Efficient handling of secondary packaging

Reducing handling costs for the dry food assortment at Metro Cash & Carry

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Abstract

This master thesis project contains an analysis of the factors that influence the handling time in the retail store (Metro Cash & Carry Netherlands). Especially the reduction in the handling costs that can be achieved with the implementation of Shelf Retail Ready Packaging is analyzed. Moreover, the implementation issues regarding a successful implementation of Shelf Retail Ready Packaging are discussed.
Preface

This master thesis preparation is the final part of my study Industrial Engineering and Management at Eindhoven University of Technology. The master thesis project was executed for Metro Cash & Carry Netherlands in Diemen.

When I started my project about SRRP, everybody was sceptic about the ‘boxes’ project. And even I myself was wondering why everybody was making so much fuss about ‘a couple of boxes’. But soon I got enthusiastic about my SRRP project and I think that many other employees within Metro got enthusiastic about the ‘boxes’ project as well.

I would like to use the opportunity to thank my colleagues, of the supply chain department of Metro, for the good atmosphere during my master thesis project. Hans de Backer in special, as we both shared the same office.

Besides, I would like to thank the employees of the Metro store in Den Bosch, who helped me during the practical part of the master thesis project. Special thanks go to Rob Hamelink, Ton van den Berg, Mathieu Craane and Erik Steenbakkers for their support and assistance. Furthermore, I would like to thank Frank van der Maale, who functioned as the ‘ideal’ shelf filler during my measurements.

Further, I would like to thank my supervisor of Metro, Niels Maas, who made it possible to carry out this master thesis project at Metro and who gave me guidelines and advices regarding my project. Besides, I would like to thank Pierre Bogers, the supply chain specialist who will take over the SRRP project. He was the one who picked me up at 6.00 a.m. in order to score a thousand ‘boxes’ at the warehouse. In addition, I want to wish them good luck, with the remaining SRRP project and the negotiations with the suppliers.

Moreover, I would like to thank my supervisors of Eindhoven University of Technology, Karel van Donselaar and Simme Douwe Flapper, for their contribution and constructive criticism to this master thesis project.

Finally, I would like to notify to all readers that the absolute figures in this document are multiplied with a certain factor due to confidentiality of the data.

Mariska van Stipdonk

Diemen, July 2007
Management summary

Problem situation
Two parallel changes, an internal and an external one, have taken place at Metro Cash & Carry and have led to the problem situation for this master thesis project.

Increased handling cost at the retailer
Until 2004 Metro sold only case packs to their customers, but in order to increase the turnover of the Dry Foods (DF) assortment it is decided that the products will also be sold in small quantities to the customers. This resulted in a lot of additional handling activities for the shelf filler as 12 separate SUs have to be stacked on the shelf instead of one case pack. The labour costs related to shelving of the products have risen with 63% and are currently 17% of the total costs.

The opportunity of Shelf Retail Ready Packaging
The definition of Shelf Retail Ready Packaging (SRRP) according to ECR Europe is; “the term used to refer to a product that comes in a ready merchandised unit which is easy to identify, easy to open, can easily be put onto the shelf and disposed of, allowing an optimisation of shelf replenishment and enhanced visibility”.
SRRP has many benefits for the retailer and consumer, but it especially provides opportunities for reduced handling costs at the retailer. As SRRP is more or less pushed into the supply chain by major European retailers, Metro should take advantage of this opportunity.

Research question
Increased handling costs in the retail store, increasing competition and the upturn of SRRP have led to the following research question:

Which products within the Dry Foods assortment of Metro Cash & Carry Netherlands are suitable for delivery in Shelf Retail Ready Packaging and what is the related reduction in handling costs that can be achieved at the retailer?

Assignment
The research question, as described above, leads to the following assignment:

- Analyze the handling process of the DF assortment at Metro.
- Make the SRP scoring tool of ECR Netherlands concrete.
- Define the attributes of 2P that have an influence on the handling process and analyze other drivers, besides 2P drivers, that have an influence on the handling process as well.
- Design a Handling Efficient Secondary Packaging Tool (HESP Tool) in order to determine the reduction in handling costs that can be realised with SRRP. Indicate as well in which part of the handling process the efficiency gains will take place.
- Verify the HESP Tool on a part of the DF assortment and indicate the expected reduction in handling costs.
- Indicate the implementation issues regarding the use of the HESP Tool and provide guidelines for the negotiations with the suppliers about SRRP.

Theoretical and practical relevance
The relevance for Metro will be the HESP Tool, which will determine the reduction in handling costs that can be achieved at the retailer when SRRP will be implemented.
The relevance for scientific literature will be defined activities within the handling process, better understanding of the effect of different types of 2P on the handling process and especially the reason why a certain type of 2P can lead to a reduction in handling cost, a case study in the research area of SRRP and a verification of the efficiency gains as expected by Van Zelst et al. (2006) regarding shelving in a tray instead of separate units.
Research design
An analysis of the handling process and the impact of secondary packaging (2P), product characteristics and other factors on the handling process is carried out. Then a time study has been carried out at the Metro retail store in order to quantify these handling activity drivers. Based on these results the HESP Tool is developed, which determines the potential reduction that can be achieved in the handling process, and an implementation plan is written.

Results
The most important results from the time study are the following:

- It is easier to find an ‘easy’ to identify 2P in an order than a ‘difficult’ to identify 2P, the search time is respectively 26.9 versus 78.8 seconds. An ‘easy’ to identify 2P is on average found in 37.9 seconds on the high racks, while it is impossible to find a ‘difficult’ to identify 2P on the high racks, this search time can go to infinity.
- Opening of a tray without a hood requires no opening time and is therefore the best opening method. Further, the more SUs in a 2P the better, as the opening time for a 2P will remain the same and the time per SU will decrease.
- It is faster to remove the old inventory with a tray than to remove it without a tray; 26.1 versus 44.8 seconds. It is also faster to fill the old inventory with a tray than to fill it without a tray; 20.8 versus 34.0 seconds.
- Filling new inventory goes much faster with a tray, than filling without a tray; 14.3 versus 57.6 seconds. When the products are filled without a tray the main determining factor for the filling time is the number of SUs in a 2P, followed by the size of the SU. When the products are filled with a tray the main determinants for the filling time are stability of the tray and visibility of the SU. Further, the more SUs in a 2P the better, as the filling time for a tray will remain the same and the time per SU will decrease.
- It is more time consuming to separate a 2P which contains plastic than a 2P that consists of pure cardboard; 9.7 seconds versus 0 seconds. The dispose of time for a 2P in the plastic or cardboard container is very short; 2.5 seconds per 2P.
- The handling time for removing the empty trays is negligible if it is done before the activity ‘stacking of new inventory’ or during the daily ‘product availability check’. When the activity is carried out separately, it will take 52.3 seconds to remove one empty tray, to move the ‘full’ tray behind the empty tray to the front and to travel in the aisle.

Conclusions

Most important handling activities influenced by secondary packaging
From all the handling activities that are influenced by 2P, the activities ‘open secondary packaging’ and ‘fill new inventory’ are the most important ones. These activities are executed for each 2P that arrives in the retail store and together they determine 70% of the reduction that can be achieved for the handling cost.

Ideal type of secondary packaging
The most ideal type of 2P is a tray without a hood, at least when it is accomplished correctly. This opening method is the best as the time for opening of the 2P is zero seconds. Besides, the 2P contains a tray and filling the new inventory with a tray is faster than filling it without a tray.
A very important conclusion regarding the 2P with a tray is that the advantage of a tray is diminished when the tray is not or can not be used or if it is from a ‘bad’ quality, e.g. the tray is unstable and/or the products in the tray are invisible, due to wrong orientation of the products or due to the fact that the tray is too high in the front.
Regarding the opening method it can be concluded that the opening methods ‘strip’ and ‘perforation’ are more time consuming than the other opening methods. This is as these opening times are heavily depending on the quality of the strip or perforation and this quality varies a lot.
Ideal type of product
The most ideal type of product for SRRP is a product with a high sales volume; “products with a high sales volume require much handling time as those products have to be replenished more often than other products” (ECR Europe, 2007). Furthermore, small and light products are ideal regarding SRRP.

Potential reduction in handling cost
SRRP can lead to a significant reduction in the handling cost at the retailer. The yearly reduction in handling cost that can be achieved at the DF department of Metro is € 967,436. This reduction in handling cost will be achieved if all the products of the DF assortment will be delivered in a ‘good’ quality tray without a hood. Two other factors which are crucial in order to achieve this reduction in handling cost are; it should be possible to use the tray on the shelves and the empty trays should be collected during the regular process if possible.

Recommendations

Apply HESP Tool on fast movers
The supply chain specialists of Metro should start with scoring the articles that have the highest turnover on a yearly base.

Negotiate with suppliers
Key points in the negotiation will be the opening method and the availability of a tray. As the objection from the supplier will be that these kinds of changes in the 2P will lead to additional cost for the supplier, Metro can offer compensation. The savings due to SRRP are known, thus the height of the compensation can be determined. Moreover, attention should be paid to the number of SUs in a 2P. More SUs in a 2P will lead to higher efficiency gains for many handling activities.

