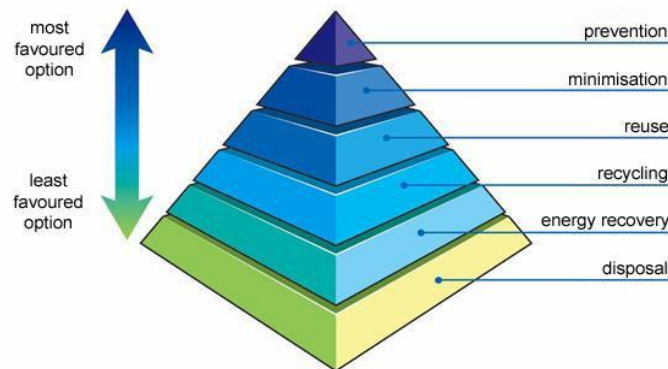


Figure 38 - Waste hierarchy pyramid²⁶³

Depending on how industrialized the society is there will be different demands from a customer perspective. Also the level, or rather the size of the company is essential to what the company will focus on. In some developed countries all layers in the waste hierarchy will be considered. While in some developing countries, only the two top layers will be involved in the decision making process for the business purchases. However, improvements happen constantly and even less developed countries have begun to work themselves up to an industrialized level to compete internationally. This means that some countries have begun to achieve one or more of the three Rs, reduce, reuse and recycle. By reducing the material in the secondary packaging, the container becomes thinner and the quality may decrease.

²⁶² Svedberg, G., 2001

²⁶³ Figure: <http://mediaenvironment.files.wordpress.com/2009/06/image0053.jpg> 2010-03-19

Control Process for secondary packaging

Another reason for a decrease in quality is the increasing use of reused and recycled material. Reused and recycled materials do not have the same strength as virgin materials. In order to understand the role of packaging in the distribution chain the totality has to be considered.²⁶⁴ Different properties are required in different parts of the value chain so the solution of finding the right packaging must be based on customer requirements, adapted to the whole chain for not creating sub optimizations within the value chain which detrimental to the customer and the environment.²⁶⁵

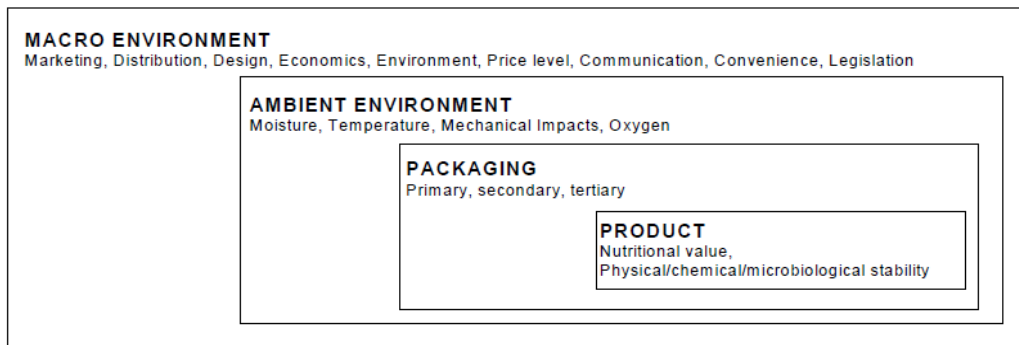


Figure 39 - Levels in packaging logistics²⁶⁶

The consumption of packages is very unequal in the world. There is a major growth potential in developing countries, since the bulk of the earth's population live there and the population growth is high.²⁶⁷

Exporting secondary packaging to developing countries is not an option since the corrugated cardboard has a low economic value and the transportation cost would be too expensive. This is the reason why customers buy their packages locally and why international companies help with quality can be of interest for the customer to communicate to their other suppliers.²⁶⁸

In 2004, global packaging sales increased 7% from 2003, to a value of \$65 billion. This increase was boosted by rising demand in markets in Eastern Europe, the Middle East and Asia. The largest regional market is North America, accounting for around 31% of sales ahead of Western Europe (27%) and Asia (26%). But Asia is set to overtake North America as the largest regional market by the year 2009, with a 29% share. By that time, the sales will be growing at an annual rate of 4%, and the real value of the beverage packaging market will reach around \$80 billion.²⁶⁹

²⁶⁴ http://www.innventia.com/upload/Gamla_PF-sidor/REPORT_194.PDF 2010-03-23

²⁶⁵ http://www.innventia.com/upload/Gamla_PF-sidor/REPORT_194.PDF 2010-03-23

²⁶⁶ <http://www.sustainablepack.org/database/files/SPA%20paper%2022nd%20IAPRI%20Symposium%202005.pdf> 2010-03-24

²⁶⁷ Svedberg, G., 2001

²⁶⁸ Svedberg, G., 2001

²⁶⁹ Pearson, K., President WPO (World Packaging Organization), 2008

4.2 Packaging performance in developing countries

Packaging has played an important role in the developing industry and in improving daily life. According to ITC the corrugated box industry is the main packaging industry within the developing world.²⁷⁰ However, dealing with corrugated boxes gets more complex in developing countries since many of them lie in tropical or sub-tropical areas with a high humidity. The distribution will therefore demand an even more advanced packaging solution than in the developed countries.²⁷¹

During the period 2001 to 2006, the global corrugated production grew by an average 4.2 % per annum, and between 2004 and 2006, the growth was averaging 4.9% annually.²⁷² From 2008 till 2013, corrugated cardboard growth will slow down marginally and thereby reflecting lower growth in worldwide manufacturing activity. However, in some emergent regions, in particular regions such as China and Hong Kong, growth will continue to be strong. In this forecast period, China will overtake the U.S. as the largest corrugated producer in 2009.²⁷³

Since the market is becoming more globalized, export promotion is seen as an important policy for economic growth in developing countries. Various measures are being adopted to promote export competitiveness by governments in these countries.²⁷⁴ Packaging performance is one of the crucial factors why developing countries and leased developed countries, LCD, has a hard time exporting their products. However some countries in Asia, have managed to increase their share in world trade and income, which has lead to a reduction of their high incidence of extreme poverty. In Africa on the other hand, many LCD have seen decreasing shares in world trade and income, and thereby an increasing incidence of extreme poverty. Some of the reasons as to why their export haven't increased are the country's location, government, infrastructure and the lack of specific support measures that gives reliability and/or meet international standards.^{275,276}

However, the growth has been limited since the domestic market had a smaller customer demand for high packaging performance than developed countries. Another reason for the limited growth of both the absence of standardization processes and general industry has been the lack of awareness among both the public and decision makers of the importance and benefits of packaging. This is true, particularly for the food industries in many developing countries since the demand for quality packaging materials for domestic use and export cannot be met only by the local industry, but packaging materials have to be imported.²⁷⁷

Since most of the packaging industries are small and medium sized enterprises in underdeveloped countries, they cannot afford to maintain their own testing facilities. In some countries it can be hard to provide attestation of product quality by a third party because focus on the packaging performance is not prioritized before other more essential

²⁷⁰ International Trade Centre UNCTAD/WTO, 1999, The packaging industry in Nepal

²⁷¹ International Trade Centre UNCTAD/WTO, 1998, Adapting Packaging to Meet Market

²⁷² The International Corrugated Case Association, release of global corrugated forecasts 2007-2011

²⁷³ The International Corrugated Case Association, release of global corrugated forecasts 2007-2011

²⁷⁴ Aggarwal, A., 2005

²⁷⁵ United Nations, 2007

²⁷⁶ Aggarwal, A., 2005

²⁷⁷ International Trade Centre UNCTAD/WTO, 1999, The packaging industry in Nepal

Control Process for secondary packaging

tests for product safety that can directly affect the customers.²⁷⁸ This lack of national and/or company standards of packaging products and processes also obstruct the implementation of quality control processes.²⁷⁹

The greatest problem is though the fact that most underdeveloped countries have very little interest in standards, standardization and quality control processes. Therefore, investment in quality is seen as nothing more than an additional and unnecessary cost. In the meantime this leads to that manufacturers cannot export, even though there is a market abroad.²⁸⁰

An ever increasing concern in the end-use markets is consumer health. In the Pira/ WPO survey 27 % view health awareness as the most important factor as a packaging growth driver and a critical factor to market development, another 64 % is viewing it as very important.²⁸¹

The Asian packaging market is valued to approximately \$121 billion and is increasing with a CAGR of 6 %, and by 2011 it is predicted to reach a value of \$174 billion. The sophistication level of the Asian packaging industry has been increasing steadily the last decade. In several countries in the region, the packaging sectors growth is ahead of the nations GDP growth. This is based on new major research and provides expert analysis of this fast-growing market. By breaking it down to packaging material, end-use sector, and geographic region, it gives an in-depth review of the Asian market. With quantitative forecasts to 2011, it is the essential tool for business planning, market research and presentations.²⁸²

4.2.1 Vietnam

Exports of Vietnamese products in need of packaging, increased demand on consumer goods, and foodstuffs, is making the packaging industry in Vietnam the most rapidly developing industry in the country. What is fuelling this consumer demand and industrial growth is a rapid increase in economic growth, growing personal income, and an excellent demographic profile. According to the Vietnam Packaging Association, the growth of the packaging sector is at least 15%-20% annually. In Vietnam 70% of 900 Vietnamese packaging manufacturers is located in the Southern part of the country.²⁸³

Vietnam's nascent machine tools industry is unable to fulfill the demands for the country's social development. And the demand will be driven forward and increase with the domestic growth industries such as shipbuilding and telecommunications. The growing demand for quality food is making Vietnam one of the central places of the food processing and packaging industry. With an economy that is growing with 20%-30% every year, the packaging and processing industry are very important growth sectors. Having a very positive

²⁷⁸ Kenya Bureau of Standards (KEBS) web page, 2010-05-19

²⁷⁹ International Trade Centre UNCTAD/WTO, 1999, The packaging industry in Nepal

²⁸⁰ International Trade Centre UNCTAD/WTO, 1999, The packaging industry in Nepal

²⁸¹ Pearson, K., President WPO (World Packaging Organization), 2008

²⁸² The Asian Packaging Federation web page, 2010-05-24

²⁸³ Chan Chao International Co., Ltd, web page, 2010-05-24

Control Process for secondary packaging

impact on the intra-regional trade in food products is the Vietnamese membership of ASEAN (Association of Southeast Asian Nation).²⁸⁴

4.2.2 China

During 2006 to 2011, \$41.6 billion square meters is, by ICCA, the predicted increased demand in the global corrugated market. This can be compared to \$27.8 billion square meters in the period 2002-2006, and China is thought to generate 56 % of this increased demand.²⁸⁵

Asian output of corrugated grew at an annual rate of 5.7% between 2000 and 2003, and expected to accelerate to nearer 6% into the second half of the decade. Much of this growth will be attributable to China. Currently standing at around 13 million tones, output is forecast to grow by 7% year on year, driven in part by rising output across a range of consumer products.

Since the mid-1980s, the Chinese packaging industry has been growing steadily and is now one of the fastest growing in the international packaging arena, and therefore they are now the third largest packaging market in the world. With a contribution of 2.5 % of the Chinese GDP, the packaging industry is the 14th largest sector in the country.

Due to a rapid international and domestic trade, foreign direct investment, and rapid market liberalization, the domestic packaging industry has gone through a great evolution. By doing so, they have reached new levels of sophistication deserving of international attention. Since the 1980s, the industry has produced more than 11,000 packaging enterprises with a production value of over RMB 400 billion (RMB= Renminbi, the Chinese currency). By 2015 this value is predicted to surpass RMB 600 billion with an annual growth of 16 %. While their economy continues to grow higher, living-standards follow and create a demand on convenience that transforms customer behavior. With busier consumers, the Chinese are more and more interested in products that can accommodate their changing lifestyle.²⁸⁶

4.2.3 Kenya

With a Gross National Income (GNI) of \$12.2 billion in 2002, Kenya is the largest economy in East Africa.²⁸⁷ With agriculture providing more than 75 % of the Kenyan population with their livelihood, it is also the cornerstone of the Kenyan economy. There are great opportunities for improvement in technology infrastructure such as packaging, storage, and transportation. Compared to China and India, productivity isn't just low, but it is falling behind, the Kenyan manufacturing firms haven't seen gains on more than 10 years. On the other hand, China and India has seen great gains in productivity.²⁸⁸ Due to old-fashioned management and production processes, the Kenyan industrial sector has been rendered obsolete by more recent structures based on the concepts of Lean Production/World Class Manufacturing. Applied not only in high-income, but also in low-income countries, these forms of organization seem to have passed the Kenyan industry. Instead, this provides a potential,

²⁸⁴ Vietnamese Embassy in Switzerland, the Vietnam Chamber of Commerce and Industry, VCCI in Hanoi and the Swiss-Asian Chamber of Commerce in Zurich, 2010

²⁸⁵ The International Corrugated Case Association, release of global corrugated forecasts 2007-2011

²⁸⁶ Euromonitor International Ltd., 2009

²⁸⁷ The International Trade Center web page, 2010-05-19

²⁸⁸ The International Trade Center web page, 2010-05-19

Control Process for secondary packaging

especially for foreign investors, for output expansion and cost reduction at an attractive incremental capital cost.²⁸⁹

4.2.4 Egypt

Food processing is Egypt's second largest industry next to textiles with annual production valued at \$3.5 billion, and a strong annual growth rate of 20% to support it. This is due to Egypt's high quality and low priced agricultural output, but at the same time the sector is lacking in adequate processing and distribution facilities. Because of this, both the product quality and value are low. The Egyptian procedures for import standards, testing and certifications are a cause for many delays or outright rejections of food and agricultural imports. To make food and agricultural products more competitive in the world, Egypt is working with the USDA to make their import standards, testing and certification procedures more efficient and consistent with international standards. It is also thought that these technical improvements will benefit the consumers. The additional cost has caused some concerns among the US exporters. They are also concerned about the uncertainties and delays caused by inefficient and faulty laboratory testing and inspection systems in Egypt. A project for training and technical assistance to strengthen the Egyptian Government's system of food inspection and analysis laboratories is being developed by USDA. Indications say that to be able to export to the European Union, they have to achieve ISO 9000 registration. These companies located in Egypt are very uncertain about the advantages and gains these extended processes will give; they think that it will be too expensive and that there will be resistance from the shop floor managers. But it is still very important for the Egyptians to adopt a model for improving the quality of the product produced by the companies located in Egypt.²⁹⁰

4.2.5 Standards in developing countries

A standard for a product can be seen as any document that establishes provisions that have the effect of reducing unnecessary variety in the marketplace, and thereby enables economies of scale to occur, with a consequent reduction in the unit cost of production. In an efficient market system, these reduced costs are passed on along the supply chain to the eventual purchaser.²⁹¹ According to the International organization for standardization, a standard can be defined as *"document, established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context"*.²⁹²

Developing countries face particular challenges when it comes to the development and use of standards. The choice has to be made as to whether it is appropriate to develop purely national standards or to adopt and disseminate existing international or, in some cases, regional standards in their jurisdictions. Development of purely national standards requires significant technical resources and expertise, and results in standards that, while focused on national needs, might hamper international trade with other countries that have gone the

²⁸⁹ The International Trade Center web page, 2010-05-19

²⁹⁰ Sherif EL-ARABY et al., 2005

²⁹¹ International Organization for Standardization, 2008, Fast forward

²⁹² International Organization for Standardization/International Electrotechnical Commission Directives, Part 2, 2004 p.8

Control Process for secondary packaging

“international” route. The adoption of international standards leads to better trading opportunities and may reduce avenues for the dumping of poorer quality good. This also causes many problems for industries in developing countries which might not be in a position to produce according to the international standards, and thereby lose market share to imports.

All the mentioned countries in previous chapters have their own testing institute. However, not all of them have selected standards for secondary packaging or selected testing methods that can be traced to a certain standard. Developing countries don’t often have the resources or the expertise to establish national accreditation bodies. They are also frequently operating at a low economic level that makes it unprofitable for a third party conformity assessment providers to operate exclusively in their territory. It is recognized that for many countries the cost of providing all these activities at their most advanced level is prohibitive. Even in the case of developed countries, there are variations in the sophistication of each part of the technical infrastructure.²⁹³

4.3 Secondary packaging supply chain

The secondary packaging supply chain is an essential part in this Master Thesis. Understanding the process first will help to the implementation of a control process, but it will also identify where it should be introduced. In Figure 40, the supply chain for secondary packaging is shown, as well as the primary packaging and the product itself.