Collaborate with other retailers
In order to convince the suppliers for delivery in SRRP, Metro should collaborate with the other retailers. This as the market position of Metro in the Dutch food market is small and it is more likely that the supplier will adjust the 2P if all retailers require SRRP. Agreement among the retailers should be achieved about the most optimal type of SRRP. An important aspect in this agreement is the number of the SUs in a tray and the number of facings of the tray. When a common implementation approach towards SRRP is derived, the retailers should negotiate with the suppliers collectively.

Adjust internal organization
In order to achieve the reduction in handling costs, awareness of SRRP should be created in the internal organization; Spaceman should adjust the planograms to the dimensions and number of facings of the tray, the purchasing department should incorporate SRRP in the negotiations with the suppliers and the shelf fillers should use SRRP if possible and they should use it in the right way.

Execute store audits
In order to maximize the reduction in handling costs, two main issues should be checked by the supply chain specialist on a regular base in the retail store; are the trays used by the shelf fillers if possible and are the empty trays removed during the regular process if possible? The ideal situation is that all empty trays are removed during stacking of the new inventory or during the product availability in the morning. Besides, the employee should collect the empty trays on his way, whenever he goes to the backroom.

Maintenance and further development of the HESP Tool
The supply chain specialists will become the owners of the HESP Tool and should regularly update the HESP Tool. For example if the frequencies, with which the handling activities are carried out, change. Besides, small adjustments should be made in the HESP Tool, so it can also be used for the non-food assortment.
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1 Company description

The master thesis project is carried out at Metro Cash & Carry Netherlands, which is a sales division of the Metro Group. In this chapter some general background information about the Metro Group and about Metro Cash & Carry Netherlands is presented.

1.1 The Metro Group

The Metro Group was founded in 1996 by merging several independent smaller commercial chains. One of those chains was Metro Cash & Carry. In 1998 the Makro and Lukas Klamer stores in the Netherlands were bought by the Metro group. The first Makro store was opened in Amsterdam in 1968 and the first Lukas Klamer store was opened in Groningen in 1886.

The Metro Group is the third largest retailer in the world, with around 270,000 employees in 2400 stores in 30 countries. The headquarters is located in Düsseldorf (Germany). The turnover in 2006 was € 59.9 billion, which is 7.5% more than the previous year. 44% of the turnover is realized in Germany, but the Eastern Europe and Asia market are rapidly growing.

The group operates in the business to consumer environment as well as in the business to business environment and consists of 4 independently operating sales divisions as displayed in figure 1; cash & carry, food retailers, non-food specialty and department stores.

![Figure 1; Organisation structure of the Metro Group](image)

Metro Cash & Carry is the biggest sales division of the Metro Group and the division is still growing with the focus on the Eastern Europe and Asia markets. Metro Cash & Carry is global market leader in self service wholesaling and sells only to registered companies, who can apply for a special card in order to enter the stores. Metro Cash & Carry has 95,000 employees in 540 stores in 30 countries. The turnover in 2006 was € 29.9 billion, which is 6.5% more than the previous year.

1.2 Metro Cash & Carry Netherlands

The headquarters of Metro Cash & Carry Netherlands is established in Diemen. The turnover in 2006 was € 1.3 billion with 5,400 employees.

Currently Metro Cash & Carry Netherlands has 13 Makro and 3 Lukas Klamer stores. The Lukas Klamer stores are smaller than the Makro stores as their non-food assortment is smaller, but the Lukas Klamer stores are growing and will be slowly changed into Makro stores. This as Metro Cash & Carry originally operates under the brands of Makro and Metro. The smallest Lukas Klamer store is 6,300m² and the biggest Makro store is 17,000m².

In those stores 20,000 food products and 30,000 non-food products are sold to 1.2 million customers in the business to business environment. Those 50,000 products are purchased from 1,100 suppliers.

The non-food assortment consists of:

- Hardware (e.g. household goods)
- Electronics
- Soft/sport (e.g. clothes)
The food assortment consists of:

- Fresh and deep frozen foods; diary, fish, meat, bread and fruits & vegetables
- Dry foods; non-perishables, beverages and cosmetics

Metro Cash & Carry Netherlands is market leader in the self service wholesaling market with a market share of almost 25%. The market share in the Dutch food market is much smaller, around 4%. Metro Cash & Carry Netherlands will be named Metro in the remaining report.

1.3 Shelf Retail Ready Packaging

The definition of Shelf Retail Ready Packaging (SRRP) according to Efficient Consumer Response (ECR) Europe (2006) is; “the term used to refer to a product that comes in a ready merchandised unit which is easy to identify, easy to open, can easily be put onto the shelf and disposed of, allowing an optimisation of shelf replenishment and enhanced visibility”. SRRP is synonymous with RRP (Retail Ready Packaging) and SRP (Shelf Ready Packaging). ECR Europe (2006) distinguishes three main alternatives of SRRP (figure 2):

- Shelf: a tray with separate selling units (SUs) on the shelf
- Merchandising unit; a promotional display, roll-rack or pallet
- Re-usable; a plastic tray or crate

![Figure 2: Alternative display strategies of SRRP (ECR Europe, 2006)]

Currently, some products are already provided in SRRP, but that concerns only a small part of the whole assortment. Recently, major retailers in Europe asked their suppliers to deliver more products in SRRP. Suppliers are deliberating to deliver other products in SRRP as well, but they prefer one standard packaging concept for all their European customers. Thus if the major retailers are going to receive the products in SRRP, the small retailers will as well. Therefore ECR has started a SRRP project with the goal to create a common implementation approach towards SRRP within Europe. The supply chain manager of Metro is the chairman of this SRRP project and besides Metro various retailers, suppliers and packaging manufactures in the food industry take part in this SRRP project.

1.3.1 Metro’s opinion regarding Shelf Retail Ready Packaging

The display strategies of presenting products in trays, merchandising units, crates or on pallets attracts Metro as it fits in the concept of a wholesaler, as those display strategies are likely to be associated with discount products.

At the moment promotional articles are already displayed on pallets or merchandising units, crates are used for fresh foods and big/heavy products with high daily sales are presented on pallets. Those display strategies are already applied on a big scale in the Metro stores and the use of those display strategies is assumed to be already optimized.

But the following display strategy; a tray with separate SUs on the shelf, can still offer good possibilities for Metro as this isn’t applied yet on a big scale in the Metro stores in the Netherlands.
2 Introduction
This chapter will give an overview of the problem situation at Metro, the resulting research question, assignment and theoretical and practical relevance. Finally, the research design in order to fulfil the assignment and the structure of the remaining report are discussed.

2.1 Problem situation
Two parallel changes, an internal and an external one, have taken place at Metro and will be discussed in the following two subparagraphs.

2.1.1 Increased handling costs at the retailer
Until 2004 Metro sold only case packs to their customers, but in order to increase the turnover of the Dry Foods (DF) assortment it is decided that those products will also be sold in small quantities to the customers. Therefore many products within the DF assortment can nowadays be bought both in a case pack and as a separate SU. E.g. it is possible to buy one separate can of carrots instead of a case pack that includes 12 cans.

This has resulted in a lot of additional handling activities for the shelf filler as 12 separate SUs have to be stacked on the shelf instead of one case pack. The DF department has estimated the extra labour costs related to those shelving filling activities and these extra costs are huge compared to the original costs. The original costs, when only case packs where sold, and the current costs, when also separate SUs are sold, are displayed in respectively figure 3 and 4. The computation can be found in appendix B. The shelf filling costs were only a small part of the total cost (7%), but the costs have risen with 63% and are expected to be 17% of the total costs nowadays. The effect of selling separate SUs on other costs such as, dispose of waste and control of goods in the backroom aren’t estimated by the DF department, but it is very likely that those have risen as well. The calculation leads to the conclusion that the total costs have risen with at least 11%.

2.1.2 The opportunity of Shelf Retail Ready Packaging
The concept of SRRP has been described in paragraph 1.3 and in appendix C several advantages of SRRP and results of case studies, named by ECR Europe, are described. Some of the benefits mentioned are desirable for Metro regarding the high handling costs in the Metro stores; improved labour efficiencies, reduced number of products that has passed the shelf life, potential to reduce damages and easier identification of 2P throughout the store.

Figure 3; Original cost division at Metro
Figure 4; Current cost division at Metro

The costs related to shelf filling, control of goods and waste disposal in the retail store are explicitly mentioned as these are expected to be influenced by secondary packaging (2P), as will be discussed in the remaining report. The other store costs, which aren’t influenced by 2P, consists for 76% of inventory costs and the remaining costs are for ordering and receiving of goods in the backroom.

It can be concluded that selling separate SUs besides traditional case packs has resulted in a significant increase of the handling costs in the retail store. It is therefore essential for the logistic department to reduce the handling costs at the retailer.

2.1.2 The opportunity of Shelf Retail Ready Packaging
The concept of SRRP has been described in paragraph 1.3 and in appendix C several advantages of SRRP and results of case studies, named by ECR Europe, are described. Some of the benefits mentioned are desirable for Metro regarding the high handling costs in the Metro stores; improved labour efficiencies, reduced number of products that has passed the shelf life, potential to reduce damages and easier identification of 2P throughout the store.
Besides ECR, Van Zelst et al. (2006) state that SRRP will most likely result in labour efficiency for supermarkets; an efficiency gain of 12% can be realized if the stacking regime is changed from unit to tray. This will be further discussed in the literature review (paragraph 3.1). Based on those two sources of information, it can be concluded that SRRP provides good opportunities for reduced handling costs at the retailer. And as SRRP is more or less pushed into the supply chain by major European retailers, Metro should take advantage of this opportunity.

It is possible that SRRP will have an impact on other costs, besides the handling costs, or that it will lead to increased sales due to better marketing possibilities when the products are presented in a display tray. But those aspects will be left out of scope in order to achieve enough depth in the master thesis project. Besides, the most relevant benefit for the logistical department of Metro is the reduction in handling costs at the retailer. It is important for Metro to decrease those costs as the margins of each retailer are decreasing over time due to the high levels of competition. Therefore Metro wants to investigate the possibility for a reduction in handling costs and the implementation issues related to the implementation of the display strategy ‘a tray with separate SUs on the shelf’. This display strategy will be indicated as SRRP in the remaining report.

2.2 Research question

Increased handling costs in the retail store, increasing competition and the upturn of SRRP have led to the following research question:

Which products within the Dry Foods assortment of Metro Cash & Carry Netherlands are suitable for delivery in Shelf Retail Ready Packaging and what is the related reduction in handling costs that can be achieved at the retailer?

The following terms need further explanation;

- Dry Foods assortment; this is a specific product assortment group of 12,000 articles within the Metro stores. The DF assortment includes all food products, beverages and cosmetics, but excludes fresh and deep frozen foods.
- Suitable; a product is suitable for delivering in SRRP if the handling costs at Metro will be reduced when the product is delivered in SRRP.
- SRRP; Shelf Retail Ready Packaging; the display strategy of presenting SUs in a tray on the shelf.
- Reduction; this will be expressed in absolute costs and as a percentage of the current costs.
- Handling costs; these are all direct labour costs required for carrying out the handling activities at the retailer, from order receipt in the backroom to stacking of the goods and disposal of waste in the store. The handling activities will exactly be determined in the analysis phase.

2.3 Assignment

The research question, as described above, leads to the following assignment:

- Analyze the handling process of the DF assortment at Metro.
- Make the SRP scoring tool of ECR Netherlands concrete.
- Define the attributes of 2P that have an influence on the handling process and analyze other drivers, besides 2P drivers, that have an influence on the handling process as well.
- Design a Handling Efficient Secondary Packaging Tool (HESP Tool) in order to determine the reduction in handling costs that can be realised with SRRP. Indicate as well in which part of the handling process the efficiency gains will take place.
- Verify the HESP Tool on a part of the DF assortment and indicate the expected reduction in handling costs.
- Indicate the implementation issues regarding the use of the HESP Tool and provide guidelines for the negotiations with the suppliers about SRRP.
2.3.1 Assignment restrictions

The assignment is restricted in order to achieve enough depth in the master thesis project:

- Only the first display strategy of SRRP, separate SUs in tray on the shelf, will be discussed. Thus pallets, crates and promotional displays will be left out of scope (subparagraph 1.3.1).
- Only the effect of SRRP on the handling costs at the retailer will be investigated. Thus not the effect of SRRP on sales or on other costs in other parts of the organization (subparagraph 2.1.2).
- Other factors, besides SRRP, which can lead to a reduction in the handling costs at the retailer, will also be left out of scope.

2.4 Theoretical and practical relevance

The master thesis project will be relevant for both Metro and scientific research. The relevance for Metro will be:

- A HESP Tool in Ms Excel that is suitable for the DF assortment and which will determine the reduction in handling costs that can be achieved at the retailer for a certain product when SRRP will be implemented.
- An associated implementation plan for SRRP in order to reduce the handling costs of the DF assortment at the retailer.
- The HESP Tool and the implementation plan as described above will be the starting point for two supply chain specialists of Metro, who joined the SRRP project in May. The tools will be used by them in order to select the products that are most suitable for delivery in SRRP. This is supported with the implementation plan so that the supply chain specialists of Metro know how to use the tools. The implementation plan informs them also about the most important implementation issues, such as important aspects that should be negotiated about, the relevance for other retailers and the possible objections from the supplier. This master thesis project will thus provide the fundamentals for the two supply chain specialists of Metro who will negotiate with the suppliers about SRRP in order to reduce the handling costs at the retailer.

The relevance for scientific literature will be:

- Defined activities within the handling process, this can be a first step towards standards in handling activities as required according to Saghir and Jonson (2001) in order to generalize and compare results (paragraph 3.2).
- Better understanding of the effect of different types of 2P on the handling process and especially the reason why a certain type of 2P can lead to a reduction in handling cost. This can be a first step towards a standardized method in order to analyze the handling efficiency of different types of packaging which is required according to Saghir and Jonson (2001) (paragraph 3.2).
- Verifying the tool on the DF assortment will function as a case study in the research area of SRRP and the efficiency gains as expected by Van Zelst et al. (2006) regarding shelving in a tray instead of separate units can be verified (paragraph 3.1).

2.5 Research design

The master thesis project is carried out according to the research design as displayed in figure 5 on the next page. This model is based on the model of Wijnen et al. (2001). According to Wijnen et al. a research can be divided in three stages and six phases;

1. Analysis; the initiation and definition phase
2. Solution; model development and implementation plan
3. Implementation; implementation and maintenance

The analysis and solution phases are carried out during this master thesis project and this report is the deliverable of those phases, together with the HESP Tool in Ms Excel. The exact steps which are carried out during this master thesis project are displayed in figure 5 and will be further discussed in
the next paragraph. The last stage, implementation, is out of scope of this master thesis project and will be carried out by the two supply chain specialists of Metro, who joined the SRRP project in May.

Figure 5: Research design and structure of the remaining report (Wijnen et al., 2001)

2.6 Structure of the report

The structure of the report is graphically represented in figure 5, where the numbers at the left hand side correspond with the chapters in the report.

A short company description can be found in chapter 1 and the problem situation and assignment are presented in this chapter. Chapter 3 contains a short summary of the literature study that has been carried out before the start of this master thesis project. This is followed by an analysis of the handling process and the effects of 2P and other factors on the handling process in chapter 4. These handling activity drivers are quantified in chapter 5. This in order to determine the most important handling cost drivers. In chapter 6, the development of the HESP Tool is described, whereas the application of this tool in a practical and a scientific context is described in chapter 7. Chapter 8 contains the implementation issues, and the final conclusions and recommendations are discussed in chapter 9. Finally, a reflection on the master thesis project is given.
3 Literature review

The complete literature review can be found in Van Stipdonk (2007). A short summary of the most relevant literature regarding this master thesis project is discussed in this chapter.

3.1 Handling process in the retail store

Van Zelst et al. (2006), Kotzab and Teller (2005) and St-Vincent et al. (2005) propose models for handling activities in the retail store. Important regarding the factors mentioned by St-Vincent et al. is that this analysis was carried out in a warehouse superstore, which is comparable to a wholesaler. All models will be a good starting point for modelling of the handling activities and the associated drivers within Metro.

Van Zelst et al. (2006) determined the time for each stacking activity in a supermarket and concluded that the time for stacking new inventory is most time consuming activity (figure 6).

![Figure 6; Store replenishment time (Van Zelst et al., 2006)](image)

The main drivers for replenishment efficiency are also identified and have led to the following recommendations;

- Choose a tray or loose stacking regime for as much items as possible; an efficiency gain of 12% can be realised if changed from unit to tray and one of 42% if changed from tray to loose.
- Increase all unit/case pack sizes, as large as possible.
- Increase the number of units/case packs that are stacked simultaneously.
- Training for the workers should be considered as important as the effect of the worker on the shelf replenishment should not be neglected.

The first recommendation leads to the assignment of this master thesis project as SRRP is a kind of strategy with which the stacking regime can be changed, in this case from unit to tray.

Important regarding this assignment is that the differences between a supermarket (in the research of Van Zelst et al.) and a wholesaler (Metro) should not be neglected. But this difference has diminished since Metro is selling separate SUs as well as traditional case packs.

Kotzab and Teller (2005) introduced a model for instore logistic processes. The following handling activities are distinguished; receipt and control of incoming goods in the retailer’s backroom, transport of the goods from the receiving area to the shelves or to a storage place in the backroom, storage in the backroom, transport of the goods from the storage place in the backroom to the shelves, storage of products on the shelves, transaction at the desk when a customer buys the goods, re-order of goods and disposal and/or recycling of packaging.
St-Vincent et al. (2005) described the main determinants of the handling activities for a wholesaler:

- Workplace layout;
  - Marketing strategies; the number of products to be stacked on a shelf is determined by the number of facings and the stacking height and dept. The higher the number of products to be stacked, the more handling activities that have to be carried out in general.
  - Characteristics of the shelves; high and deep shelves are more difficult to stack as it is difficult for stockers to reach for the products.
  - Space limitations; due to the limited storage space on the shelves it can be difficult to reach the products (especially the products in the back).

- Products;
  - Physical characteristics; handling time of products is often determined by the weight and size of the product.
  - Characteristics of the packaging; the lack of stability of the packaging leads to additional handling time in the store.

- Management of stock and arriving merchandise;
  - Poor planning of purchases; incompatibility between arriving products and shelf space can lead to additional handling activities, such as stacking the products that do not fit on the shelves in a storage place.