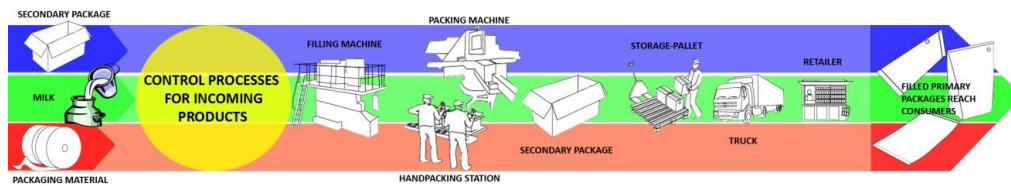


Figure 40 - The supply chain

4.3.1 Customer

When talking about the customer, the authors do in this case mean the customer of the two packaging suppliers, i.e. the producer of the product itself who pack the product into a package. In Tetra Pak’s case, the dairy is the customer since they are packing the product, i.e. the milk. There are many differences between the customers within developing countries. The most obvious are the difference related to the size of the customer. Customers within multinational organizations tend to have a well integrated culture and quality thinking. They also tend to have more controls and influence in the distribution chain. Smaller customers focus more on the cost than on the quality. They have less insight in the distribution chain and less influence on suppliers.²⁹⁴

²⁹³ International Organization for Standardization, 2008, Fast forward

²⁹⁴ Interview Package Engineer B, Tetra Pak, 2010-02-18

Control Process for secondary packaging

Many of the customers are aware of the concept with quality and the packaging performance. But the level of knowledge varies considerably whether the customer is big or small on the market, but also in which country the customer is located.²⁹⁵

At the customer site the product is packed and sealed into the primary packaging by filling machines. When the packages come out of the filling machine, they enter the packing line and are assembled in a certain pattern into the secondary package, which is often recommended by the primary package supplier. In less industrialized countries the secondary packages may be manually loaded and unloaded several times in one day and thrown in the air from person to person by local workers, which demand certain strength and quality from the package.²⁹⁶

The secondary boxes are then sealed with tape and palletized for a few days of incubation. The incubation aims to ensure that there will be no bacteria growth in the primary packaging. For instance, if there would be a small hole in the package, it would take in oxygen and eventually explode due to the biochemical process during the incubation time. After this, the faulty milk packages are sorted out, whereas the others continue in the distribution chain to the warehouse.

4.3.2 Primary packaging supplier

The primary packaging supplier provides primary packaging material and filling machines. This supplier does have a slightly different situation compared to the secondary packaging supplier. The difference is that although both suppliers' packaging performance depends on each other, it is often the primary packaging supplier that first receives claims. This is due to the fact that the product itself is associated with the primary packaging. Therefore, it is of great interest for the primary packaging supplier that the whole packaging system works properly, since it will come back to them in the end via claims.²⁹⁷

4.3.3 Secondary packaging supplier of corrugated cardboard

The development of corrugated cardboard around the world has barely changed for a long time. The same test methods have been used since 1930.

In Europe, over 60% of the transportation packaging is made out of corrugated cardboard, but to a lesser extent in less developed countries.²⁹⁸

²⁹⁵ Interview Package Engineer B, Tetra Pak, 2010-02-18

²⁹⁶ Interview Package Engineer B, Tetra Pak, 2010-02-18

²⁹⁷ Interview Package Engineer B, Tetra Pak 2010-02-18

²⁹⁸ Interview, The Design Centre Manager at SCA Packaging Sweden AB, Mariestad 2010-03-18

Control Process for secondary packaging

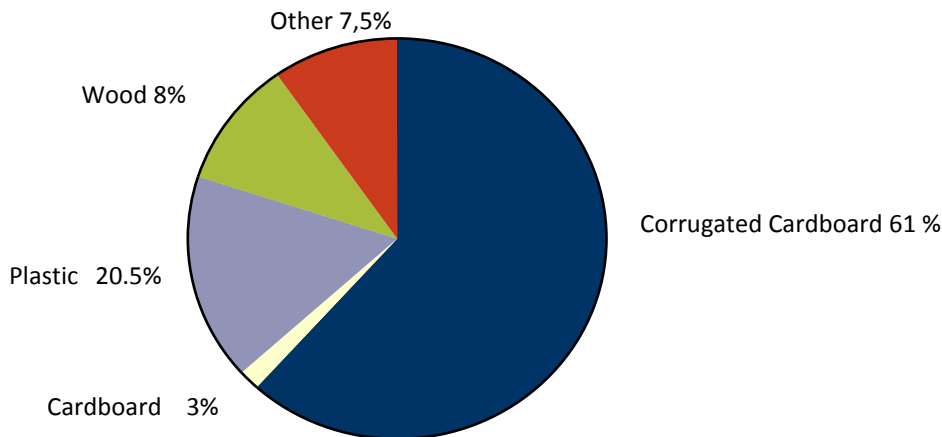


Figure 41 - Proportion of Materials on the European market (in 2007).

²⁹⁹

The corrugated cardboard supplier, SCA, has conducted experiments with adding a layer of lacquer on the liner and impregnating the fluting in order to extend the length of life. This was made since paperboard is known for being a very lively material, and in certain cases a very strong protection against water is needed, and this turned out to be a good solution. The main factor that deteriorates the performance of paperboard is the different cycles in the environment. When the weather goes from cold to hot, and wet to dry, the paper is inevitably worsen.

In order to develop a corrugated cardboard box, one needs to know what kind of distribution chain and what kind of environments it will be subjected to. If this isn't known, an optimized corrugated cardboard box is impossible to develop. In only 10% of the cases the right conditions are known, and therefore most of the boxes delivered from SCA are over dimensioned. Since 60% of the costs of corrugated cardboard are pure material costs, there certainly is money to save.

Then one needs to know the maximum load that a corrugated cardboard box will be subjected to. For instance, if the maximum load will be equal to 100 kg, and the environment and transportation conditions are given, a stacking factor of 4 might be used. This is SCA's own system for dimensioning the boxes. With a stacking factor of 4, the box will be developed to pass a BCT test of 400 kg or 4000 N. Depending on the climate, transportation, layers of stacking, and the distribution time, a stacking factor up to 12 can be used at SCA. The Design Centre Manager at SCA Packaging Sweden ensures that a box with a stacking factor less than 3 would certainly not enter the distribution chain, thus SCA has at least a safety factor of 3 in all their delivered boxes.³⁰⁰

The BCT is a better test method than ECT since the latter only considers a small piece of corrugated cardboard. This specimen is only 25 mm high and it is simply too small to consider the bending ability. The bending stiffness together with ECT will result in the BCT. One could say that BCT takes into account both the bending stiffness and ECT, and is therefore a better test method in evaluating the total performance of the box and how well it will perform during distribution. This is also why the height of the box is such an important parameter to

²⁹⁹ Interview, The Design Centre Manager at SCA Packaging Sweden AB, Mariestad 2010-03-18

³⁰⁰ Interview, The Design Centre Manager at SCA Packaging Sweden AB, Mariestad 2010-03-18

Control Process for secondary packaging

consider. The higher the box is the more important is the bending stiffness for the material. Typically 10 boxes are tested at SCA to get a statistical view of the general performance of the batch. SCA does not test its own boxes before delivery but this is done afterwards. However, secondary boxes for dangerous goods are an exception and are always tested before delivery.³⁰¹

Bursting strength is also a very interesting test method for SCA. However, the method does not provide much information for the ability to stack, and for a long time its ISO standard was too high. The Design Centre Manager at SCA Packaging Sweden believes that it is difficult to judge the performance out of the weight. The blank might have the right weight, but still the liners might be very light and the fluting very heavy. Thus the proportions between them must conform too; otherwise the performance isn't better than its weakest link. However, the weighing gives an indication of which quality had been used.

The optimization of the boxes for the pallets is important. If the dimensions of the boxes aren't optimized, there may be an overhang on the pallet. A one inch overhang may result in deterioration in compression strength of up to 32%. Moreover, an interlocking pattern is not recommended to use for the three bottom layers on the pallet since this will decrease the stack ability up to 45%.³⁰²

4.3.4 Transport & Distribution

Since the way of distribution in developing countries is often simpler and rougher, the secondary package becomes even more important for the primary package. The primary and secondary packages do not have the same conditions when it comes to transportation. The packages are often transported by trucks, cars, and on bicycles on bumpy gravel roads. Sometimes, pallets are not used for the distribution of the packages. Therefore, the secondary package might act as a pallet, making it even more exposed to risks.³⁰³ Furthermore, the climate has got a great impact during the distribution. Most of the countries where the milk packages are distributed lie in warm and tropical areas, where the temperature and the relative air humidity vary greatly. The packages are exposed to the sun and then to the cold and humid air at night, and this fact has a negative effect on the packaging performance.³⁰⁴

4.3.5 Retailers & Consumers

The expectations from the customer can vary a lot since the countries studied in this Master Thesis are different. There are many different cultures and levels of industrializations which lead to different demands from the customers. The retailers can also be of different kind, in Africa for example, the retailer can be a person selling the product on the street, whereas in Vietnam or China, the retailer can be a big, highly developed company.³⁰⁵

³⁰¹ Interview, The Design Centre Manager at SCA Packaging Sweden AB, Mariestad 2010-03-18

³⁰² Schueneman, H., Paper and corrugated paperboard, Westpak

³⁰³ Internal Video documentation from Kenya and Egypt, Carton Economy, Tetra Pak

³⁰⁴ International Trade center, 1998, Africa Adapting Packaging to Meet Market

³⁰⁵ Interview Package Engineer B, Tetra Pak 2010-02-18

4.4 Business environment in developing countries

Many developing countries are faced with a shortage of skilled staff, difficult economic and social conditions, weak political institutions, and deeply rooted cultural and religious beliefs that all have an impact on development in various ways.³⁰⁶

Government politics may at times have a greater impact on business than one may believe, with all laws and paragraphs sometimes having a disproportionately large effect on economic activities. Almost all countries have free economies with a true working democracy. However, many developing countries, mainly in Africa, still have controlled economies. They have experienced “fortress economy” policies with imports of raw materials severely restricted for a long time. Therefore, there are still strict controls on imports of packaging or packaging raw materials today. In many cases this results in materials being substituted, often of lower quality, which leads to poorer packaging performance, and also lower cost effectiveness. The real cost of such policies is certainly higher than intended. For this reason, several developing countries have moved to fashion more open economies lately³⁰⁷. Governments in developing countries may also be less effective in regulating other aspects of commercial activity, including those related to health, public safety and the environment. One way which is common in developing countries, is to have legislation on the taxes that could regulate the behavior of industry and commerce. For instance, tariffs on imports are still an important part of the developing country environment in Africa. These are sometimes put in place to protect a local company and sometimes to earn revenue, but did seldom have the desired effect on the economy.

4.4.1 The economy

When describing a country’s economy one often talk about GDP per capita, that relate to the general living standards of its inhabitants. There is often a significant difference in GDP between a developing country and an industrialized one, notably in Africa. These countries have a very low GDP per capita where the labor is very cheap. Many people in developing countries receive small salaries working in a local industry, whereas most of the rest live in an urban economy with high unemployment. Therefore it should not be surprising that many packaging features of consumer products in these countries relate closely to this essentially weak economic situation.

A developing country if often defined with a characteristic of producing largely primary products, for instance within the agricultural or clothing industry, and are therefore strongly dependent on this industry. If once the industry fails or has problems with the raw material supply, it surely affects its economy situation. Also, these economies have only a small industrial base in comparison to their primary materials resources. An exception to this is Zimbabwe, which has a larger industrial and packaging base than most developing countries, relative to its size, with two paper mills producing packaging papers. However, local packaging is a small activity compared to agricultural products, since most products are imported, packed, and ready for the local market.³⁰⁸

³⁰⁶ Sukhoo, A. et al., 2004

³⁰⁷ International Trade center, 1998, Africa Adapting Packaging to Meet Market

³⁰⁸ International Trade center, 1998, Africa Adapting Packaging to Meet Market

4.4.2 The average knowledge level

The level of knowledge in a country is often related to the economic situation. Industrialized countries do often have a better economic situation and the school system is also recognized to be better. Therefore, the knowledge in writing, reading, and mathematics and so on, is significantly lower in developing countries. Someone able to read is something that is obvious to us, but one should not take for granted that everyone can read in these countries. It is rather difficult for us to realize and understand this situation. Thus one should not overestimate the knowledge of workers at for example the dairies, which most of the time are local workers without any education. For instance, at the dairies in Kenya, new local people are waiting to get an opportunity to work there over the day. The fact that the dairy might have new workers from day to day without any education leads to low knowledge and awareness of quality³⁰⁹. Moreover, one should not believe that these workers know what is wrong or right. Therefore one cannot be sure that they will interpret the instructions given in a correct way. Maybe the instructions should be formulated in other ways than just a person explaining how to do, or a document explaining with a text. The acceptance level in developing countries can also vary widely from country to country. Often, the lower the knowledge is, the higher the acceptance level. Therefore, when package deformations occur, they may not know to which extent this is acceptable or not. For instance, a customer in Asia might represent most of the claims although most of the problems with packaging deformation occur elsewhere.

³⁰⁹ Interview Package Specification Manager TFA, Tetra Pak 2010-02-17

5 Tetra Pak

This chapter contains a compilation of the empirical data gathered from interviews at Tetra Pak and gives a description of the business relationships and how the current situation for Tetra Pak's customers look like.

5.1 Company presentation

5.1.1 Background

Tetra Pak is a multinational food processing and packaging company from Lund, Sweden. It was founded in 1951 by Dr. Ruben Rausing.

Tetra Pak's innovation is in the area of aseptic processing liquid food packaging. When combining this technique with the ultra-high-temperature processing (UHT), it allows liquid food to be stored in room temperature for up to 12 months.³¹⁰

Their vision is to make food safe and available, everywhere. They do not only aim at delivering a good product, but to facilitate and cooperate with their customers to a better total value chain.³¹¹

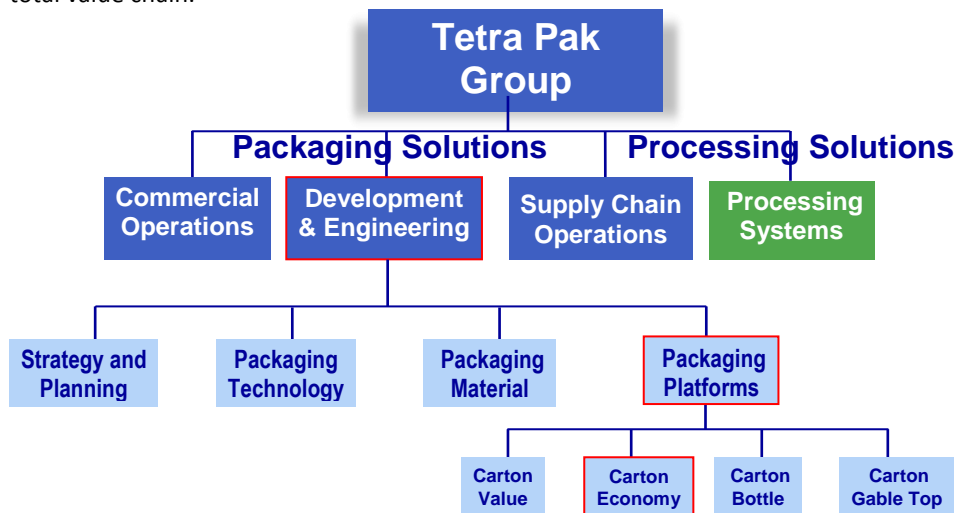


Figure 42 - The organization within the Tetra Pak Group including details of the Development & Engineering part.