3.2 The role of packaging regarding handling costs

Saghir and Jonson (2001), Dowlatshahi (1996) and Lee and Lye (2002) emphasize the relevance of this assignment. These articles are also a good starting point for the determination of the handling activity drivers.

Saghir and Jonson (2001) investigated the importance of packaging regarding handling costs;

- The cost of handling the packages through the retail distribution centre to the store shelf is about the same as the cost for retail packaging.
- The handling costs in the retail distribution centre are primarily related to the physical volume of the goods.
- 75% of the handling costs of the retail chain occurs in the retail outlet.
- The most costly handling activities in the store are related to the physical properties (shape) of the package.
- A more efficient retail packaging can reduce the retailer’s total cost, even if the cost for the packaging itself increases.
- Awareness, throughout the distribution chain, of handling costs for different packaging solutions will direct the development and choice of 2P towards more handling efficient solutions.
- 16.2% of a products price reflects the cost of selling and handling the product. Over 62% of this amount is for activities that are related to the handling of the packaging in the retail outlet.

The overall conclusion of the research of Saghir and Jonson is that there is a lack of sufficient and usable packaging handling evaluation methods in the retail and packaging industry:

- The few published packaging-handling studies that have been undertaken within retail outlets, all define the handling activities differently and not all activities are considered. Therefore there is a need for standards in handling activities in order to generalize and compare the results.
- For the same reason there is need for an accurate and standardized method in order to analyze the handling efficiency of different types of packaging concepts e.g. boxes and crates. Retailers and the packaging industry are calling for the introduction of such a method, technique or tool in order to evaluate handling and the role of packaging.
Dowlatshahi (1996) emphasizes that packaging absorbs approximately 12% of the logistics costs as poor packaging leads to lower sales, damaged content, customer dissatisfaction and higher costs of material handling, warehousing and transportation. Therefore the following packaging requirements which are related to efficient handling at the retailer should be incorporated in the product design;

- Be designed for ease of handling by simple mechanical gears and storage/retrieval systems with respect to packaging size and modules.
- Lend itself to efficient material handling, order picking and storing of products in storage/warehouses, pallets, trailers, boxer space etc. The ease and economy with which packaging is handled in stacking, order picking and product identification are essential. Package utilization and handling should be coordinated at all times.
- Facilitate ease of opening and closing, reusing, ease of handling, identification of the package and greater satisfaction for the user.
- Lend itself to proper and speedy order filling in terms of shape, size, structure and strength of materials.
- Facilitate ease of handling with respect to material handling, warehousing and transportation. Factors such as content, size, weight, height and other physical dimensions must be considered. The packaging design affects the ability to use pallets or shelf stacking.

Lee and Lye (2002) add some additional guidelines for the design of packaging regarding handling efficiency;

- Minimize the number and types of packaging items or packaging processes
- Ensure ease of handling of packaging from bulk
- Minimize the need for re-orientation during packaging
- Ensure that packaging operation cannot be undertaken incorrectly
- Maximize the symmetry of a packaging item or make it obviously asymmetrical
- Avoid wrapping products with protrusions or sharp corners or inserting them into bags
- Avoid using flexible packaging which is difficult to handle and therefore take a longer time
- Use lightweight packaging whenever possible
- Package products in bulk and in larger quantities

3.3 Standardization of packaging

The categorization in a study from FEFCO (in German distribution centres and grocery stores) is based on the package’s height/width and the way of opening (perforation, tape and other ways of opening). This way of product categorizing can be a good starting point if products have to be categorized at Metro when handling times are estimated.

Koehorst et al. (1999) gave some general recommendations for a successful introduction of new standardized packaging:

- Standardization of packaging requires both technical and organizational coordination. Technical specifications must make the new package suitable for storing, transporting and handling. And from an organizational point of view it is important to know with whom, when and how to cooperate as standardization can only succeed through coordination and negotiation with all players in the supply network. All parties should be involved and agreement on the standardization should be reached in order to succeed.
- The standard packaging should be ‘resistant’ to foreseeable future changes in the packaging requirements, as changing standardized packaging is very expensive.

Two examples of SRRP, reusable crates and roll-racks, described by Jarre and Hatteland (2003) and Koehorst et al. (1999) indicate that SRRP can be very efficient regarding handling activities. It is difficult to standardize packages for all products, but it can be efficient for certain product categories, such as the dairy products in the example of the roll-racks and fruit and vegetables in the example of the crates.
4 Problem analysis

In this chapter a problem analysis is carried out regarding the handling process and the associated handling activity drivers, including 2P.

4.1 Handling process

In this paragraph the handling process at Metro is analyzed. This is followed by an analysis of the influence of 2P on those handling activities.

4.1.1 Handling activities in the Metro retail stores

Handling activities in a retail store are described in scientific literature by Van Zelst et al. (2006) and by Kotzab and Teller (2005). Both articles together have resulted in the handling activities as represented in appendix D1. Those activities are adapted based on experiences from within the Metro retail stores; the researcher has carried out the activities herself and has observed and talked with the retail staff. The changes that have been made and which have resulted in the final set of handling activities (appendix D2) are described in appendix D3. The final set of handling activities are graphically represented in figure 7. The numbers and letters in the figure correspond respectively with the handling activities in appendix D2 and figure 8 on the next page.

At last as the interpretation of the (sub) activities might be subjective, the start and end point of each (sub) activity is defined in appendix D4.

![Handling activities within the retail stores](image)

Figure 7; Handling activities within the retail stores

In figure 7 it can be seen that some activities are not carried out for every order or article. This is indicated by dotted lines and is also described in appendix D3. Some important remarks are:

- There are two possibilities when an order is received and controlled on tertiary or 2P level (activity 1 and 2); 70% of the orders go directly to a storage place in the backroom. The other 30% of the orders are first controlled on article level (activity 4). This is normally done in a different area, the control area, but sometimes when the employee does not trust the situation, this activity can be carried out directly, in the presence of the distributor in the receiving area.
- Activity 9 ‘stack left over’s on high rack’ is only done if not all products fit on the shelves.
- Activity 11 ‘control of shelves’ is not carried out for every article. Facing of products is only done, when the shelf looks messy and when the retail staff has time left. But this is very exceptional for the DF assortment and more common for the non-food assortment. Removing of empty trays will only be done for articles that are presented in a tray. The exact frequencies of those activities are unknown.
4.1.2 Influence of secondary packaging on the handling process

Special interest goes to the handling activities that are influenced by 2P, as the goal of this thesis is to determine the reduction in handling costs that can be achieved with SRRP. Appendix D5 describes why certain handling activities are not influenced by 2P and are therefore left out of scope in the remaining report. The remaining activities that are influenced by 2P are displayed in figure.

Scope of handling activities in the retail store

<table>
<thead>
<tr>
<th>A</th>
<th>Control of incoming goods on primary packaging level (if necessary)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Check differences</td>
</tr>
<tr>
<td>B</td>
<td>Identification of goods</td>
</tr>
<tr>
<td></td>
<td>1. Identification of goods on high racks</td>
</tr>
<tr>
<td>C</td>
<td>Open secondary packaging</td>
</tr>
<tr>
<td></td>
<td>1. Open secondary packaging</td>
</tr>
<tr>
<td>D</td>
<td>Stacking of goods on shelves</td>
</tr>
<tr>
<td></td>
<td>1. Search for product location on the shelf</td>
</tr>
<tr>
<td></td>
<td>2. Check best before dates and remove 'old' inventory or</td>
</tr>
<tr>
<td></td>
<td>3. Put 'old' inventory to the back</td>
</tr>
<tr>
<td></td>
<td>4. Fill new inventory</td>
</tr>
<tr>
<td></td>
<td>5. Fill 'old' inventory (if necessary)</td>
</tr>
<tr>
<td>E</td>
<td>Disposal of waste</td>
</tr>
<tr>
<td></td>
<td>1. Separate cardboard and plastic</td>
</tr>
<tr>
<td></td>
<td>2. Dispose waste</td>
</tr>
<tr>
<td>F</td>
<td>Control of shelves (if necessary)</td>
</tr>
<tr>
<td></td>
<td>1. Removing of empty trays</td>
</tr>
</tbody>
</table>

Figure 8; Handling activities that are influenced by secondary packaging

Some of these sub-activities in figure 8 will be explained in more detail, see also appendix D3 for more information about the activities in the handling process;

- Activity A1 means that differences between the actual counting and the number of articles that should have been delivered according to the order system are checked. This in order to assure that the control was carried out correctly (the differences are indicated by the hand terminal).
- Either activity D2 or D3 is carried out; this depends on the perishableness of the product. If First In, First Out (FIFO) needs to be promoted, activity 3 is carried out followed by activity 5 and 6. Otherwise activity 4 is carried out, followed by activity 5.

4.1.3 Handling times in the Metro retail stores

A time study has been carried out by an external company and has led to the productivity figures as displayed in appendix D6. The figures displayed are the average values for the DF assortment (the data is also available per product group).

A disadvantage of the data is that it is very aggregate compared to the detailed level of this master thesis project. The diversity within a product group is still enormous and the impact of different types of 2P on those handling times is not known, which is especially of great interest regarding the goal of this master thesis project. Therefore a more extended study after the drivers of the handling time is needed.