³¹⁰ www.tetrapak.com 2010-02-08

³¹¹ www.tetrapak.com 2010-02-08

5.1.2 Carton economy

Carton Economy is one out of the four packaging platforms within Tetra Pak. Its product portfolio is the most sensitive to external influence and is not supposed to bear any load. Earlier, Tetra Pak had its own department for distribution solutions, but it got separated into the different platforms later on. Carton Economy has lately increased its focus on secondary packaging, and today several people are working with the goal to ameliorate and explore this area. However, the Carton Economy platform is however only a small part of Tetra Pak with around 10% of the total turnover for filling machines and primary package supply.

5.1.3 Carton economy portfolio

Tetra Fino Aseptic

The Tetra Fino Aseptic (TFA) is Tetra Pak's low-cost package and at the same time, it guarantees a safe product which attracts economizing customers. The package is mainly designed for white milk and other dairy products. The TFA package consists of a combination of packaging materials of several layers and a sealing system based on a combination of hot-air and induction. This makes the package resistant to tough conditions, although it is not supposed to be exposed to pressure.

The TFA exists in five different sizes; from 100 ml up to 1000 ml. The main advantage with the TFA is that the package is aseptic, guaranteeing the safety and hygiene of the liquid food. Also, the low-cost solution and the ability of long-time storage make it very attractive all over the world, especially in the developing countries.



Tetra Classic Aseptic

The Tetra Classic Aseptic (TCA) has a very innovative design, making it more attractive on the store shelves. The package has a strong characteristic shape, making it rather different compared to other packages, which attract mainly the young customers. The TCA is most suitable for juice and milk products, and the aseptic technique guarantees the quality of the liquid food for up to 12 months.

The TCA has a low material usage although the secondary package usage is high due to the challenge to optimize the space utilization inside the box. The cost for storage and distribution is lower at ambient temperature making the aseptic packaging especially useful in developing countries.³¹²

³¹² Tetra Pak web page (A), 2010-02-26

Tetra Wedge Aseptic

The Tetra Wedge Aseptic (TWA) is a modern and trendy package, offering an excellent way for young people to express their personality through what they are drinking. The package is available in two different volumes; 125 ml and 250 ml. A great aspect with the TWA is its possibility for attaching a straw on the outside. The package often comes with flavoured and cultured milk, drinkable yoghurts, juices and nectars or soy-based drinks. Thanks to the big front on the package, trademarks are easily exposed. As with all the other packages, the TWA is aseptic, making it very advantageous for distribution and storage.³¹³



5.2 The secondary package importance for Tetra Pak's packages

The need of a very strong and robust secondary package hasn't always existed for Tetra Pak. Earlier, when the portfolio mostly consisted of Tetra Classic, Tetra Rex and Tetra Brik, the primary package itself was able to withstand and bear the majority of the load. But today, the Carton Economy Product Portfolio is designed to be as cheap and attractive as possible which has resulted in that the secondary package has to bear almost the entire load. Therefore, it is predominantly the TFA, TCA and the TWA that are dependent on their secondary packages to be able to be delivered to the customer without any deformation. This portfolio is therefore more sensitive than other packages due to the design and extreme low-cost thinking, making the secondary package truly essential.³¹⁴

5.2.1 Tetra Pak's specifications and recommendations

When Tetra Pak is selling primary package material and filling machines they coordinate together with the customer regarding types of impacts from environment, stacking, time in distribution etc. that the packaging systems will be subjected to. By using the McKee model with given circumstances, an approximate dimensioning of the secondary box can be made. The model is supposed to give a rather good picture of what the box should be able to withstand, although the model contains certain simplifications. Based on these calculations, a specification sheet is created to give recommendations of values for certain parameters to the customer. However, the specifications are only a recommendation and are not a part of the specification between Tetra Pak and the customer. This means that it is the customer who decides whether the demands are to be followed when placing an order from the corrugated cardboard supplier.³¹⁵

5.2.2 McKee model

The McKee model was developed in 1963 and has for a long time been one of the most common models used in order to estimate the box compression strength or the maximum load a box can stand instantaneously. The model is a function of ECT, box dimensions and the thickness of the material. Ever since it was introduced, various modifications have been made and the estimated distribution time was taken into account. However, when the model

³¹³ Tetra Pak web page (A), 2010-02-26

³¹⁴ Interview Package Specification Manager TFA, Tetra Pak, 2010-02-17

³¹⁵ Interview Package Specification Manager TCA, Tetra Pak, 2010-02-25

was introduced it was a simplification with many constraints due to the limitations in computing tools at the time. An assumption that one of the theoretical equations provided an estimation that was accurate to plus minus 15% for the majority of single-wall boxes was made. According to a recent study by Thomas J. Urbanik et al. at USDA Forest Service, the strength estimation using the McKee formula is for many boxes off by more than 20%, and might be even higher for double-wall boxes³¹⁶. By removing the constraints and assumptions in the McKee equation, which were necessary in 1963, they improved the estimation for single-wall boxes to $\pm 8.5\%$ on average according to Thomas J. Urbanik.

5.3 Business relationships within the Tetra Pak business

5.3.1 The relationship between Tetra Pak and the dairy

As we were told in the beginning of our work, getting hold of the market companies in order to reach the dairies would be rather difficult. However, we did choose to contact them via e-mail to get an understanding of how the arrival and control of the corrugated cardboard blanks is carried out at present time. We chose three different customers located in Kenya, China and Vietnam, since these three markets have implemented a data collection of leakage rates. However, we only received an answer from two of the customers; China and Kenya. An issue we had with interpreting the data was that the answers weren't detailed.

According to the market companies some kind of control at the dairy is performed. When the blanks arrive, a weight check is done to see whether it satisfies the specified weight or not. The weight can often give a good picture of how strong the corrugated cardboard is since there is often a link between strength and weight. One of the dairies also mentioned that they have a standard procedure for arriving blanks, but weren't able to further develop what it means. The dairies also try to have proper storage that will have minimal impact on the blanks. Apart from that, no other controls were made.

When the blanks are delivered, only one of the dairies receives a specification of the corrugated cardboard values from the supplier. Enclosed parameters are ECT tolerances, material thickness, grammage, and Bursting Strength (BS).

If a batch does not pass the control at the dairy, the dairies say that they would return the batches to the supplier. One of them also claims that this has already been done, and that the supplier accepted the material being rejected.

The vision within Tetra Pak is to facilitate and cooperate with their customer to obtain a better total supply chain. Tetra Pak does not only look into the relation with their direct customer, i.e. the dairies, but they are also interested in the relation between their customer and their supplier. This way of looking into all actors through the supply and value chain is a good way to create a reliable and safe relationship. For instance, if a supplier doesn't deliver a certain quality or cannot meet certain specifications from Tetra Pak, they won't automatically change to another supplier. But they will try to work together with the supplier and show what they could do in order to obtain the desired quality. Tetra Pak development organisation is communicating with the customers through a key account manager at the local Tetra Pak market company. The knowledge about the secondary package and distribution at the market company is in general lower than the dairy. In recent years, Tetra Pak Carton Economy has started to provide a service to customers with the aim to increase

³¹⁶ Urbanik, T.J., and Frank, B., 2006

Control Process for secondary packaging

package performance without reducing profits. This was also welcomed by the dairy, indicating that they are motivated and aware of the package performance.

5.3.1.1 Recommendations

A Tetra Pak Market Company does exist on each market, and their main objective is to sell the Tetra Pak portfolio. The Market Company often has a closer contact with the dairies than with Carton Economy in Lund since regular visits and controls are performed at the dairies by them. Tetra Pak does not vend the secondary package to the dairy and thus they aren't their customer from this point of view. Nevertheless, Tetra Pak is concerned about the secondary package since it affects the whole packaging system, and in the end, the primary package. What they can do though is give the supplier certain recommendations to follow in order to obtain the desired quality. In the present situation recommendations are given to all customers when it comes to the secondary package specifications, both of the handling and the quality on the package. The recommendations have gradually resulted in an improvement on the package performance. But no process for controlling to why these deformations on the packages occur is performed. Tetra Pak has done several simulations on their primary packages with a very good outcome when following the recommended specifications of the secondary package.

5.3.1.2 Agreement

In the agreement between Tetra Pak and their customers, no demands on specific parameters exist. This means that the dairy can choose their own quality of cardboard based on discussion with the local supplier and choose quality as a balance between performance in local distribution environment and cost.

In the end, the choice of a secondary package is not always about quality, but about cost. Particularly in a developing country, the dairy will most likely choose a cheaper corrugated cardboard, thinking that in the end this will save them capital.

5.3.2 The relation between the dairy and their supplier for corrugated cardboard

5.3.2.1 Choice of supplier

Even though the dairy is aware of the need of a certain package performance, this is not always prioritized. The grocery industry, with its large production volumes and low margins, is constantly seeking for improvements to drive down the prices. In most cases, the dairy will choose the supplier that offers the lowest prices. On several markets, for instance in China, Vietnam, and Egypt, a so called *spot market* exists for corrugated cardboard³¹⁷. A spot market is a market where the customer gets more and more benefits the more one buys. The purchase price is based on last year's sale, hence the more one has bought the cheaper it will get.

The cardboard supplier is more anxious to keep the major customers rather than the minor ones. Therefore, they are also more willing to change their way of working in order to satisfy the customer. This means that if, for instance, a customer demands a better control of the cardboard quality, the supplier will most likely do their best to meet the demands and implement such a process in their work.

³¹⁷ Interview Package Engineer B, Tetra Pak 2010-02-18

5.3.2.2 **Specification**

In the present time, a number of specifications of parameters are set from the dairy for the supplier to meet. Interesting parameters could be dimensions, thickness, pulp grammage and printing. Of course, the specifications aren't the same all over the world, but adapted to the market. Important factors that vary greatly from one customer to another are the number of primary packages, air humidity and layers of stacking. When certain batches of cardboard blanks arrive to the dairy, a test specification is enclosed, showing whether the batch passed the tests or not. An interesting point of view is that the results of the specifications are measured under the current weather conditions (temperature, air humidity) at the supplier, and may accordingly vary from day to day. The ultimate way would be for the supplier to perform the test in a climate chamber at standard conditions, although this is very seldom the case.

5.4 **Current situation within Tetra Pak's customer**

When communicating with the customer in each country, Tetra Pak has to go through their local market company. This is seen as a problem since the communication between the R&D department in Lund and the local market company varies widely. Sometimes the market company is really difficult to get hold of, whereas other times they answer directly. On the other hand, the contact between Tetra Pak's customer and the market company is good. They almost have daily contact and visits by the market company are made regularly³¹⁸. The contact between the customer and the supplier of corrugated cardboard is also good. Due to the spot market, the customer buying more will get more benefits. If the customer is very big this means that he can get a special treatment. This could be a higher quality on the corrugated cardboard than requested in order to assure that the right quality really is delivered³¹⁹.

At a supplier site in Thailand, an audit showed that the die cutting tool for the blanks was made by hand in one of the employee's living room. Thus it resulted in poor tolerance levels and therefore the dimensions are really important to check. Nevertheless, not all cutting tools are made this way but laser is also used in order to have the right dimensions³²⁰.

In Vietnam and Egypt, a specification of the delivered cardboard blanks is included when delivered to the dairy. In the specification, values for BCT, ECT, BS and fluting is specified in order to see if the blanks could meet the requested values. Until now, Tetra Pak has never experienced or heard of a batch that hasn't passed the test³²¹. However, very few of the dairies verify or have a control process before the blanks enter the distribution chain.

Most of the corrugated cardboard suppliers in Egypt and China use climate chambers in order to carry out the test in standard conditions, whereas the customers in other countries do the test in the actual environment. Whether the suppliers use these climate chambers or not is mostly dependent on how big the supplier is³²². From different audits made by Tetra Pak in Vietnam, one discovered that the quality of the secondary package changed significantly throughout the year due to the different air humidity for each season.

³¹⁸ Interview Package Specification Manager TFA, Tetra Pak, 2010-02-17; Interview Package Engineer B, Tetra Pak, 2010-02-18

³¹⁹ Interview Package Engineer B, Tetra Pak, 2010-02-18

³²⁰ Interview Package Specification Manager TFA, Tetra Pak, 2010-02-17

³²¹ Interview Package Engineer B, Tetra Pak, 2010-02-18

³²² Interview Package Engineer B, Tetra Pak, 2010-02-18

Control Process for secondary packaging

Since the labor becomes more and more expensive, even in developing countries, the automatic cardboard packers become more and more common. At present time, a field test with using a cardboard packer is conducted in Vietnam, and will eventually replace the hand packing line. Nevertheless, certain problems with the automatic cardboard packers do exist. When the blanks are delivered they are sometimes packed into a plastic film or strained with a plastic strap. Sometimes the supplier tends to strain these straps too hard so that the blanks are bent. If the blanks are bent when they enter the automatic packer they might not enter and occasionally stop the packing line. When the primary packages enter the secondary box, they tend to puncture one another with their sharp edges. So far, this problem is difficult to prevent, and does not occur during hand packing. Another very important aspect is that the dimensions of the blanks are correct, and that the creasing is parallel to the other ones. If they are not, they will most likely cause a stop in production in the automatic cardboard packer. However, the inner side flaps of the blank, see Figure 43,

should have a creasing that is located half a flute height lower than the outer one. Otherwise difficulties with folding the box will occur. Therefore it is very important to check the dimensions and the creasing so that this is properly done. If the dimensions are correct, the flaps should not overlap when closed. If they do, it will most definitely cause a stop in the automatic packer. This is not only important for automatic packers, but also for hand packing since the flaps will create a pressure on the primary packages if they overlap. An interesting perspective when it comes to the specification is that the

creasing is not specified. Therefore, it is also difficult to give instructions of how the creasing should be.³²³ In China, the secondary package is also used for display in the retailer store, i.e. when you buy milk you will actually buy the secondary package too. Thus it is necessary to check the printing so that it is correct and pleases the customer.³²⁴

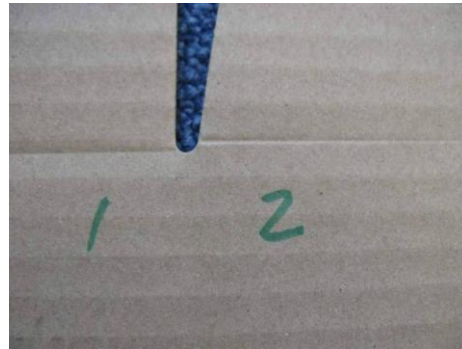


Figure 43 - The creasing of inner side flaps properly displaced

An initiative taken by Tetra Pak is to promote their customers and their distribution centers to start a data collection of the frequency of package deformation during different processes along the distribution. This was also accepted and introduced in a few countries, and shows that customers have some awareness of quality. However, at certain customer sites, poor package handling has been discovered where the workers even climb and stand on top of the secondary boxes in the warehouses.³²⁵

One believes that once the awareness and knowledge increase at the customer site, the workers themselves will question how they work and realize that one cannot step on the packages. Nevertheless, when Tetra Pak visited a customer in Egypt they truly welcomed the feedback given on their packing line. The customer in general is very welcoming when it

³²³ Interview Package Specification Manager TFA, Tetra Pak, 2010-02-17, Interview Project Manager B, Tetra Pak, 2010-04-22; Interview Package Specification Manager TCA, Tetra Pak, 2010-02-25

³²⁴ Interview Manager Primary and Secondary Package, Tetra Pak 2010-03-23

³²⁵ Interview Package Engineer B, Tetra Pak, 2010-02-18, Internal Video documentation at customer in Kenya, Carton Economy, Tetra Pak

Control Process for secondary packaging

comes to getting advice and recommendations of how they can improve their business and efficiency³²⁶.

The main reason as to why Tetra Pak wants to help their customer this way is that a chain isn't stronger than its weakest link. If the customer doesn't follow the recommendations, this will most likely increase the risks of package deformation, which in turn will return to Tetra Pak via claims. It is also more or less impossible to integrate a control process in the agreement between Tetra Pak and their customer since their business has nothing to do with secondary packages³²⁷. Moreover, Tetra Pak would prefer not to do this since it doesn't align with their work vision.

If Tetra Pak would like to implement any kind of control process for the incoming corrugated cardboard it is of importance to educate and explain to the customer why this is implemented and what it strives to achieve. In order to introduce such a process, it is important to have a very good contact with the market company since they are the one to communicate it to the customer³²⁸. As mentioned before, the contact with the market companies isn't the best although it varies from country to country. Another important aspect is to be able to show cost savings implementing the control process, otherwise it will be difficult to make the customer accept this.

When it comes to the supplier for corrugated cardboard, they seldom have their own paper mills, but they in turn have a second supplier. Different raw materials are used in order to produce the secondary boxes. For instance in Peru, sugar canes are used, Pakistan uses rice, whereas many other countries use tree plants. A few years ago, Tetra Pak discovered that some of the suppliers had difficulties in delivering corrugated cardboard blanks that were within the specified values. Either the supplier didn't make any control of the blanks before delivery, or they didn't have an understanding for it. The testing equipment at the supplier site is often basic and the testing is performed in the actual environment³²⁹. When it comes to different test methods, none of the interviewees were willing to say which test method should be preferred. It is though clear that if test methods are to be done at the customer site, they cannot be difficult to perform regarding the economy and equipment situation in these countries. Also, it is of importance to get a repeatability of the controls so that a continuous process occurs where one can look back on old deliveries in order to make a traceability of the packaging performance³³⁰.

A climate chamber was only found at a few of the suppliers' sites, and is preferred in order to get a standard reference to the results. When the cardboard blanks arrive to the customer, no controls were made, and the blanks enter the distribution chain directly.

The person responsible for the specifications for primary and secondary package is the specification owner. This person gives recommendations based on different parameters such as climate, handling and storage time, i.e. the recommendations are different for each market³³¹. The worst case scenario is in Kenya where they use a very low quality of

³²⁶ Interview Package Engineer B, Tetra Pak, 2010-02-18

³²⁷ Interview Project Manager B, Tetra Pak 2010-04-13

³²⁸ Interview Product Manager, Tetra Pak 2010-03-26

³²⁹ Interview Package Engineer B, Tetra Pak, 2010-02-18

³³⁰ Interviews Package Specification Manager TCA, Tetra Pak, 2010-02-25 and Development Engineer A, Tetra Pak 2010-02-19

³³¹ Interview Package Specification Manager TCA, Tetra Pak, 2010-02-25 and Package Specification Manager TFA, Tetra Pak, 2010-02-17

Control Process for secondary packaging

corrugated cardboard and at the same time they have a tough climate and bad road conditions.³³²

5.5 Cost of waste

According to Jönson, improper packaging, transport and storage, especially in less developed countries, are the reasons why huge amount of food gets wasted. In accordance with her³³³ the comparison of food waste figures between the Western world and the less developed countries are 2-3 % versus 50%. Through the interview with the Manager of Packaging and distribution solution at Tetra Pak Trading in China (Shanghai), importance of financial gain for the customer is a critical factor for possible implementation of the control process.³³⁴ Therefore the authors have created the chapter of cost of waste in order to give the reader an illustration of the economical aspect. However, a more specific calculation has to be done within Tetra Pak with the precise values.

5.5.1 Cost units

During the last years, Tetra Pak has started to collect data from different customers concerning packaging deformation rate, for both primary and secondary packages. Today, Tetra Pak Carton Economy collects data for the statistics of how and when packaging deformation occurs. They do this to get a better insight into their customer's problems, and to help their customers improve their situation. Carton Economy collect particular information from Egypt, Kenya, Vietnam and China. The calculations in this Master Thesis are based on the Tetra Pak collected information from Egypt, China and Kenya, since the collection in Vietnam has started just recently.³³⁵

The number of packaging deformation is gathered from different activities in the value chain; loading at site, unloading at warehouse, sorting out and loading at warehouse, unloading at wholesaler, loading at wholesaler and retailer.

The waste costs are calculated by the summation of the cost for the waste of; filled product (Raw milk cost), primary packages, secondary packages, tape, customer operational costs - COC, processing cost, transport, the labor cost for issue handling, and other cost. All costs are in Euro per 1000 packages, (€/1000p). Other cost consists of overhead costs steaming milk process, pre-processes and storage etc.³³⁶

The figure on next page show how the waste cost is spread among the different types of waste.

³³² Interview Package Engineer B, Tetra Pak 2010-02-18

³³³ Jönson, G., 2005

³³⁴ Interview Manager Packaging and distribution solution, Tetra Pak Trading, Shanghai, China, 2010-03-

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³³⁵ Interview Project Manager B, CE-Packaging and distribution solutions, 2010-04-13

³³⁶ Interview Project Manager B, CE-Packaging and distribution solutions, 2010-04-13

Control Process for secondary packaging

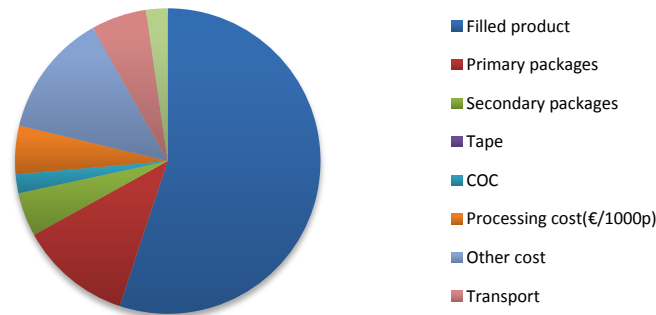


Figure 44 - Cost allocation of waste per 1000 primary packages

The waste cost for the secondary package constitutes to a third of the total cost of waste from the primary package, referring to the present estimation at Tetra Pak. According to this the interest for the secondary package should be of interest for Tetra Pak to solve since it has great influence on their product.

5.6 Calculations at Tetra Pak

The statistics gathered by Tetra Pak has later on been converted into costs by collected information from visits at the customer and through questions asked. It has also been estimated by using a “resulting packaging deformation” factor in the calculations. If a secondary package gets deformed, a leakage of milk (beverage) will render that other secondary packages becomes wet and, when that happens, the wet corrugated material loses its strength and the other secondary packages will also collapse. The “resulting packaging deformation” factor can vary from 0.5 to 0.8 depending on primary package size, secondary package quality and packaging patterns.³³⁷

The estimated calculation model by Tetra Pak has only been made for the countries which Tetra Pak gathers data from, therefore caution must be taken to the result since the calculations are only made for internal use. If calculation shall be used as justification to the customer, more detailed information has to be gathered with the purpose of estimating the cost of secondary packages without relation to the primary packages.³³⁸

5.7 Indirect savings

Some savings are hard to estimate because they depend on how well the implementation is done and how well-developed the process works in practice. Indirect savings also depends on how well the customer understands the importance of quality and if the customer in practice return not approved boxes or if the customer chooses to use, even those in their activities. In an ideal case the customer understands, follows, and implements the recommendations, making the process work excellent. If the employees are integrated into the process and understand the importance of their work, there will probably be more indirect savings in the longer term because of better quality: less stops, fewer distortions and fewer claims from retailers and consumers.

³³⁷ Interview Project Manager B, CE-Packaging and distribution solutions, 2010-04-13

³³⁸ Interview Project Manager B, CE-Packaging and distribution solutions, 2010-04-13

6 Analysis

The analysis of the empirical study, based on the theoretical framework, will be presented in this part. The chapter includes the authors' findings and suggestions regarding the areas that were found in the empirical study.

Seven major gaps related to the secondary package in the supply chain were found during the analysis work. The first one is the lack of knowledge of the secondary packaging performance within the employees at the customers. There were also a gap identified throughout the distribution related to the shortcoming in knowledge of packaging performance of the secondary packaging and the traceability of packaging deformation. Finding the root cause to the secondary packaging deformation is today almost impossible, since there are so many factors that add up to the packaging performance making the traceability very complex. Furthermore, there is no reference measurement that can guarantee the initial packaging performance before the packages enter the mutual supply chain. Another gap was the absence of collaboration within the supply chain. According to studies done in developed countries there are a lot of potential for developing countries through enlargement of their business relationships. However, not all of Tetra Pak's customers have realized the potential and therefore, Tetra Pak has to take an initiative to improve the overall efficiency and effectiveness throughout the supply chain. Although taking an initiative can be very difficult since it also indirectly involves other suppliers connected to Tetra Pak's customer.

6.1 Managing the supply chain management

According to Meier et al., organizations are no longer competing business versus business; instead the entire supply chain is competing against other supply chains. It has therefore become very important to reduce cost and waste throughout the supply chain to stay competitive. This can only be done by looking at the supply chain as an entire system and finding the optimal solution for the system that will maximize customer satisfaction. In order for Tetra Pak to expand its business, the customers have to expand theirs. If the customer wants to be able to do so, the output of their business must be of a certain quality, which implies that the input has to live up to specific standards. However the system thinking and the advantage of the supply chain management strategy is still a new term in many developing countries. The authors have chosen to divide the customers into different groups based on the information gathered from the studied customers. Those who have great knowledge within supply chain management, those whom have recognized the problem but don't act upon it and those who haven't recognized it at all.

6.1.1 Customer knowledge within SCM

Throughout the research the authors have been able to identify different patterns of what kind of people that have got the knowledge within the area of supply chain management and those who haven't. Customers who are a part of a great multinational organization have often already a deep knowledge within quality and system thinking. These companies have often quality as an essential part of the business culture and sometimes they even own the entire supply chain, which makes it easy to control and manage it.

Control Process for secondary packaging

Another group is fast growing companies. Since their business is expanding, their rate of waste does the same, and the company has now realized the problem. However, they still have little insight in the entire supply chain and there are many different operators. The last group is often small companies that have little influence on suppliers and other operators within the supply chain. In some cases the choice of supplier is not the optimal and cannot be changed due to the economic and political conditions in the country. According to research, the level of knowledge shall not be seen as a country related consequence; instead the authors point out that the size of the customer business is far more important and crucial. As the size of the customer grows, the impact on suppliers and distribution companies follows.

The optimal mutual goal for the supply chain is to deliver a product that the consumer wants to buy and will buy over and over again. To make this happen, a product within the beverage or food industry primarily has to be delivered without damages so that the product is intact. The delivery also has to reach the retailer in a certain time to ensure that the customer can be able to use the product before expire date. In developing countries, most customers are very price sensitive and therefore the costs throughout the supply chain have to be kept low so that the price of the product can be attractive for the customer. This is also the reason as to why Tetra Pak's customer in developing countries cannot raise the price to get greater profitability in order to expand their business. It is therefore essential for Tetra Pak's customer to constantly try to reduce cost and waste to maximize the profit and to get financial resources to expand their business. According to studies at customer sites made by Tetra Pak and the customers, secondary packaging deformation occurs in many stages in the supply chain.

The authors have not been able to see any pattern of more deformation within a certain group or region among the identified groups. However, there are more claims regarding packaging deformation on the TFA since this primary package is more fragile. All deformations do however not end up in claims to Tetra Pak, which can be seen as an outcome of different acceptance levels in different business cultures. According to the iceberg theory³³⁹ and to specification owners within Tetra Pak, it is only a small part of all deformations that end up in claims. This is the reason as to why the authors have decided not to investigate claims, but instead focus on how to handle the problem with the amount of packaging deformation that already occurs in the dairy before it even reaches the customer. By focusing on this area the impact of customers' expectations can be excluded and the solution aims to solve the packaging performance issue. This is due to that customers have different abilities to change working procedures made in the entire supply chain, both before and after leaving the customer's site. The authors have focused on the packaging deformations that the customer can influence and eliminate.

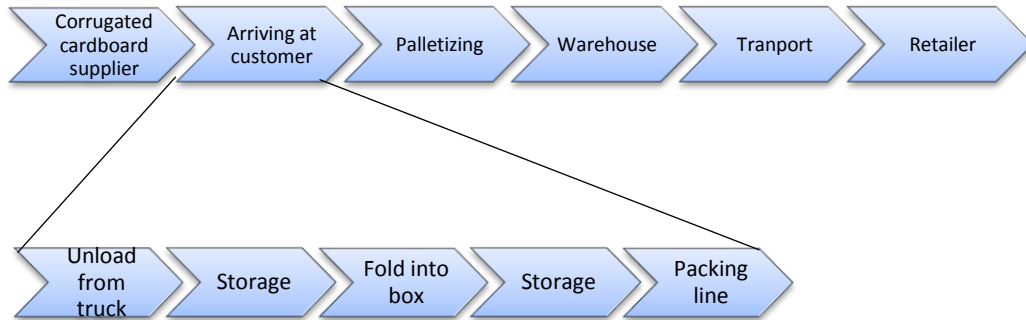
6.2 Process mapping of the main processes at customer site

When the secondary package has gone from being a single value chain product to be a part of the mutual supply chain of delivering milk to the consumer, it will pass a couple of processes during its distribution. When the secondary packages arrive at the customer site, the following arrival processes were identified through movies and interviews.

³³⁹ Frid, B., 1997

Control Process for secondary packaging

6.2.1 Process identification



Corrugated cardboard supplier

The performance of the secondary packaging depends on raw material, how it has been manufactured, if the creasing is well done and how the printing has affected the fluting. It also depends on how it has been stored, what temperature and climate it has been exposed to, and if it has been wrapped with plastic straps or plastic film. However, these are all procedures that can vary depending on the choice of secondary packaging supplier. Tetra Pak can do recommendations on what specifications their customer shall demand from their supplier, but the customer cannot decide upon how the supplier business shall be conducted. Instead the customer can make demands, develop relationships and decide which supplier they want to work with.

Arriving at customer

The first contact the customer has with the secondary boxes is when they arrive at the customer site. Depending on how developed the site is, the trucks will be unloaded with a forklift or by hand. In both cases, damage can occur on the secondary package. The storage of the blanks of corrugated cardboard is very important since the environment strongly affects the paperboard. This means that the material ages when it is exposed to different climates. The customer should for that reason store the blanks away from sun, rain and changes in temperature and humidity. Yet, this is not possible for every customer because of the lack of resources or available knowledge within the local society.

After storage, the blanks are folded into packages, either by hand or in an automatic packer. If the blanks are made from tools that have wrong dimensions and tolerances, problems might occur in the folding procedure. According to the specification owners these problems are rather common and no dimension check is carried out when arriving. One way of dealing with this problem is to check the dimensions of samples before the batch enters the customer packing line.

The dimension of the secondary package is essential for its performance. Even though the dimensions are specified in the order to the cardboard supplier, minor modifications by the supplier can affect the shape and in turn affect how the primary packages can be packed optimally and how the boxes will fit when palletized.

Control Process for secondary packaging

In order to find potential improvement areas, the authors have analyzed the problem using an extended 4M model.

6.2.2 Machine

The possibility to buy advanced machinery on the sites in developing countries is small due to the general poor economic situation for many customers. When testing automatic packers, one realized that the primary packages tend to puncture one another, and this is seen as a problem. Furthermore, no advanced testing equipment can be installed, thus a simple and effective test method that will test as much as possible must be considered.

6.2.3 Method

Today, the method of working within the customer does not include any control of the incoming corrugated cardboard blanks. However, certain routines with controlling the primary packages exist, and similar routines should also be implemented regarding the secondary package. However, in order to change the dairy's working process, an understanding as to why the control process is implemented must exist, and can probably only be accepted if cost savings can be proofed.

6.2.4 Man Power

Although an implementation of an automatic cardboard packer is considered at certain sites, the labor is still relatively cheap. The issue is that there may be new workers every week and they do in general have a very low knowledge and their awareness of quality is often very poor. It is therefore important to try to educate and create an understanding for the employees.

6.2.5 Materials

The pulp and paperboard building up the strength in corrugated cardboard is an important factor for the success in delivering liquid food products. The quality of paperboard varies depending on which raw material that has been used. The longer the fibers in cellulose are the stronger paper. However, the strength of corrugated cardboard is related to the weight, concluding that this is a good enough reason to include weighing in the control process.