4.2 Shelf Retail Ready Packaging

In this paragraph, a tool named the “Shelf Retail Ready Packaging (SRRP) Tool” will be developed. The primary goal of the SRRP Tool is to communicate with suppliers regarding the 2P in which the products are delivered. This in order to improve the 2P, especially regarding the handling costs for the Metro retail stores.
4.2.1 Development of the SRRP Tool

The basis for the SRRP Tool, as displayed in figure 9 below, is the Shelf Ready Packaging Scoring Tool (SRP Scoring Tool), which has been developed by ECR NL. Both scoring tools are based on the following five ‘easies’;

- Easy identification; the right information should clearly be visible on the packaging so that the retail staff can easily identify the product in the backroom and on the high racks. It assists the selection of the right product and helps to reduce errors and misses during the handling in warehouses and retail stores. E.g. staff overlooking a specific product in the backroom or on the high racks that should be replenishment on the shelves.
- Easy open; the intended opening method should immediately be clear to the retail staff and the 2P should be quick and easy to open, without damage to the content, product or employee.
- Easy shelf; replenishment and rotation of a product should be done with one-move. E.g. the tray is placed on the shelf in one move rather than decanting single units.
- Easy dispose; packaging should be reduced to a minimum and it should be as easy as possible for the retail staff to separate and dispose it.
- Easy shop; customers can easily identify, locate, select and pick or replace (if necessary) the products in the shop.

<table>
<thead>
<tr>
<th>Shelf Retail Ready Packaging Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Easy Identification</strong></td>
</tr>
<tr>
<td>1.1 Is it easy to identify brand?</td>
</tr>
<tr>
<td>1.2 Is it easy to identify variant?</td>
</tr>
<tr>
<td>1.3 Is it easy to identify size and amount of units?</td>
</tr>
<tr>
<td>1.4 Is it easy to identify the barcode and is the right barcode displayed?</td>
</tr>
<tr>
<td>1.5 Are brand, size, unit, barcode and variant information displayed on at least 2 sides?</td>
</tr>
<tr>
<td><strong>2 Easy Open</strong></td>
</tr>
<tr>
<td>2.1 Are the guidelines for opening of the secondary packaging clear?</td>
</tr>
<tr>
<td>2.2 Does tape obstruct opening due to wrong positioning?</td>
</tr>
<tr>
<td>2.3 Do the tear to open perforations / strips or glued parts allow one-step opening?</td>
</tr>
<tr>
<td>2.4 Does it open neatly and reliably (without damaging the packaging or product)?</td>
</tr>
<tr>
<td><strong>3 Easy Shelf</strong></td>
</tr>
<tr>
<td>3.1 Does the SRRP solution allow one-step replenishment (e.g. with a tray)?</td>
</tr>
<tr>
<td>3.2 Does the tray with products remain stable during the shelf filling process?</td>
</tr>
<tr>
<td>3.3 Is the product visible and correctly oriented (i.e. facing to the front) within the tray?</td>
</tr>
<tr>
<td>3.4 Is it easy to stack enabling multi-display options (e.g. end of aisle)?</td>
</tr>
<tr>
<td><strong>4 Easy Dispose</strong></td>
</tr>
<tr>
<td>4.1 Is the remaining waste easily separable to different materials?</td>
</tr>
<tr>
<td>4.2 Is the remaining cardboard (e.g. box) easy to collapse and dispose off?</td>
</tr>
<tr>
<td>4.3 Is the remaining waste (e.g. plastic) easy to dispose off?</td>
</tr>
<tr>
<td><strong>5 Easy Shop</strong></td>
</tr>
<tr>
<td>5.1 Are product, brand and variety visible to the shopper?</td>
</tr>
<tr>
<td>5.2 Is shopper negligible information hidden to the shopper?</td>
</tr>
<tr>
<td>5.3 Does the secondary packaging enhance category image as a whole?</td>
</tr>
<tr>
<td>5.4 Can the shopper easily pick up the product?</td>
</tr>
<tr>
<td>5.5 Can the shopper easily put back an unwanted product after pick up?</td>
</tr>
<tr>
<td>5.6 Do the remaining products stay stable as the article is shopped?</td>
</tr>
<tr>
<td>5.7 Does the secondary packaging still look appealing when partially shopped?</td>
</tr>
<tr>
<td>5.8 Is the product still visible once the first consumer units are sold?</td>
</tr>
</tbody>
</table>

Figure 9; Shelf Retail Ready Packaging Tool
As can be seen in figure 9 on the previous page, every ‘easy’ is based on a few attributes, which are translated into questions. Each attribute has impact on one or more of the following four areas; handling time, customer convenience, environment and/or safety. Special interest regarding this master thesis project goes to the attributes that have an influence on the handling time as the goal of this master thesis project is to determine the reduction in handling costs that can be achieved with SRRP. But also the attributes that have an influence on customer convenience receive some interest as it is a very important factor and a requisite for successful packaging. Besides, unfulfilled customer convenience will probably result in additional service required by customers which is time consuming for the retail staff.

Thus the attributes that have impact on the handling time and/or customer convenience are included in the new developed SRRP tool and the other attributes that only have an influence on safety or environment are left out of scope. This is the main difference between the SRP Scoring Tool (appendix E1) from ECR NL and the new developed SRRP Tool (figure 9 on the previous page). The exact process that is carried out in order to transform the original SRP Scoring Tool into the SRRP Tool is further described in appendix E2 and the exact definitions of the attributes of the SRRP Scoring Tool are outlined in appendix E3.

### 4.3 Handling activity drivers

In the previous paragraph it has been shown that 2P has an influence on some of the handling activities in the retail store. But according to literature there are other factors that affect the handling time as well. Those factors are described in appendix F1 and a decision is made if those factors are important regarding this master thesis project at Metro or not. The factors are clustered into three types of drivers; 2P, product and other drivers. Those drivers and their influence on the handling process at Metro are discussed in appendix F2. The result is represented in the Easy Handling Matrix in figure 10 on the next page. The rows represent the handling activities that are influenced by 2P (figure 8) and the columns represent the handling activity drivers (appendix F2). A cross means that the handling activity is influenced by the indicated handling activity driver and a single line indicates that the handling activity might be influenced by the driver depending on the type of 2P.

### 4.4 Conclusion

In this chapter the handling process in the Metro retail stores and the characteristics of 2P have been described. Besides, the effect of 2P, the effect of product characteristics and other factors on the handling process are analyzed. The Easy Handling Matrix represents the relation between those handling activity drivers and the handling process. The next question is how important each of those relations are, this in order to determine the main handling activity drivers. Especially the most important 2P drivers are of great interest regarding the goal of this project; negotiating with suppliers about 2P in order to reduce the handling costs at the retailer. A research method in order to determine the most important handling activity drivers is presented in the next chapter.
## Easy Handling Matrix

<table>
<thead>
<tr>
<th>Handling activities in the retail store</th>
<th>Secondary packaging drivers</th>
<th>Opening method</th>
<th>Reliability of opening</th>
<th>Availability of a display tray</th>
<th>Stability of display tray</th>
<th>Type of material(s)</th>
<th>Product drivers</th>
<th>Number of SUs per secondary packaging</th>
<th>Size of the SU</th>
<th>Weight of the SU</th>
<th>Number of variants of the SU</th>
<th>Stability of the SU</th>
<th>Other drivers</th>
<th>Employee</th>
<th>Shelf height of SU on the shelf before the start of the activity</th>
<th>Remaining SUs on the shelf after the start of the activity</th>
<th>Number of secondary packagings handled simultaneously</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Control of incoming goods</td>
<td></td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>2.1</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
<td>2.5</td>
<td>3.1</td>
<td>3.2</td>
<td>3.3</td>
<td>3.4</td>
</tr>
<tr>
<td>1. Check differences</td>
<td>X</td>
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<td>B Identification of goods</td>
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<td>1. Identification of goods on high racks</td>
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<td>C Open secondary packaging</td>
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<td>1. Open secondary packaging</td>
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<td>D Stacking of goods on shelves</td>
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<tr>
<td>1. Search for product location on the shelf</td>
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<tr>
<td>2. Check best before dates and remove 'old' inventory</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>3. Put 'old' inventory to the back</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>4. Fill new inventory</td>
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<td>X</td>
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<tr>
<td>5. Fill 'old' inventory (if necessary)</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>E Disposal of waste</td>
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<tr>
<td>1. Separate cardboard and plastic</td>
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<tr>
<td>2. Dispose waste</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>F Control of shelves (if necessary)</td>
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<tr>
<td>1. Removing of empty trays</td>
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<td>X</td>
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</tr>
</tbody>
</table>

Figure 10: Easy Handling Matrix
5 Quantification handling activity drivers

The relations between the handling activities and the handling activity drivers are indicated in the Easy Handling Matrix. Those relations will be quantified in this chapter and then the most important relations can be determined.

5.1 Measurement methodology

At first sight it was thought to use the orthogonal full factor experiment or the differential research method. But as explained in appendix G1, those experiments will lead to an enormous amount of samples that have to be gathered. E.g. already 32 samples are needed for the activity ‘open secondary packaging’.