6.2.6 Measurement

To measure and control the performance of the incoming corrugated cardboard blanks is essential since one does not know if the requested quality is met. In chapter 3.3 important facts about different test methods were presented, and the authors consider this *M* from the Ishikawa diagram to be the most important in order to establish the control process. It is here of great importance to use a test method that will test as much as possible, without being too complicated to carry out. Due to the economic situation the measure process cannot require advanced testing equipment. The authors may therefore have to come up with their own version of a test method, equal to a professionally executed one. Very few of Tetra Pak's customers have a control when the blanks arrive. Parameters that are important to measure for a good working distribution according to our research are dimensions, creasing, thickness, and the test method BCT, analyzed and further explained in chapter 6.2.9.

6.2.7 Mother Nature

The environment is having a great influence on the performance of secondary package. This is another *M* that the authors find very crucial for the packaging performance and also something that should be considered when the control process is carried out. Most of the developing countries have harsher environmental conditions than Sweden, with varying temperatures and air humidity. As can be seen in chapter 3 regarding relative humidity, the BCT-strength is significantly decreasing with an increase in relative humidity. Since the relative air humidity is increasing during night, a consideration to this should be taken. A suggestion could be to let the testing of the arriving boxes be executed early in the morning in order to take into account the given environmental conditions. Moreover, a climate chamber is an extreme investment for a customer, and is not seen as an option. The authors believe that it is good to carry out the testing in the actual environment since it should correspond to the conditions that the box is being subjected to.

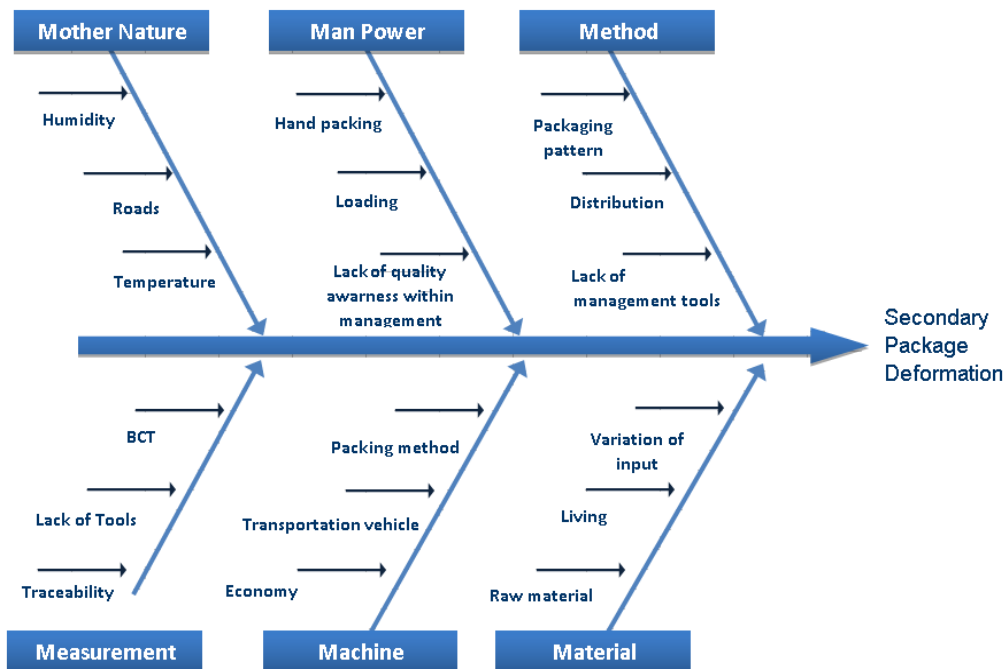


Figure 45 - The Ishikawa diagram

The different categories visually described by the Ishikawa diagram to easier get on overall picture of the situation to identify the root cause.

6.2.8 The identified gaps

Through a thorough comparison of the current situation within the beverage industry, the theory presented, and the case of Tetra Pak, the authors have identified certain gaps that are of interest for the secondary packaging performance as well as the packaging system performance.

- Customers have little insight in how the packaging system is handled after leaving

Control Process for secondary packaging

the site.

- Customers have gaps in their handling routines with the packages
- Customers have limited equipment for their daily work.
- The employees at the site can vary from day to day
- The client is not working proactively to solve problems. The solution of random or sporadic problems is usually not sustainable since the same problem often arises again.
- Customer tends to purchase the cheapest secondary package and have a variety of suppliers instead of working with long-term relationships.
- The customer is having difficulties tracing the secondary packaging deformations that occur, and they do not know if it depends on material, design, or handling.

According to the theory about variations in chapter three, variations can be seen as random and sporadic. Tetra Pak's customer will probably achieve more from dealing with random variations, although these can be hard to locate. Today, when packaging deformations occur, the root cause is almost never identified, which leads to repeating problems in the supply chain. Through the fishbone diagram a couple of assignable variations have been found. These variations have to be controlled by a process and by a change in business culture and working procedure. In order to manage the process, Juran, Crosby and Deming all recommend education of management. If the management is missing knowledge within control processes, the human factor, equipment, materials, and environment, it will be difficult to communicate the importance of quality to the employees.

6.2.8.1 Redesign of working process

In order to know the quality level of the secondary packages when they arrive to the customer, the authors recommend following change in the customer's working process.

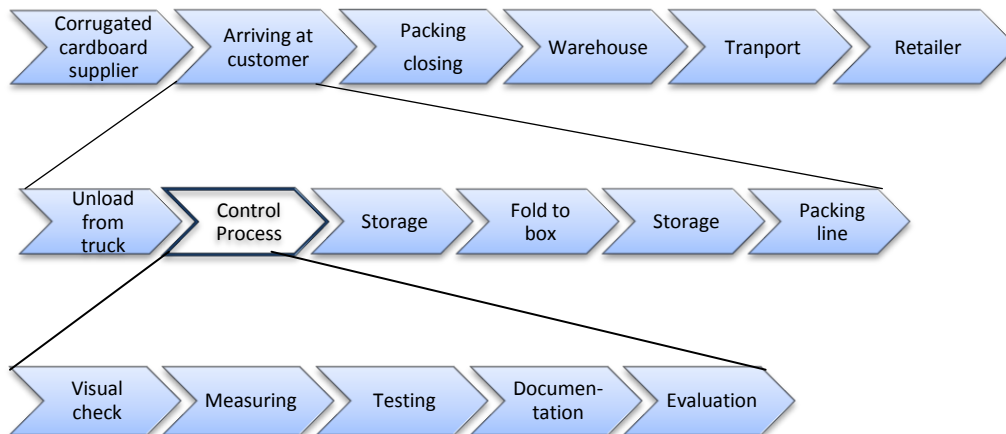


Figure 46 - Redesign of working process

6.2.9 Critical factors for the control process

In order to choose one or few methods to test the quality of corrugated cardboard, an analysis has been made out of the gathered theories, test reports and interviews. Seven different test methods have been investigated, but the authors have also been looking into

Control Process for secondary packaging

other aspects to control the incoming corrugated cardboard. One realizes that all of those test methods cannot be implemented at the customer site due to their complexity, but also due to the economic investment that has to be done to purchase the testing equipment. Our goal has been to identify critical factors that have to be tested in order to assure that the secondary package won't cause any problems during the packing and distribution process. However, this is difficult to attain and although a batch of secondary package fulfill the specified recommendations, problems may still occur.

Most of the seven test methods analyzed in this paper are in some way checking the performance of the corrugated cardboard. However, there are two methods, PAT and COBB, which measure something else. PAT is important to check when it comes to the adhesive ability between the liner and the fluting. Although the PAT doesn't look at the strength of the corrugated cardboard box, it greatly affects the total performance of the box. If the gluing between the liner and the fluting is poor, it doesn't matter how strong the paperboard itself is, but the box will most likely fail since the two liners do not connect, resulting in very low bonding strength. The authors have though realized that a rather good PAT can be conducted without buying the equipment for the test. By grasping the inner and outer liner with your fingers, separating the two liners from the corrugated medium should not be possible. Of course one is able to separate them when using violence, but during normal conditions one should struggle to be able to do it. The more humid the air is the bigger is the risk that the glue will dissolve and lose its adhesive ability.

To check the resistance to humidity, the COBB test is often used in order to see how the corrugated cardboard is affected by its environment, i.e. the humidity. However, a small amount of moist is good to have in paper; otherwise it would be fragile and loosen its strength. The test is though not fully corresponding to how the real environmental conditions are, since the specimen is submerged into water. The authors are aware of that the humidity is a very critical factor for the performance and that it is of importance to take into account. Therefore the authors investigated the option with putting a plastic film around the blanks in order to isolate them from moisture influences. Yet this procedure is complicated for the supplier to do, and surprisingly, it did have the opposite effect from what was expected. The plastic film wasn't perfectly sealed and thus moisture was found behind it, liquefied and turned into water. The results turned out to be really bad and the authors soon ignored this alternative.

COBB is an important test method, but since the method isn't a pure performance control, another test method should first be prioritized. The authors believe that it is good for the comprehension of different humidity levels impact on the packaging performance for the dairy.

The bursting strength test was for a long time considered and used to be the standard test method when measuring the performance of corrugated cardboard. It was for a long time misunderstood that the bursting strength and the BCT-strength had a correlation. But this is not the case, and the bursting strength is understood to be a measure of the general strength to bursting of the box. Thus it gives no important information regarding the design or the compression strength of the box. The test is rather useful when the content wants to burst the box, i.e. when the content is heavy and wants to break out from the bottom. An example of this could be a large secondary package shipping a heavy plasma-TV. Since this is

Control Process for secondary packaging

not the situation for the dairy, the authors have chosen to disregard from this test method, and focus on test methods regarding the compression of a secondary box

The FCT is another test that reminds a little of bursting strength. The result of this test is strongly depending on the thickness of the fluting. The thicker the corrugated cardboard is the higher will the FCT-value be. Therefore, this test gives a good insight of the fluting stiffness and how well the box dampens shocks when a box is being dropped. However, this method gives little information of how the performance of a stacked corrugated cardboard box is reduced when the corrugated medium is compressed. A very important aspect though is that if one let the fluting go back to its initial position after being compressed, the FCT value is slightly changed, whereas the bending stiffness has decreased dramatically.

Throughout the authors investigation it became clear that the bending stiffness is a very important factor for the ability to stack and support heavy loads. It is the combination of the thickness of the corrugated board and the tensile stiffness of the liners which mainly determines the bending stiffness of the corrugated cardboard. This can also be confirmed by looking at the expression of bending stiffness in the *Theory part*. The authors have therefore decided that the thickness of the delivered corrugated cardboard is a critical factor. The thickness must be as specified and should therefore be checked as a routine when the blanks are delivered.

It soon became obvious to the authors that the ECT is one of the most interesting parameters to test to look into the ability of stacking for a corrugated cardboard box. It is related to both the stacking strength and the overall transportation performance of a corrugated board box. ECT must though be measured in an as accurate way as possible. Different test methods are in use, and give different results since the specimen tends to break by the edge where the actual failure of a box never occurs. The failure of a box always starts somewhere in the middle. This has for a long time been a problem, and potential faults could be too high test pieces in relation to the thickness or badly cut samples. A way of evaluating whether the ECT method really measures the pure compression strength of corrugated cardboard is to investigate how well the compression strength calculated from the raw material agrees with the measured ECT-value. This method is probably the best one in order to make a comparison of the pure compression strength between different paperboards. Therefore, this test is important when considering buying different qualities of corrugated cardboard. Nevertheless, ECT is performed on a specimen only 25 mm high, and does therefore not regard a very important factor – the bending stiffness. The ECT and bending stiffness are together the two most critical factors when determining the stack ability for a corrugated cardboard box. Conveniently the BCT corresponds very well to what the box is subjected to during distribution – compression regarding the whole box. Therefore this test has the advantage to consider both the ECT and the bending stiffness. The authors have thus identified the most critical factors regarding test methods for the stack ability. The bending stiffness for a given flute height and corrugated cardboard grammage can in practice only be increased by distributing as much of the grammage as possible to the liners. In McKee's formula, the geometric bending stiffness is only raised to the power 0.25, and is therefore easily underestimating the effect on BCT. In reality, the BCT-value is most easily changed by increasing the bending stiffness. The reason is that the bending stiffness increases dramatically with even a moderate increase in the grammage of the liner.

Control Process for secondary packaging

When normally conducting a BCT test, an advanced compressing machine is used, preferably in a conditioned environment with the standard settings of 50% RH at 23°C.

To ask the dairies to invest in BCT test equipment is yet not economically sustainable. An investment of such testing equipment could attain 12 000 €, and very few of the dairies would have the economic possibility to purchase one of those. The authors have realized that a simplification of the test method must be used. Therefore they have chosen to create their own BCT-test for developing countries. The test starts with placing the folded secondary box on a flat surface. Then, a plate is placed on top of the box in order to distribute the stresses on the box. Finally weights corresponding to the specified BCT-value are put onto the plate for a few seconds in order to see if the secondary package is able to withstand the load. It is of importance that the box doesn't collapse when the test is conducted. Because if it is, it does not meet the specifications provided from the supplier.

The authors earlier concluded that the air humidity has got a great impact on the performance of the paperboard. Since the authors neglected from doing a COBB test, they somehow want to take into account the changes in air humidity over the day and create an understanding and educate the dairy personnel. Therefore, the testing should be conducted when the air humidity is as high as possible, i.e. early in the morning. The authors have also chosen to recommend conducting the test during 24 hours so that awareness of the creep and fatigue is initiated. The box is though not expected to pass this test, but is rather conducted in order to educate that the performance decreases with a long term load.

A disadvantage with not testing in a conditioned environment is that no reference exists i.e. other people cannot know how the performance of the box is since a reference to the standard conditions does not exist. However, the authors do believe that testing in the actual environment is better for the understanding and since it is actually conducted in the environment on the site. Major changes in air humidity during different seasons are common in certain countries and maybe consideration should be taken to the dimensioning of the secondary package from season to season.

It has also been shown that if the conditioning atmosphere is varied while the box is under load, the compression strength of the corrugated board box is reduced to a greater degree than if the corrugated board box was unloaded when the same atmospheric conditions are changed.

A difference between conducting a BCT-test and having the box in the real distribution is that the box is empty when tested. Although the primary packages aren't supposed to be subjected to any compression, they sometimes tend to push the walls outwards. This may have a negative effect on the stack ability since the load tends to bend the walls around the center point. This will create a torque on the liners and most likely decrease to strength to stack. Therefore, stiff liners and high bending stiffness is to prefer.

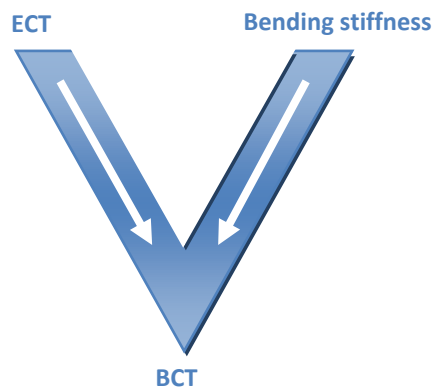


Figure 47 - BCT's components

Control Process for secondary packaging

When analyzing the interviews it also became clear to the authors that the quality of the boxes is not all about performance. There are several parameters that have to be checked before letting the batch enter the distribution. Elementary criteria as controlling the dimensions are of great importance since it affects the performance. A difference of 5 mm is huge and could definitely be crucial for the performance as well as for the automatic cardboard packer. The flaps might in the end overlap and create a pressure on the primary packages when stacked. Another scenario is that the blanks are too big and cannot enter the automatic packer, which in turn will stop the whole packing line. Moreover, the creasing must be clear and absolutely parallel so that the box can be folded properly. If these criteria are not met, cracks can occur on the edge when the box is folded or the walls of the box might not turn out parallel. The automatic packer is more sensitive to that dimensions and creasing are correctly made than the hand packing line, although they are important for both cases.

Tetra Pak also discovered that suppliers had difficulties in delivering the right dimensions and tolerances due to the handmade die cutting tool. Therefore, the authors find it vital that the dimensions are correct and controlled to show the supplier that a low or almost no tolerance level is accepted.

According to the interviewees who made audits on different sites in developing countries it was also common that the blanks were strained too hard with plastic straps when delivered. This might cause damages on the edges of the blanks, but more importantly, they were bent. If the blanks are bent they will also be bent when folded, which decreases the ability to stack, but it also makes it more difficult for the blanks to enter the automatic packing line.