Apart from the above there is an extra difficulty; all handling activity drivers except for driver 3.1, 3.3 and 3.4 are extraneous (Graziano and Raulin, 2004). This means that the drivers are pre-determined and can not be manipulated by the researcher. For example the researcher can select ‘easy’ and ‘difficult’ to identify 2Ps from the existing population, but the researcher can not influence the recognizableness of a certain 2P. This nature of the drivers makes it difficult to gather a good sample that fulfils all the drivers in the required way as the researcher is dependent on the available population, which may be limited for a certain combination of drivers. Besides, it can be difficult to decide ‘from the outside’ whether a 2P fulfils a certain driver. An example of this is the stability of the tray, which will only be noticed during the shelving process.

In order to reduce this complexity, the measurement methodology, as displayed in figure 11, will be used for the quantification of the relations of the Easy Handling Matrix. The numbers in the blue boxes correspond with the paragraphs of this chapter.

First, some measurements will be carried out in order to ‘get some feeling’ for ‘the most important’ handling activities and the associated drivers. The results of these first measurements will be analyzed with an Independent-Samples t Test or with an One-way Anova, but only if there are sufficient measurements and if the samples are normally distributed. Otherwise the measurements will be analyzed with the box plot and the mean values. Based on the analysis of the first measurements and the frequencies with which a handling activity is carried out, a distinction will be made regarding the importance of the handling activity. This distinction has to be made as the time for carrying out this master thesis project is limited and the complexity of the measurements high, as discussed before.
for the ‘less important’ activities. Additional, some relations between the handling activity drivers will be tested in this chapter.

In the following subparagraphs the dependent and independent variables of the measurements will be described, even as the independent variables that will play an important role in the first measurements.

5.1.1 Dependent variables
The handling times for the activities are the dependent variables in the measurement that will be carried out. The exact start and end point for each of those activities can be found in appendix D4. Regarding the measurements, it would be most ideal if the activities can be measured separately from each other. As described in appendix G2 all the activities can easily be measured separately from each other, except for activity E1 (separate cardboard and plastic) and activity D (stacking of goods on shelves). This as the employee will separate the waste directly after stacking of each 2P. The waste will be put on the pallet on which the other 2P, that still have to be stacked, are on. The separability of the handling activities is displayed in figure 12.
The separability of the handling activities has also a relation with the second point of interest; the measurement scale of the variables. It differs per handling activity if the activity is carried out per tertiary packaging, per order line, per 2P or per SU and ideally the handling time will be measured on the same scale as on which it is carried out. The measurement scales per activity are displayed in figure 12. The activities indicated with a ‘*’ are measured per order line, but carried out per 2P. This, as the two sub-activities can not be measured separable from the other sub-activities, which are carried out per order line. The number of 2P handled will be notated, thus the time per 2P can still be computed.

<table>
<thead>
<tr>
<th>Handling activities in the retail store</th>
<th>Measurement scale</th>
<th>Dependency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Control of incoming goods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Check differences</td>
<td>Order line</td>
<td>Separable</td>
</tr>
<tr>
<td>B Identification of goods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Identification of goods on high racks</td>
<td>Order line</td>
<td>Separable</td>
</tr>
<tr>
<td>C Open secondary packaging</td>
<td>Secondary Packaging</td>
<td>Separable</td>
</tr>
<tr>
<td>1. Open secondary packaging</td>
<td>Secondary Packaging</td>
<td>Separable</td>
</tr>
<tr>
<td>D Stacking of goods on shelves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Search for product location on the shelf</td>
<td>Order line</td>
<td>Linked</td>
</tr>
<tr>
<td>2. Check best before dates and remove ‘old’ inventory</td>
<td>Order line</td>
<td></td>
</tr>
<tr>
<td>3. Put ‘old’ inventory to the back</td>
<td>Order line</td>
<td></td>
</tr>
<tr>
<td>4. Fill new inventory</td>
<td>Order line</td>
<td></td>
</tr>
<tr>
<td>5. Fill old inventory (if necessary)</td>
<td>Order line *</td>
<td></td>
</tr>
<tr>
<td>E Disposal of waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Separate cardboard and plastic (if necessary)</td>
<td>Order line *</td>
<td></td>
</tr>
<tr>
<td>2. Dispose waste</td>
<td>Tertiary Packaging</td>
<td>Separable</td>
</tr>
<tr>
<td>F Control of shelves (if necessary)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Removing of empty trays</td>
<td>Tertiary Packaging</td>
<td>Separable</td>
</tr>
</tbody>
</table>

Figure 12; Measurement scale and separability of the dependent variables

5.1.2 Independent variables
The handling activity drivers are the independent variables in the measurement that will be carried out. It is not known if there is any relation between any of the handling activity drivers, but some expected relations, based on intuition from the researcher, are;

- The reliability of opening can depend on the opening method. E.g. opening of a cardboard box with perforations will more likely result in an unreliable opening than opening of a 2P with a separate hood.
- It is more likely that a tray with big and heavy products is unstable than a tray with the same number of small and light products.
- Regarding the size and weight of the tray it is more likely that the number of SUs in a tray will be higher for small and light SUs.
- A stable tray is often higher than an unstable tray and it is very likely that this required high tray will limit the visibility of the SU.
- It is more likely that the SU will be invisible if the tray is stacked on a high shelf, then when stacked on a shelf in the middle or below.
- Unstable products are more likely to be light with a small ground surface, than heavy with a big ground surface.

The measurement scale of the independent variables is another important topic regarding the measurements that will be carried out. All independent variables, except for variable 3.4, will be measured on an ordinal or nominal scale and each variable can be measured across several levels. This is shown in column 2 ‘code’ and column 3 ‘value’ of figure 13 on the next page and further explained in appendix G3. Variable 2.1 (number of SUs per 2P) will be measured on an ordinal scale, but the exact value will be notated as well. This might be useful during the analysis of the measurements.

### 5.1.3 Controlled independent variables

The first measurements will be carried out in order to ‘get some feeling’ for ‘the most important’ handling activities and the associated drivers. In those measurements only the drivers that are expected to be most important will be controlled. This means that the sample for a certain handling activity will contain a significant number of measurements for all values of the controlled driver. As the focus is on the controlled drivers it is possible that the number of measurements for the uncontrolled drivers in the sample is not significant. This can be analyzed at the end as the values of the uncontrolled drivers are registered. If a certain variable will be controlled is displayed in the last column ‘role’ in figure 13. This is further explained in appendix G4. It can be concluded that one handling activity driver will be kept constant and that five handling activity drivers will be controlled during the composition of the samples for the first measurements.

When the Easy Handling Matrix is combined with the handling activity drivers that need to be controlled it can be concluded that at most two drivers need to be controlled per handling activity for the first measurements. The samples which are needed for the various handling activities are described in appendix G5. As there are still 20 different samples needed, it is decided that 10 measurements will be gathered for every sample. So, 200 measurements are needed in total for the first measurements.

### 5.2 Measurements

The measurements are carried out on random weekdays in one of the smallest Metro stores; a Lukas Klamer store. This store is chosen because it will also be the base for the supply chain specialists, who will do the implementation phase of the SRRP project.

The same employee is asked to carry out the required handling activities. Only activity A (check differences after control of incoming goods) is carried out by another employee as there are specific employees for the activities in the backroom. The handling activities are carried out with the slightest interruption to the normal process and all activities are recorded with a video camera. The big advantage of recording with a video camera is that the process can be reviewed. This is necessary regarding the short cycle times of the handling activities and the many different drivers that have to be registered as well. These can not be viewed and registered all at the same time.

First, all movies were watched in order to register the values of the handling activity drivers. This was done according to the definitions of the values (appendix G3). Secondly, the handling times were measured with a stopwatch. Especially the activities of the process ‘shelf stacking’ have been analyzed several times as the various sub-activities have to be measured separately.

During those analyses an important insight has led to a change in the handling activity drivers; it seemed that there were various options in the way the shelves are stacked. As this stacking method influences the handling time, one additional handling activity driver is added to the Easy Handling Matrix; stacking method.
The new driver ‘stacking method’ can have one of the following five values; two options as discussed before (named first) and three new options:

<table>
<thead>
<tr>
<th>Handling activity drivers</th>
<th>Code</th>
<th>Value</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secondary packaging drivers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Identification of the secondary packaging (IU 2P)</td>
<td>1</td>
<td>Easy</td>
<td>Controlled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Difficult</td>
<td></td>
</tr>
<tr>
<td>1.2 Opening method (O.Method)</td>
<td>1</td>
<td>Tape</td>
<td>Controlled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Glue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Perforation (Perf)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Strip</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Shrink</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Fixed Hood (F.Hood)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Hood</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>1.3 Reliability of opening (O.Reliability)</td>
<td>1</td>
<td>Reliable (Rel)</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Unreliable (Unrel)</td>
<td></td>
</tr>
<tr>
<td>1.4 Availability of a display tray (Av.Tray)</td>
<td>1</td>
<td>Available (Av)</td>
<td>Controlled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Unavailable (Unav)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Available Not Used (Av NU)</td>
<td></td>
</tr>
<tr>
<td>1.5 Stability of the display tray (St.Tray)</td>
<td>1</td>
<td>Stable (St)</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Unstable (Unst)</td>
<td></td>
</tr>
<tr>
<td>1.6 Visibility of the SU within the tray (Vis.SU)</td>
<td>1</td>
<td>Visible (Vis)</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Invisible Orientation (Inv.O)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Invisible Tray (Inv.T)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Invisible Orientation+Tray (Inv.O+T)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Inv. O. Not Handled (Inv.O.NH)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Inv. T. Not Handled (Inv.T.NH)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Inv.O+T. Not Handled (Inv.O+T.NH)</td>
<td></td>
</tr>
<tr>
<td>1.7 Type of Material (Mat.)</td>
<td>1</td>
<td>Cardboard (CB)</td>
<td>Controlled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Shrink (Shr)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Cardboard+Shrink (CB+Shr)</td>
<td></td>
</tr>
<tr>
<td><strong>Product drivers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Number of SUs per secondary packaging (# SUs/2P Cat.)</td>
<td>1</td>
<td>≤6 (&lt;=6)</td>
<td>Controlled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>&gt; 6</td>
<td></td>
</tr>
<tr>
<td>2.2 Size of the SU (Size SU)</td>
<td>1</td>
<td>Small</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Big</td>
<td></td>
</tr>
<tr>
<td>2.3 Weight of the SU (Weight SU)</td>
<td>1</td>
<td>Light</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Heavy</td>
<td></td>
</tr>
<tr>
<td>2.4 Number of variants of the SU (# Var.SU)</td>
<td>1</td>
<td>≤5 (&lt;=5)</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>&gt; 5</td>
<td></td>
</tr>
<tr>
<td>2.5 Stability of the SU (St.SU)</td>
<td>1</td>
<td>Stable (St)</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Unstable (Unst)</td>
<td></td>
</tr>
<tr>
<td><strong>Other drivers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Employee</td>
<td></td>
<td></td>
<td>Constant</td>
</tr>
<tr>
<td>3.2 Shelf height of the SU (Loc.SU)</td>
<td>1</td>
<td>Low</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Middle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>3.3 Remaining SUs on the shelf before the start of the activity (# SUs Shelf)</td>
<td>1</td>
<td>0</td>
<td>Uncontrolled</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>≤12 (&lt;=12)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>&gt; 12</td>
<td></td>
</tr>
<tr>
<td>3.4 Number of 2P handled simultaneously (# 2P)</td>
<td>1…n</td>
<td>Ratio scale</td>
<td>Uncontrolled</td>
</tr>
</tbody>
</table>

Figure 13: Measurement scales of the independent variables
- Old inventory removed; check best before dates and remove the old inventory, fill new inventory and fill old inventory. This in order to promote FIFO. The times related to those activities are measured separately by respectively activity D2, D4 and D5.
- On top or before old inventory; put the old inventory to the back and fill the new inventory in front of the old inventory. This is often done in one move; the new inventory is filled and in the meanwhile the old inventory is pushed to the back. It is also possible that the products are already in the back of the shelf or that the new products can be filled on top of the old products. In all cases the time, besides the time for filling the new inventory, is expected to be negligible and therefore not measured separately. Thus handling activity D3 ‘put ‘old’ inventory to the back’ can be removed from the Easy Handling Matrix.
- Old inventory to the side; the old inventory is moved to the facings on the left and to the front (this can only be done in case an article has more than one facing). The new inventory is than stacked behind the old inventory or on the most right facing. FIFO is promoted in most cases, as the old products are moved to the front and to the left, which is the most likely location where customers pick their products. The time related to moving the old inventory to the side is measured separately and will replace activity D3 in the Easy Handling Matrix with ‘put old inventory to the side’.
- Behind old inventory; place the new inventory behind the old inventory (this can only be done if the headroom between the product and the shelf above is big enough). This stacking method promotes FIFO as well. The time, besides the time for filling the new inventory, is expected to be negligible and therefore not measured separately.
- No old inventory; there is no inventory on the shelf or some of the facings are empty. In this case no old inventory obstructs the shelf stacking, thus there is no extra time, besides the time for filling the new inventory and again FIFO is promoted.

5.3 Results of the first measurements

The SPSS outputs for the various activities can be found in appendix H. The results of the first measurements are put in MS Excel and transferred and analyzed with SPSS. These results are displayed in figure 14 on the next page. The figure displays successively:

- The concerning handling activity.
- The frequency, in times a day and as a percentage of the total number of 2Ps handled on a day, with which the activity is carried out (this is clarified in appendix I1).
- The test variable is the controlled handling activity driver of which the relation with the handling activity is tested by an Independent-Samples t Test or the One-way Anova.
- The different values of the driver.
- The mean handling time of the activity for each value of the driver in seconds. This time is multiplied with a certain factor due to confidentiality of the data.
- The number of measurements carried out for each value of the driver.
- The distribution of the measurements as normality is a prerequisite for carrying out an Independent-Samples t Test and an One-way Anova.
- The result of the Independent-Samples t Test or the One-way Anova. With this method the group means of the different values of the controlled drivers can be compared. For the activity ‘check difference’ for example, the handling time for an ‘easy’ to identify 2P is compared to the time for a ‘difficult’ to identify 2P. More information about the Independent-Samples t Test and the One-way Anova with underlying assumptions can be found in appendix I2.

A1 (Check differences after control of incoming goods)

Only four measurements have been carried out for this activity, as it is very difficult to measure this activity. Especially the influence of the employee on this activity is very big as they often identify a 2P which is badly designed or even unrecognizable for an outsider. This is due to the experience of the employee, which differs per employee. This can lead to the situation that a very experienced employee will recognize a ‘difficult’ to identify 2P faster than an ‘easy’ to identify 2P. Further, the location of the 2P on the pallet is important, even as the number of pallets, the order is consisting of. I.e. can the
2P directly be seen or is it ‘hidden’ under or beyond other 2P and what is the number of pallets the 2P can be stacked on?

Based on the four measurements it can be concluded that ‘easy’ to identify 2P is more easily found during this activity than ‘difficult’ to identify 2P. However, this is not statistically validated and there should be kept in mind that there are many other factors that influence this activity.

### A1

It is easier to find an ‘easy’ to identify 2P in an order than a ‘difficult’ to identify 2P, the search time is respectively 26.9 versus 78.8 seconds.

### Table: Results of the first measurements

<table>
<thead>
<tr>
<th>Handling activity</th>
<th>Frequency</th>
<th>Test var</th>
<th>Values</th>
<th>Duration</th>
<th># Meas</th>
<th>Distribution</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Check differences</td>
<td>18 / day</td>
<td>0.25%</td>
<td>ID 2P</td>
<td>Easy</td>
<td>26.9</td>
<td>Not normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Diffcult</td>
<td>78.8</td>
<td>Not normal</td>
</tr>
<tr>
<td>B</td>
<td>Identification of goods on high racks</td>
<td>29 / day</td>
<td>0.41%</td>
<td>ID 2P</td>
<td>Easy</td>
<td>37.9</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Diffcult</td>
<td>Infinity</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>Open secondary packaging</td>
<td>7042 / day</td>
<td>100%</td>
<td>C: Method</td>
<td>Tape</td>
<td>22.9</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Glue</td>
<td>18.3</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Perf</td>
<td>56.2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Strip</td>
<td>10.2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shrink</td>
<td>33.3</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F-Hood</td>
<td>21.1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hood</td>
<td>9.7</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tray</td>
<td>0.0</td>
<td>4</td>
</tr>
</tbody>
</table>

| D | Search for product location on the shelf | 2349 / day| 33%    | Id 2P   | Easy    | 11.1   | 13           | Not normal |
|   |                                         |           |         |         | Diffcult| 22.9   | 12           | Normal     |
|   | Check best before dates and remove ‘old’ inventory | 984 / day| 14%    | Av. Tray| Av.  | 26.1   | 5            | Normal     |
|   |                                         |           |         |         | Unav    | 44.8   | 4            | Normal     |
|   | Put ‘old’ inventory to the side       | 845 / day | 12%    | Av. Tray| Av.  | 53.8   | 2            | -          |
|   |                                         |           |         |         | Unav    | 48.3   | 6            | Normal     |
|   | Fill new inventory                    | 7042 / day| 100%   | Av. Tray| Av.  | 15.4   | 33           | Normal     |
|   |                                         |           |         |         | Unav    | 56.9   | 35           | Normal     |
|   | Fill ‘old’ inventory                  | 984 / day | 14%    | Av. Tray| Av.  | 20.8   | 6            | Normal     |
|   |                                         |           |         |         | Unav    | 34.0   | 4            | Normal     |
| E | Separate cardboard and plastic       | 7042 / day| 100%   | Mat.    | CB     | 0.0    | 11           | Not normal |
|   |                                         |           |         |         | Shr     | 10.4   | 5            | Not normal |
|   |                                         |           |         |         | CB+Shr  | 9.0    | 5            | Normal     |
| F | Disposal of waste                     | 7042 / day| 100%   | -       |          | 2.5    | 2            | Not normal |
|   | Control of shelves                    | 750 / day | 11%    |          |          | 52.3   | 3            | Not normal |

**Figure 14: Results of the first measurements**

(The handling times and frequencies are multiplied with a certain factor due to confidentiality of the data)

### B1 (Identification of goods on high racks)

No measurements are carried out for ‘difficult’ to identify 2P, as it is impossible to recognize this kind of 2P when it is stacked on height. Thus it is pure coincidence when this kind of 2P is found and it will mostly be very time consuming. Twelve measurements are carried out for ‘easy’ to identify 2P, but again, as by activity A1, the influence of the employee is big. Other factors, which are observed during the measurements, and are expected to have a big influence on this activity, are;

- The location of the products on the high racks; the products are more easily found if they are stacked right above the shelf location. It takes more time if they are stacked a few metres to the left or right. The purpose is already to stack products right above the shelf location, but that is not always possible due to space limitations on the high racks.