6.3 Development of the Control Process

As a departure in the development of the control process the international standard ISO has been used as an inspiration tool. The authors chose this standard since there have been studies showing that many developing countries struggle with problems regarding export conditions that are not met to international demands. According to the study in Africa made by André A. de Waal organizations in developing countries

request methods that easily can be implemented. The ISO standard make demands on advanced documentation and to fully implement the recommendations of ISO can therefore be difficult for many companies in developing countries. The standard has for that reason been combined with the theory statistic quality control and the findings of critical factors for the control process. Different test methods have been analyzed in order to evaluate the most beneficial for companies with limited resources.

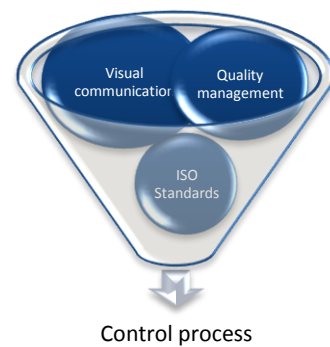


Figure 48 - Development of control process

Control Process for secondary packaging

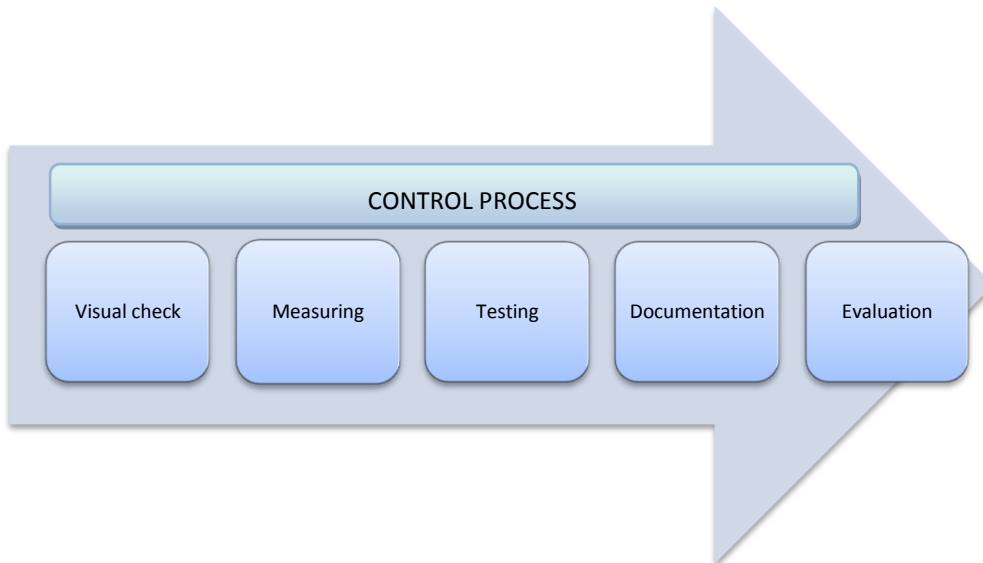


Figure 49 - Visual model of the developed control process

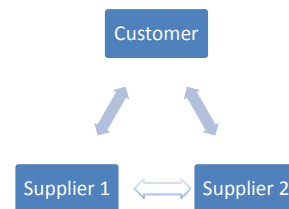
Following problems will be adjusted with the developed control process:

1. Wet boxes will be rejected at arrival through a visual check
2. Boxes will be measured to be certain that they fit in the automatic cardboard packer and to ensure that the dimensions are the requested ones in order for the box to have the expected performance characteristics.
3. Testing will be done both in purpose to educate the employees and to check that the performance of the box meets the specifications
4. Documentation will be used by management to trace weaknesses within the business. The purpose of the documentation is therefore a set point that can be used for tracing problems and finding improvement areas.

The control process has been developed as a checklist. The authors have chosen this approach since a checklist is easy to follow by given steps. The checklist has then been complemented with pictures describing every step of the process. This has been done since the knowledge of writing and reading is limited in many developing countries. Using visual models has been essential since a manager at the customer site shall use the results, and they need useful visual tools to create positive commitments within the organization. The control process is presented in appendix 3.

6.4 Implementation of control process

According to Holmen (2000) the business relationship within the supply chain has become very important during the last two decades in the developed countries. However, developing countries are nowadays increasing their acting on the global market, which means that they will have to compete on the same conditions as developed countries. In order to do so they need management and quality tools to develop or control their performance. This in order to collect information on how they can improve their business to be internationally competitive. Since more and more



Control Process for secondary packaging

companies are competing on supply chain level, organizations in developing countries that have business relationships with multinational companies that master the knowledge needed can be in great use. To understand how to share information and knowledge in the best way, it is important that organizations know what kind of relationship they have with each other. In this Master Thesis the authors will mainly study the relationship between the Primary supplier and the customer. There can be many other relationships internally at the primary supplier that can affect the business relationship to the customer but these will not be discussed in this Master Thesis. The relationship between the primary supplier and the secondary supplier is affected by the relationship the customer has with other suppliers, in this case the secondary package supplier. All these relationships can then be seen as relationships in the context of a wider network with other business relationships. This means that the performance of a supply chain depends not only on the conditions of a single company's involvement, but the connection to other companies' activities and resources within supply chain are essential. To handle this relationship from a customer perspective, they must first be aware of what kind of relationship or network they are involved in. Today the relationship of the case company and their customer can be seen as the triad relationship. At first sight it would probably be referred to as a forbidden triad. However, even if the direct communication between the two suppliers is nonexistent, there is still an indirect relationship. According to Blankenburg (1992), Tetra Pak's relationship with the customer and the secondary packaging supplier can be seen as an open triad. They have no direct communication but still some information to the secondary packaging supplier is transferred through the customer, such as requirements in the recommended specification.

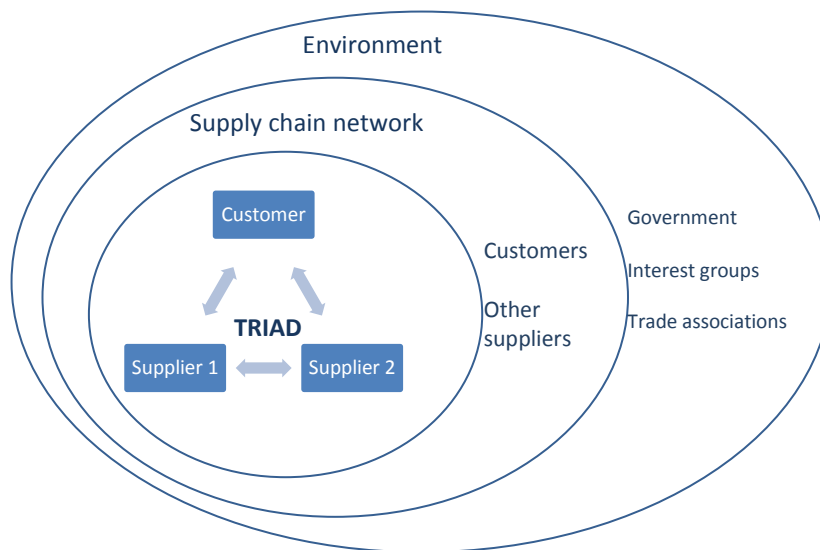


Figure 51 - The triad getting involved

Later on this triad can be seen in a bigger perspective, which also makes the situation more complex since the different actors might have different goals. Looking at the greater dimensions of the business environment, other stakeholders can be integrated in the network which can affect the relationship of interest. There can also be other actors within the supply chain and other surrounding stakeholders like the government or other companies outside the supply chain. A possible interest in the focal relationship could exist

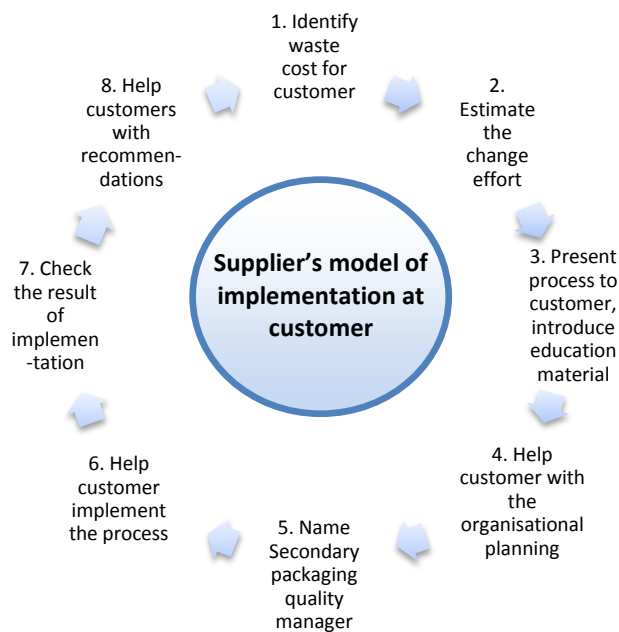
Control Process for secondary packaging

since it might affect their business in one way or another. Because of the complexity of business networks there can be different interests from the two parties to get involved in the business relationship. Therefore it is essential for Tetra Pak to analyze the customer interest in solving the problems with secondary package deformation, but also for the customer to get hold of Tetra Pak's knowledge. However, creating a mutual picture of the goals and the end performance of the control process is the most challenging for Tetra Pak. If the result from the control process does not meet the expectations from the customer, Tetra Pak's knowledge can be questioned. The implementation process can, if it turns out that the secondary packaging supplier does not deliver the agreed quality, result in conflicts between the customer and the secondary package supplier. It is therefore necessary for Tetra Pak to be aware of this problem in advance. Since the cost of waste for the secondary package constitutes a third of the one for the primary package, it should be in Tetra Pak's interest to develop knowledge within the field of corrugated cardboard and secondary packaging performance. One way of doing this is to develop a communication with a secondary package supplier. This can be done by letting the market companies work in a triad with the customer and secondary package supplier, resulting in the development of communication between the suppliers.

The implementation of the control process can be seen in two major steps. The first step is for Tetra Pak to introduce the idea to their customer. However, some of Tetra Pak's customers have during the spring already requested help with methods for controlling the secondary package quality. In these cases, the implementation will be easier than in those cases where the customer hasn't realized that the variation in secondary packaging performance can be the reason to the primary packaging deformation.

When Tetra Pak presents the idea to the customer, the authors recommend them to use the following developed model, which is a combination of the PDCA-cycle, change management, and the information received from the interviews.

Figure 52 - Internal introduction model at Tetra Pak (Created by the authors)



Control Process for secondary packaging

Through the interviews it has been identified that to be successful with the implementation to the customer, it is important to plan the changes closely and keep track of customer activity. All customers require their own adaptation to the overall implementation process. It is also very important to highlight the beneficial effects of a control process.

For the customer to work with the implementation of the control process in their business, the authors recommend the Seven-p process in combination with the PDCA-model. These models are an easy base to understand and for creating a simple implementation process that can be understood and used in developing countries despite organization size.

6.4.1.1 Positive commitment

Positive commitment shall be created by motivation and education according to the Seven P-Process. In order to create motivation within Tetra Pak's customer, certain motivation factors have been identified; savings from cost of waste, education, future profitability, and applicable methods that are easy to follow. An interesting point of view is how the customer can make cost savings through reduced waste cost. Future profitability can be seen as how the customer can expand their company by more satisfied customer and better reputation. They will also earn more money since waste now will reach retailers and be sold to consumers. To create positive commitment, the authors have developed a quick guide, see Appendix 5, that shall be used to motivate the customer's management to implement a control process. The quick guide can later on also be used by the customer to spread information within their company about secondary packaging importance and the control process activities. However, in order to motivate the customer, the market company has to be committed to the new process. The economic aspect of the secondary package waste has to be calculated into figures that are easy for the customer to understand.

6.4.1.2 Planning

This part involves the planning of how to carry out the implementation. During this sector the quality manager of the secondary packaging shall be named and the different parts of the control process implementation shall be planned.

6.4.1.3 Participation

In order to succeed with the control process, the participation is the most essential after the choice of measuring parameters. According to Sandholm (2006), it is very important to first create a deeper understanding of the impact from quality on the organization's performance. Since the current level of knowledge varies from customer to customer, local adjustments have to be considered in order to get everyone involved in the process. After creating an overall knowledge about quality within the company, the employees involved in the control process for secondary packaging will be educated in how to manage the process in practice and how to follow up the results and spread the knowledge within the company.

Control Process for secondary packaging

In the table below, the different responsibilities for the implementation process are described (Created by the authors).

Step	Positive commitment	Planning	Participation	Process control	Problem identification	Problem elimination	Performance
Management	√	√					√
Managers		√	√				√
Quality responsible or Quality manager			√	√	√		
Key employees			√	√			
All employees			√	√			
Primary packaging supplier	√				√	√	√
Secondary packaging supplier					√	√	√

6.4.1.4 Process Control

After creating participation the control process will be introduced to the employees and introduced in the daily work.

6.4.1.5 Problem identification

Problems with the implementation of the control process will be identified through evaluation session between managers and employees. Secondary packaging problems identified through the control process will be documented and the batch will be returned to the supplier.

6.4.1.6 Problem elimination

Organizational problems at the customer site will be taken seriously and handled immediately in order to guarantee that the process will turn out in a preferable way. Problems regarding the secondary package that might be identified in the process will be handled in the relationship between the customer and the secondary packaging supplier.

6.4.1.7 Performance

In order to change the working process of today, managers have to be committed to the process implementation and continually evaluate the need of process activities and acceptance criteria. This should be made to ensure that the process is up to date and that the right specifications of parameters are measured.

The implementation of quality measurements for the control process should involve as many cognizant of employees as possible to stimulate ideas and reinforce the notion that this is a team effort. There are many benefits realized by organizations in implementing a control process. One of them is improved understanding of processes by all employees. The authors believe that this control process can be a good way for the customer to develop understanding of quality through the employees that will affect other processes positively as well.

6.4.2 Implementation and problem handling model

The authors have found a lack of suitable models for implementation of a process within their customer, involving both Tetra Pak and the secondary package supplier. Therefore, a model managing implementations in triangular business relationships was created. The model is created through the idea of the PDCA model and combines the Seven P - process for implementation of TQM with consideration to the triad relationship. The model highlights where in

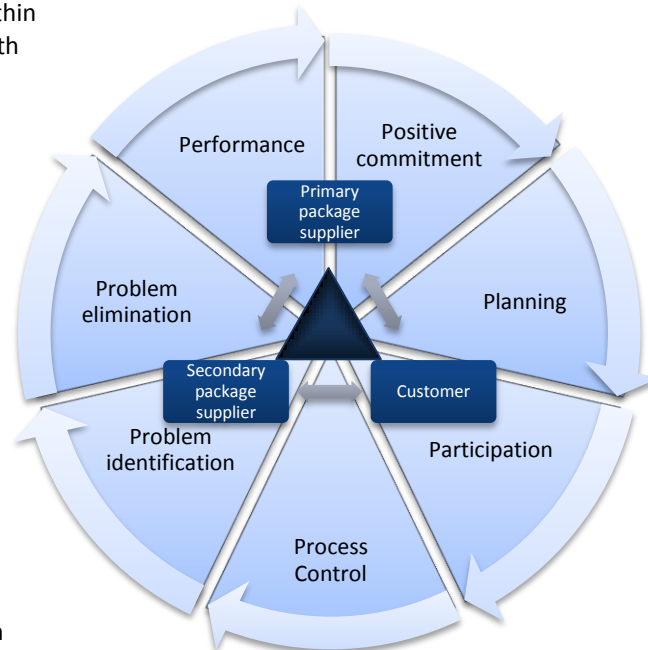


Figure 53 – Process implementation in triad relationship (created by the authors)

the process the different actors have their responsibility to solve the problem in the supply chain. In this case, Tetra Pak is the initiator, primary packaging supplier, and is therefore placed in the beginning with the responsibility to create positive commitment. The customer is the one to perform the control process and has therefore the greatest responsibility for the participation of the control process. Together with the initiator, the customer plans the implementation of the process. Later on, if the secondary packages do not meet the specifications, the supplier of those boxes has the main responsibility to solve this in order to meet their customer expectations. Hence, the problem identification and problem elimination can be the responsibility of both the primary packaging supplier, and the secondary packaging supplier. Finally, the initiator will help the customer to verify the implementation and the control process together with the other two parts. The implementation plan has been created in order to give the customer an easy tool to work with, and at the same time create understanding for the triad relationship in the business.

7 Conclusions & Recommendations

In this chapter the results and conclusions will be described, which reflect on the collected empirical material and the analysis. Furthermore findings and recommendations that have been found in the study will be described.

7.1 Results

For supply chains with limited resources the BCT is the single most important test to conduct in order to look at the performance of a RSC of corrugated cardboard. The test method takes into account the design of the box, but also the rigidity of the material, whereas with the ECT it is impossible to take this into account due to the small and low specimen. Therefore this test is strongly recommended to carry out prior to the blanks enter the distribution chain. Another very important factor is the impact from the climate, changing the properties and performance of corrugated cardboard. To better adopt the testing to tough climate, the authors suggest that the BCT is performed when the air humidity is as high as possible, i.e. during early morning, and so that the material gets a chance to adapt to the humidity. Moreover, a 24-hour static BCT is recommended, in order to show the impact from air humidity and long lasting compression. Furthermore the condition of the incoming blanks when it comes to creasing, gluing, dimensions, flaps, and printing has to be controlled in order for the packing line and distribution to work out. But more importantly, it has to be controlled and properly done for the performance of the box and to decrease the variation in quality. The most important tests have been included in the control process which can be viewed in appendix 3, where pictures and more detailed instructions are made. The control process has been made for the case company but can be used by every other company using corrugated boxes for transportation that are in need of improving quality, reduce variation and create knowledge within the organizations employees.

The developed control process is made to meet the needs in small to middle companies in developing countries. Since the authors have chosen to use picture as a communicative tool the process can be used in many different countries. However there might be some companies that will need to translate the test into the native language in order to avoid misunderstanding. The control process and checklist is a first step for smaller and middle companies in developing countries to grow en expand internationally. The process main purpose is to reduce the number of variation and thereby in this case reduce the risk for food poisoning.

Over time the authors hope that the control process will be developed and updated in sequence to meet the current challenges in the future, this in order for the company to stay competitive by constantly improve their processes. For multinational companies, the authors recommend the control process but instead of BCT, the ECT with complementary tests can be used. By doing more tests and more specific ones the company will get more information out of the process and thereby understand the reason to deformation faster. They will also be able to respond to the problem much faster than their competitors.

7.2 Discussion

7.2.1 Empirical findings

Most of the successful modern companies manage to identify their customer needs and create the processes that enable the business to deliver the product. This is important even for Tetra Pak, and with the authors work, one step towards the goal is taken.

When finding the critical factors for the control process, the authors based their results on theoretical framework and empirical data. Most of the people that have been interviewed have experience from being at the customer sites, giving them a good picture of how it really works in reality. The authors have never visited a customer, and they do believe that it would have been beneficial for them to actually have experienced the real world. This would probably have given them a better insight to other critical factors. However, the interviewees and market companies are in this case representing what the authors themselves couldn't experience.

When saying that the BCT is the most important test method for the stack ability, the authors would have appreciated if not only interviewees could have strengthen this, but a scientific result based on a comparison between ECT, BCT and the actual performance too.

The authors are aware of the big differences between different developing countries and know that certain dairies are more developed than others. The most developed dairies, with good economic possibilities should therefore also consider doing more than one test. This should be done in order to broaden the reliability of the quality, and will most likely lead to a better understanding of which parameters that aren't fulfilled. The added test methods that are recommended are ECT, BS, and COBB. ECT will look into the true material strength to see whether this one is obtained or not. The BS is a good way to test strength different from that the compressive one. Finally COBB will be used to analyze the resistance to water and humid air since this truly affects the performance of the box.

When implementing the control the authors truly believe that the instructions in order to understand the process are essential and an important step in order to succeed with the implementation. Although the pictures are trying to simplify the instructions, the authors believe that there is always a risk that some of the phases can be misinterpreted.

The fact that the authors haven't tested their control process at a site is a disadvantage and would be very valuable in order to improve and validate it.

A real verification has not been implemented although feedback from external persons has been retrieved. To better verify the control process, the ultimate alternative would have been to travel to one of the developing countries to test the control process on the site. However, a verification will be done by co-workers visiting Vietnam the coming week, and the authors wait impatiently for feedback.

Another interesting perspective that probably increases the validity would have been to compare the control process to other companies with similar issues, and study how they have done to solve the situation.

In this paper only a few countries have been investigated. To get a broader view of the situation more countries could have been studied. There is though a difficulty in using a process in several countries since adoptions and changes have to be done for different

Control Process for secondary packaging

cultures and technologies, but also to the size of the company. The authors are well aware of that many companies in China has more similarities with Western companies than with organizations in Kenya, and that there can be a huge difference from one developing country to another.

7.2.2 Theoretical findings

Today, many developing countries struggle with difficulties to export and keep national product safety. They are in need of standards that can help them control the quality and improve safety. However, the international standards are mainly developed in addition to developed countries and developing countries have often a hard time implementing them since they do not have the same tools and routines. In order to prevent food poisoning, and help developing countries to enter the international market, the international and western methods have to be simplified. Starting with the basics to create an understanding among the employees and the society is a necessity. The authors have chosen to work with the PDCA method since it is simple to understand and has been used for centuries. However, developing countries of today are being industrialized with a higher velocity than the western countries were. To prevent that developing countries will reduce their development speed by using outdated models that are not strengthen the organization's competitiveness, the authors have combined the PDCA model with more advanced ones, which in turn has been simplified so that they can be used immediately.

The implementation model has also been combined with the triad relationship in order to create an understanding of where the responsibilities within the implementation lie. Here the authors have chosen to start with the primary supplier as initiator since the primary supplier is the organization that has the package that surrounds the product and thereby a package deformation results to product waste. This leads to that the primary package supplier usually is contacted for the product waste before the secondary package supplier even if the reason to deformation has been a too weak secondary package.

The most difficult in implementing a quality process is that the success is strongly depending on the employees' attitude and the managers' commitment. It is very difficult for a supplier to criticize and have opinions about a customer business. Therefore, it is of importance to focus and develop a substantial tool that will fill its function and indirectly interests the customer to learn more. The process shall therefore be implemented within customer who knows or suspect that the quality of secondary boxes varies.

7.3 Conclusions

The purpose of this Master Thesis was to identify critical factors that are to be used for controlling the secondary package performance. The objective was also to create a control process and come up with an implementation plan for customers, as well as for other distributors of liquid food with two different suppliers.

In many developing countries the cost perspective together with product safety is the only essential drivers. Although quality could be seen as a given driver, many of the customers looking into the whole supply chain still have problems working with quality practically. The outcome of this Master Thesis shall therefore be seen as a tool in order to help customers to improve their business and together work for a competitive supply chain by eliminating package deformation caused by fragile secondary packages.

Control Process for secondary packaging

The authors claim and believe that the control process can be implemented at any dairy or liquid food producer in developing countries, as long as disturbances in quality and a motivation for cost reductions can be indicated. The steps in the control process are general and easy to follow, with simplified, illustrating pictures, making it suitable to any distributor using corrugated cardboard boxes as secondary packaging. Certainly, adjustments to different dairies have to be done, such as different test method, hand packing versus automatic packing and environment. However, the procedures in the control process as BCT, delamination, creasing, and weight of the corrugated cardboard are general parameters that check the performance. Therefore, the work should not be connected to a certain company, but it is interesting for the whole industry of corrugated cardboard. A customer in Latin America, or South America, face similar problems with corrugated cardboard, as customers in Asia and Africa. It is also very common to have different suppliers for different packages that in the end will merge into the same packaging system. The outcome of this Master Thesis is therefore a helpful tool for any distributor of liquid food, using corrugated cardboard as a secondary packaging material. When it comes to the amount of time used for the control process, the authors estimate a 20 minute use for every arriving batch, and see this time as a good investment in order to assure the quality of the secondary packages. They believe that the conviction can be done when cost savings can be presented, together with an interest from the management group.

7.4 Recommendations for further studies

Throughout our working process thoughts about how to improve the quality process and others ideas came up. We listed a few of the ideas below so that other people can get hold of our reflections and maybe another Master Thesis could be done out of these suggestions.

- How can one introduce a way of specifying the creasing for corrugated cardboard? For instance, one way could be to specify the breaking force per length unit needed.
- Which services are interesting for Tetra Pak's customers in developing countries?
- How can an Internet website facilitate and complement the control process? – A website where the customer can find a control process for each step in the distribution depending on where he/she has discovered problems.
- Which is the most effective way to influence the third part in the triangular relationship?
- How should Tetra Pak expand their knowledge within corrugated cardboard and secondary packaging production?

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³⁴⁰ With inspirational literature the authors refer to the literature studied during the pre-study but haven't been used in the Master thesis. However this material has a certain influence on the basis of knowledge the authors got before seeking deeper into the used literature.

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8.5 Internal company documents

Tetra Pak video documentation

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Corrugated cardboard supplier in Vietnam, Christina Quach – Package Engineer B, CE Package Validation & MMI

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8.6 Interviews

Tetra Pak

Per- Jan Stenberg, Project Manager B, CE-Packaging and distribution solutions, 2010-04-13

Mohsen Djalali, Manager Packaging and Distribution solution, Tetra Pak Trading, Shanghai, China, 2010-03-31

Lena Palmfält - Package Specification Manager TFA, CE Packaging and Distribution Solutions, 2010-02-17

Brita Sheehan - Package Specification Manager TCA, CE Packaging and Distribution Solutions, 2010-02-25

Linda Hall – Associate Product Manager TFA, CE Product Management, 2010-03-25

Samit Chowdury – Product Manager, CE Product Management 2010-03-26

Christin Ljungdahl – Package Manager TWA, CE Product Management , 2010-03-22

Claes Wallin-Klevås – Development Engineer A, CE Primary and Secondary Design, 2010-02-19

Christina Quach – Package Engineer B, CE Package Validation & MMI, 2010-02-18

Maria Strömberg – Project Manager B, CE Package Validation & MMI , 2010-04-22

Marie Henriksson – Package Specification Manager TWA, CE Packaging and Distribution Solutions, 2010-03-08

Johan Bengtsson – Communications Manager, CE Product Communications, 2010-04-22

Daniel Andgren, Packaging and Distribution Solutions, 2010-02-12

Anette Immelborn – Manager, CE Primary and Secondary Package, 2010-03-23

Ulf Nyman, PM New Material Design, 2010-03-16

Other

Claes Pettersson, Design Centre Manager at SCA Packaging Sweden AB, Mariestad 2010-03-18

Mikael Blomé, Assistant Lecturer, Ergonomics and Aerosol Technology, Ingvar Kamprad Design Centre, Lund, 2010-03-31

Per-Johan Gustavsson, Professor at the department of Structural Mechanics, LTH, 2010-04-13

Ola Johansson, Professor, PhD, Packaging Logistics, LTH, 2010-04-15

9 APPENDIX

9.1 Appendix 1 - Questions used during interviews at Tetra Pak

- Hur ser distributionskedjan ut hos kund och vilka steg genomgår sekundärförpackningen?
- Hur fungerar relationen mellan Tetra Pak och dess kund, och hur ser den ut?
- Hur ser kontakten ut mellan wellpappleverantören och kunden?
- Hur ser leveransen av wellpappen ut och vilka rutiner genomförs?
- Bifogas specifikationer från leverantören vid leverans av wellpapp?
- Vilka parametrar är normalt bifogade i specifikationen?
- Utför leverantören av wellpapp testning i klimatkammare?
- Hur kritiskt är det att dimensioner stämmer vid handpackning och vilka toleranser är tillåtna?
- Vilken är er uppfattning vad gäller de deformationer som sker på sekundärförpackningen, och vilken tror ni är huvudorsaken till varför detta sker?
- Vilken är den generella kvalitetsmedvetenheten hos olika kunder och hur är deras kunskapsnivå för hur förpackningen påverkas?
- Hur går processen med claims till och vem tar emot dem?
- Vilken är Tetra Pak's vinning i att förebygga variationen av sekundärförpackningen?
- Hur tror ni att kunden skulle ställa sig till ett införande av en kontrollprocess?
- Vad tror ni är viktigt när man ska implementera en kontrollprocess ute hos kund?
- Hur viktig roll har marknadsbolaget i en eventuell implementering och vilken relation har Tetra Pak till dem?
- Hur tror ni papperskvaliteten från leverantören är och vilka kontroller finns det idag på att den verkligen överrensstämmer med den specificerade?
- Hur är inställningen hos de anställda att minimera läckagenivån hos olika kunder?
- Används det olika limning för sekundärförpackningarna i olika länder?
- Vilka kontroller utförs på sekundärförpackningar hos leverantören av wellpapp?
- Testar era kunder förpackningarna när de anländer till dem?
- Finns det någon kund som använder sig av testutrustning för att testa den inkommande wellpappen?
- Finns det en förståelse för wellpappens egenskaper ute hos kund?
- Vilka kontroller rekommenderar ni era kunder att göra?
- Kan man via avtalen begära att kunden ska kontrollera den inkommande wellpappen i mejeriet?
- Har kunden någon gång fått en leverans där specifikationerna inte varit uppfyllda från leverantör?
- Samlar Tetra Pak in någon form av data från sina kunder för att bättre anpassa förpackningarna?
 - Vilken typ av data och varför?
 - Hur använder ni den i företaget?
- Hur påverkar transport och lagerhållning era varor i utvecklingsländer?
- Hur sker lagringen av wellpappen innan den når kund?
- Hur skulle era kunder mäta/testa förpackningarna om ni fick bestämma?
- Vilka anser ni är de enklaste metoderna för att mäta kvalitén på en låda och på

Control Process for secondary packaging

blanks?

- Hur kan man mäta förpackningens dimensioner säkrast och enklast?
- Vilken hänsyn tas till luftfuktigheten vid dimensionering av wellpappen?
- Hur kan man motivera kunden att mäta och testa förpackningen av wellpapp?
- Hur kan man öka kundens kunskap kring vilken kvalité de behöver köpa in?
- Vad avgör styrkan i den färdiga wellpappen?
 - Hur kan man mäta detta?
 - Vilka tester är de mest intressanta?

9.2 Appendix 2 - Questions used during interviews at SCA

UTVECKLINGSLÄNDER

Har SCA några speciella anpassningar för förpackningar i utvecklingsländer?

- Tillverkar ni förpackningar i alla 60 länder som ni har anställda i?
- Tillverkar ni i något utvecklingsland som har fuktigt klimat?
- Vilka anser du är svårigheterna i utvecklingsländer?
- Anser du att era kunder har god förståelse för de krav förpackningarna utsätts för i utvecklingsländerna?
- Vad efterfrågar utvecklingsländer för kartonger?
- Beställer de rätt kartonger från er som motsvarar kraven?
- Vilken typ av primärförpackning brukar packas i era förpackningar?
- Varför utgår man från relativ luftfuktighet och inte absolut?
- Anpassas limmet i era kartonger för mer fuktiga klimat?
- Gör ni några andra anpassningar för fuktiga klimat?
- Ger ni rekommendationer för hantering och av era förpackningar till kund?
- Finns det även krav på vad lådan får utsättas för, i avtal med kund?

FÖRPACKNINGEN

- Mekanisk prestanda
- Hur viktigt är det att dimensioner stämmer vid handpackning?
- Tillverkar ni lådor av annat material än pappersmassa?
 - Hur påverkar olika råmaterial förpackningarnas prestanda?
Sockerrör? Ris? Trä?
- Hur mäter ni kvalitén på liner och fluting?
- Hur påverkar sammansättningen av liner och fluting kvalitén på wellpappen?
- Hur kan man mäta kvalitén på wellpappens olika lager i efterhand?
- Vilka yttre faktorer påverkar förpackningen?
 - Kan man mäta klimatets påverkan på förpackningen på något annat sätt än med COBB och kontaktvinkel?
- Använder man olika produktionstyper beroende på vart kartongen ska användas?
- Hur upplever du att era kunders hantering av wellpappen påverkar kvalitén i senare led?
- Vilka olika typer av limning finns det?
- Används det olika limning för olika länder?


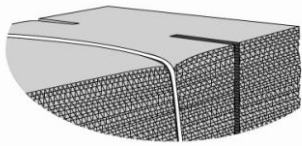
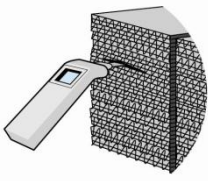
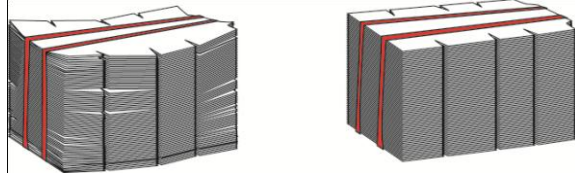
KONTROLL

- Vilka kontrollprocesser utför ni på era förpackningar?
- Vilka kontroller rekommenderar ni era kunder att göra?
- Vilka testmetoder använder ni er av?
- Tester era kunder förpackningarna när de anländer till dem?
- Samlar ni in någon form av data från era kunder för att bättre anpassa förpackningarna?
 - Vilken typ av data och varför?
 - Hur använder ni den i företaget?
- Hur påverkar transport och lagerhållning era varor i utvecklingsländer?

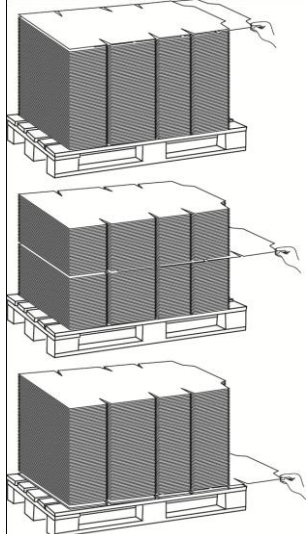
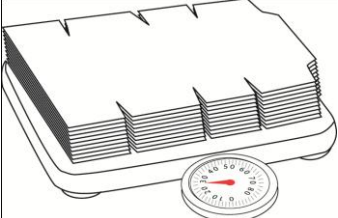
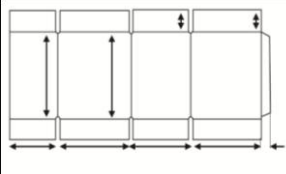
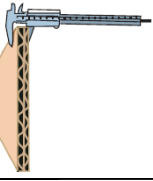
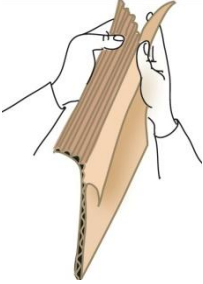
Control Process for secondary packaging

- Har ni någon lagring av varor innan de når kund?
- När testas varor i relation till det att de anländer till kund?
- Hade ni varit intresserade av att era kunder mäter kvalitén på förpackningarna när de anländer till dem?
 - Varför? Vilka fördelar? Nackdelar finns?
- Hur skulle era kunder mäta/testa förpackningarna?
- Om man inte kan testa allt, vad är viktigast att mäta/testa?
- Upplever du att det finns många kunder som köper in förpackningar från mindre bra leverantörer?
 - Upplever du att kunderna då saknar kunskap om vad de egentligen behöver för låda?
- Vilka anser du är de enklaste metoderna för att mäta kvalitén på en låda och på blanks?
 - Hur kan man testa om man inte har maskiner till att testa?
- Hur kan man mäta förpackningens dimensioner säkrast och enklast?
- Kan man på något enkelt sätt se på strukturen i wellpapp för att avgöra kvalitén?
 - Måste man ha mikroskop för detta?
- Hur stort urval behöver man för att testa förpackningar?
- Använder ni några checklistor? Skulle en förenklad version av dessa kunna fungera ute hos kund?
 - Hur är checklisterna uppbyggda?
- Utgår ni från någon standard i era testningar? Använder ni samma standard internationellt?
- Vilka begränsningar ser ni med denna standard?
- Skulle denna standard kunna fungera i utvecklingsländer? Hur skulle man kunna ändra den och ändå få ut den viktigaste informationen om förpackningens kvalitet?
- Har ni något dokument som ni lämnar över när ni levererar varor i utv.länder? Hur ser detta ut?
- Vad är svårast att mäta?
- Vilken påfrestning på förpackningen är svårast att undvika? Hur hanterar ni det?
- Hur ofta testar ni era förpackningar och i vilka skeden? Tomma? Blanks? Fyllda?
- Hur påverkar kombinationer av yttre faktorer och vilken är svårast att förebygga?
- Hur kan man testa kvalitén på lim som använts i tillverkningen och hopsättningen av låda?
- Hur påverkar storleken på porer upptagningen av vatten?
- Hur kan man motivera kunden att mäta och testa förpackningen av wellpapp?
- Hur kan man öka kundens kunskap kring vilken kvalitet de behöver köpa in?
- Vad avgör styrkan i den färdiga wellpappen?
 - Hur kan man mäta detta?
 - Vilka test är viktigast?
- Har ni implementerat någon process hos era kunder?
 - Vad? Hur? Vad ville ni uppnå? Hur lång tid tog det? Lyckades ni?

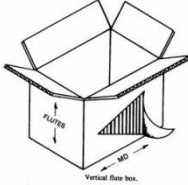
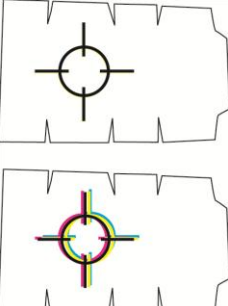
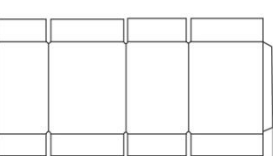

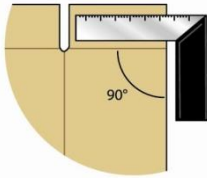
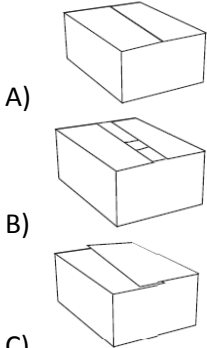
9.3 Appendix 3 – Control Process

GENERAL INSPECTION AT ARRIVAL			
No.	INSTRUCTION	ACCEPTANCE CRITERIA	PICTURE
1	<p>ARRIVAL CONDITION If the blanks are wrapped with plastic, check for condensation. Check if the blanks are wet.</p>	<p>If the blanks are wet, consider rejection – let dry and then continue the test.</p>	
2	<p>WRAPPING Check for damages on blanks from wrapping or strapping etc.</p>	<p>Ripped or damaged secondary packaging is not accepted.</p>	
3	<p>MOISTURE CONTENT Measure moisture with the humidity meter.</p>	<p>Moisture content should be about 4% to 6%. If the paper is too dry, it may become brittle.</p>	
4	<p>WARP Have the plastic straps deformed the blanks? Are the blanks bent into the shape of a banana</p>	<p>The blanks should not be curved at all</p>	

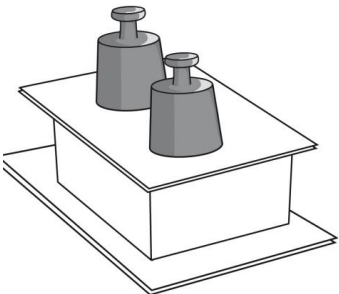
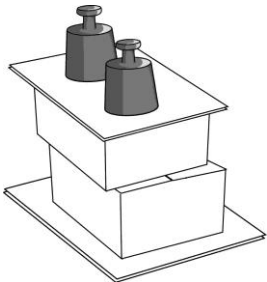

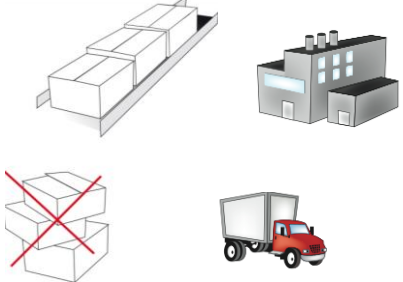
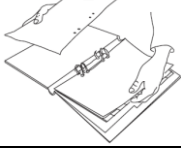
Control Process for secondary packaging

MEASUREMENT				
No.	INSTRUCTION	ACCEPTANCE CRITERIA		PICTURE
5	SAMPLES Select samples from different levels of the pile.	RECEIVED BATCH SIZE	SAMPLE SIZE	
		≤ 1000	10	
		1001-5000	15	
		5001-10000	20	
		10001-20000	25	
		20001-30000	30	
		> 30000	40	
6	WEIGHT Weigh ten blanks.	Weight below 90% of specified is not accepted.		
7	BLANK DIMENSIONS Measure the dimensions of the blanks.	A tolerance of ± 3mm is accepted		
8	THICKNESS Measure the corrugated board thickness.	If it differs more than ±10% from specification – batch is not OK		
9	DELIMINATION Try to separate the liner from the fluting by hand.	Should not be possible		

Control Process for secondary packaging

<p>10</p>	<p>FLUTE DIRECTION Check in what direction the fluting is.</p>	<p>Should be vertical</p>	
<p>11</p>	<p>PRINTING Does the registration mark align? Is the printing clear?</p>	<p>Misregistration of printing should not be accepted</p>	
<p>12</p>	<p>CREASING Check creasing Is the creasing visible? Is the creasing parallel?</p>	<p>The creasing and the parallelism must be very clear!</p>	
<p>13</p>	<p>NO CREASING CRACKS Look for cracks along the creasing</p>	<p>There should not be any cracks on the blanks!</p>	
<p>14</p>	<p>CORNERS Check the perpendicularity of the corners with a square.</p>	<p>The corners shall fit into the square and the side shall touch the squares'.</p>	
<p>15</p>	<p>FLAPS Check the flaps. How do they fit when closed? Measure the space or overlapping.</p>	<p>Only A is acceptable.</p>	

Control Process for secondary packaging

TEST PRCEUDRE			
No.	INSTRUCTION	ACCEPTANCE CRITERIA	PICTURE
16	<p>BCT</p> <p>A) Expose the box to maximum load during a few seconds!</p> <p>B) Expose the box to maximum load during 24 hours!</p> <p>Repeat this procedure with the other boxes. Note date and time!</p>	<p>The box should be able to withstand A). If it does not fulfill criteria A), the batch should be rejected.</p>	
17	<p>DISPLACED BCT</p> <p>Place one box on top of another displaced by 2 cm and expose the top box to maximum load during a few seconds!</p> <p>Repeat this procedure with the other boxes. Note time and date!</p>	<p>The box is not expected to pass this test, but has as objective to create and understanding for stacking</p>	
DOCUMENTATION			
No.	INSTRUCTION	ACCEPTANCE CRITERIA	PICTURE
18	<p>DOKUMENTATION</p> <p>Which criteria are fulfilled?</p> <p>If the blanks pass the test make a mark at each test.</p>	<p>Make a mark and sign your initial after the mark.</p>	
19	<p>EVALUATION</p> <p>Approve OR reject the batch.</p>		
20	<p>STORE DOCUMENTATION</p> <p>Place the checklist in the binder. Don't forget to note the date!</p>		

9.4 Appendix 4- Checklist Control Process

Supplier: _____

Arriving date: _____

Test date start: _____

Test date finish: _____

ARRIVING

- No wrapping in plastic film
- Wrapping OK
- Not wet
- No Damage
- Moisture content OK
- No Warp

NUMBER OF SAMPLES

- 8
- 10
- 12
- 14
- 16

MEASUREMENT

- Weight OK
- Blank dimensions OK
- Thickness OK
- Delimitation OK
- Flute direction vertical
- Creasing is very clear and folds easily
- Creasing is parallell everywhere
- No creasing cracks
- Flaps OK

TEST PROCEDURES

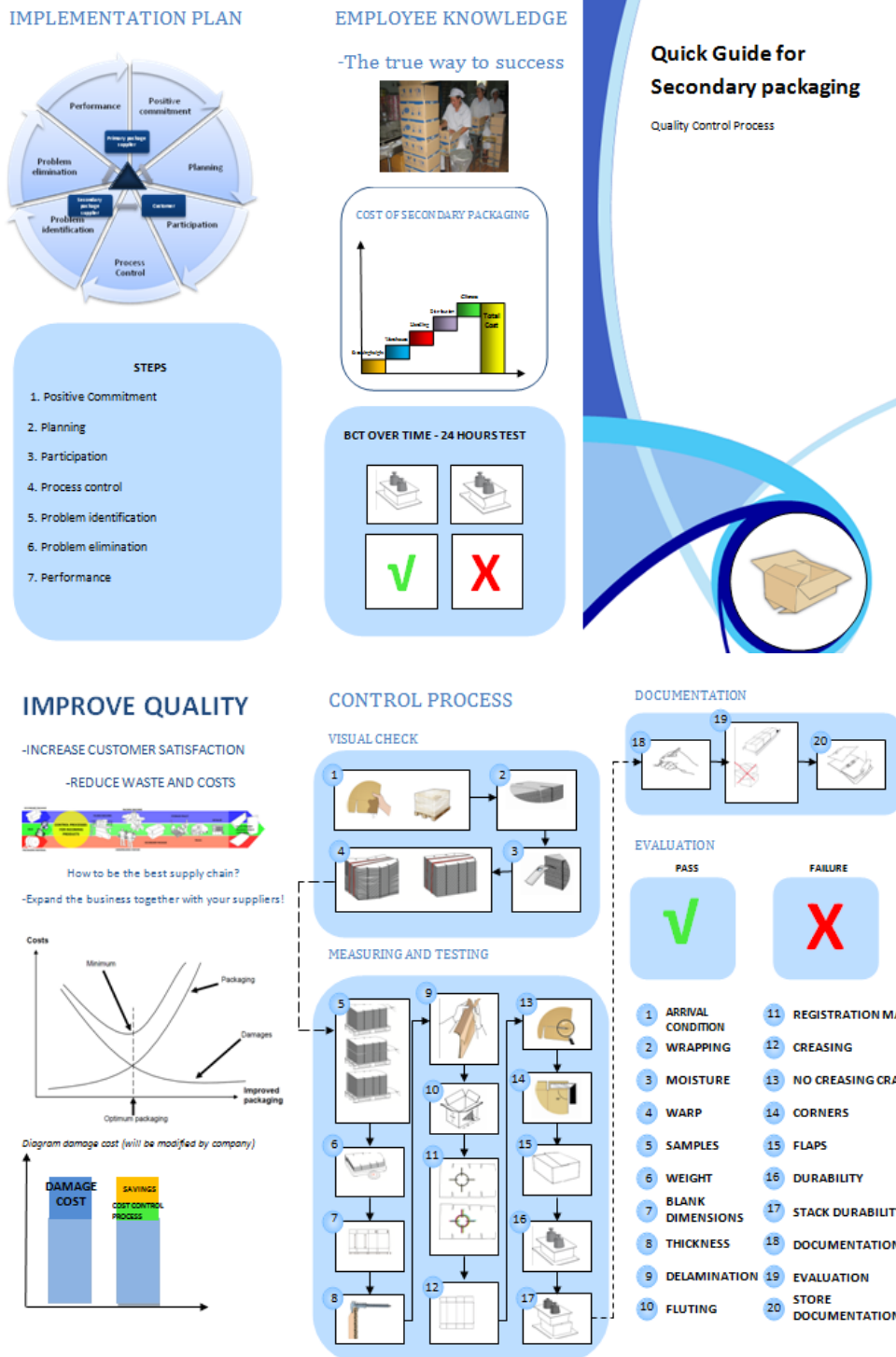
- A. BCT Passed Failed
- B. BCT 24 hours Passed Failed
- Displaced BCT Passed Failed

DOCUMENTATION

- Evaluation Batch accepted Batch rejected

Control Process for secondary packaging

9.5 Appendix 5 - Quick guide



The quick guide is only a first draft, and all drawn pictures can be viewed earlier in this Master Thesis. The other figures are just examples for development.