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20
- The location of the products on the pallet; only the products in the front row on the pallet can be seen.
- The number of products stacked on the high racks; the more of the same products stacked together, the more easily it can be found.
- Size of the product; this is related to the previous issue as it is more easily to find a big product than a small product that will ‘disappear’ between all the other (bigger) products.

The box plot shows that there is much variation in the handling time of this activity, which is probably due to the many factors that influence this activity. A very important conclusion regarding this activity is that it can be eliminated. For example, with a system that registers the type of products that are stored on the high racks, eventually with the associated quantities, locations and best before dates.

B1 An ‘easy’ to identify 2P is on average found in 37.9 seconds on the high racks, while it is impossible to find a ‘difficult’ to identify 2P on the high racks and this search time can go to infinity.

CI (Open secondary packaging)
The sample of the opening method ‘glue’ is normally distributed after deletion of the ‘extreme’ outlier. Then the only sample which is not normal distributed is the opening method ‘strip’. This is due to the fact that only two measurements were carried out, as this opening method is very rare. The average opening time for this method is also very high compared to the other methods, but two measurements are doubtful proof for saying that the time for this measurement is significant higher.

D1 (Search for product location on the shelf)
After deletion of the ‘extreme’ outlier, the sample ‘difficult’ is normal distributed. The sample ‘easy’ is not normal distributed and this is impossible as the sample is bounded with a search time of zero seconds on one side. Based on the average time can be concluded that the product location of a ‘difficult’ to identify 2P is found faster than the location of an ‘easy’ to identify 2P, respectively 22.9 versus 11.1 seconds.

But during the first measurements a lot of factors were observed and those are expected to play an important role in the search time for the product location:

- The experience of the employee; often the employee just knows the location and does not have to search. In those cases the search time is zero and those times were not registered.
- Design of the product packaging; sometimes the tray is very low in the front and than the design of the product packaging is more important than the 2P.
- Number of variants; the more variants, the easier the product group is found on the shelves, but the more time consuming it can be to find the right variant.
- Size of the product; small products are more difficult to identify as they kind of disappear between the other (big) products.
- Shelf location; products on eye height are more easily found than products on for example the lower shelves, those are more easily overseen.
- The number of products on the shelf; it is difficult to find a product location if the shelf is empty as there are no products to recognize.

Therefore it is unexpected that the identification of the tray has an impact on the search time of the product location. This can also be concluded from the box plot as some product locations with a ‘difficult’ to identify 2P are still found in 1 second. One reason can be that the identification of the tray differs from the identification of the 2P, as the tray is only a part of the 2P. This as the identification of the 2P is registered by the researcher, but only the identification of the tray will have impact on this activity.

It is concluded that the identification of the 2P has no influence on the search time for the product location, as there are many other factors that play an important role during this activity.
It is expected that many factors, besides the ‘identification of the 2P’, play an important role in the search time for the product location. It is probably more time consuming to find the right product location on the shelf when the SU is small, there are a lot of variants, the shelf height is below hips or above shoulders and when there is no ‘old’ inventory on the shelf. Further, it is expected that the product packaging plays an important role in this activity.

Ten measurements are carried out for this activity. This number is depending on the stacking method and as discussed in paragraph 5.2 there are five stacking methods. One of them is to remove the old inventory before the new inventory is stacked. This is a time consuming method which has been carried out in 14% of the cases (figure 15).

This 14% seems quite low for the DF assortment as 80-85% of the assortment has a best before date. But this date is often 2-4 years ahead and therefore the employees do not check the dates every time new products are stacked. Once in a while the employee checks the best before dates and removes the old inventory before the new inventory is stacked. This is possible because, every employee has his own aisle and therefore knows when the dates are checked for the last time.

The data of the measurements are normal distributed, thus the t Test can be used. From the t Test is concluded that the mean of the sample with a tray is significant different on an 86% confidence level from the mean of the sample without a tray. The mean difference is 18.7 seconds, but due to the big standard deviation of especially the sample without a tray, the confidence level for a significant difference is quite low.

During the measurements it was experienced that removing the old inventory with a tray is much easier as it is easier to collect the remaining products. Especially small products in the back of the shelves, which are normally hard to reach when shelved separately. Further, the advantage is that several products can be removed together in one move.

It is faster to remove the old inventory with a tray than to remove it without a tray; 26.1 versus 44.8 seconds.

Eight measurements are carried out for this activity and again this number is depending on the stacking method. This stacking method is carried out in 12% of the cases (figure 15) and can only be carried out when an article has several facings.

Only two measurements are carried out for the population where a tray is available, thus the conclusions for this measurement will therefore not be very reliable. Besides, the t Test can not be used as the sample is not normal distributed. From the box plot can be concluded that there is no significant difference between the handling time for the population with a tray and without a tray. This is quite logical as several products, shelved without a tray, can easily be moved together to the side with the arm of the employee and then advantage of a tray is negligible. The tray can also have the following disadvantage; SUs in different ‘half filled’ trays have to be put together in less ‘full’ trays.
The availability of a tray is a disadvantage if the old inventory has to be put to the side. It takes 48.3 seconds without a tray and 53.8 seconds with a tray.

D4 (Fill new inventory)
Both samples are normally distributed, after deletion of the ‘extreme’ outlier for the sample ‘tray unavailable’. But as the assumption for equal variances does not hold, the t Test for unequal variances is used. The t Test indicates that it is significant faster to shelf products with a tray than without. This is also clearly seen when looking at the mean values (figure 14) and the box plot. Some important remarks need to be made regarding this process:

- It happens quite a lot that products are delivered in a tray, but that the products are not shelved in the tray. This can have several reasons; the planogram is not adapted to the size or the number of facings of the tray, the employees do not know that they have to shelf the products in the tray or they do not want to shelf the SUs in the tray if the tray is ugly, unstable or if the products are invisible in the tray.

- Relation to the remark above is that everybody handles the invisibility of the SU differently and even in the experiments carried out with one employee the invisibility of a SU was handled differently. Sometimes the tray was not used when the products were invisible. Other times the tray with products was just placed on the shelf without removing part of the tray and/or turning the SUs so that the SUs remain invisible and sometimes the tray was used and part of the tray were removed and/or SUs were turned so that the visibility of the SU was improved. As invisibility was handled differently the extra time related to turning of the products and tearing of part of the tray was measured separately. Those results can be found in appendix J.

It is faster to fill the new inventory with a tray than to fill it without a tray; 15.4 versus 66.9 seconds.

D5 (Fill ‘old’ inventory)
This activity is related to activity D2 ‘removing of the old inventory’, thus again 10 measurements are carried out for this activity. Both samples are normal distributed, thus the t Test can be used. The confidence level, with which can be stated that filling the old inventory with a tray is faster than filling the old inventory without a tray, is quite low 87%. But it seems very logical that filling the inventory with a tray is faster than filling it without a tray.

It is faster to fill the old inventory with a tray than to fill it without a tray; 20.8 versus 34.0 seconds.

E1 (Separate cardboard and plastic)
This activity is quite difficult to measure as it is integrated in the shelf stacking activity. As can be seen in figure 14, 22 measurements are done for this activity. The time for the cardboard box is negligible as the empty cardboard box is just randomly placed (in another box) on the pallet. The handling time for folding of the plastic shrinks and putting it in one separate box is less negligible. As can be seen in the box plot there is a lot of variety in this activity, especially for the sample ‘shrink’. This as this activity is sometimes carried out after filling one 2P and sometimes for several 2Ps together at the end. Due to this variety the shrink sample is not normal distributed and therefore the t Test can not be used.

It is assumed that the differences between both samples of 2P with plastic are negligible and take on average 9.7 seconds. On the other hand, the difference between those two samples of 2P with plastic and the 2P with only cardboard is more clearly present, 9.7 versus 0 seconds.

It is more time consuming to separate a 2P which contains plastic than a 2P that consists of purely cardboard; 9.7 seconds versus 0 seconds.
E2 (Dispose waste)
Two measurements are carried out on order level for this activity, each representing 45 2Ps. The time per 2P for this activity is very minimal as the time for disposing all the 2P on the pallet took only 93 respectively 125 seconds. Thus the time per 2P is almost negligible.

E2  The dispose time for a 2P in the plastic or cardboard container is very short; 2.5 seconds per 2P.

F1 (Removing of empty trays)
Three measurements with a various number of trays, 6, 12 and 18 trays, are carried out and an average time for each tray is determined; 52.3 seconds. This time includes; picking up of the empty tray, moving the ‘full’ tray behind the empty tray to the front and travelling in the aisle.
This activity can also be carried out during stacking of the goods on the shelves and then all empty trays are removed before new products are stacked. In that case the time for removing the empty tray is almost negligible as it only needs to be picked up and thrown on the pallet.

F1  The handling time for removing the empty trays is negligible if it is done before the activity ‘stacking of new inventory’ or during the daily ‘product availability check’. When the activity is carried out separately, it will take 52.3 seconds to remove one empty tray, to move the ‘full’ tray behind the empty tray to the front and to travel in the aisle.

5.4 Distinction between ‘important’ and ‘less important’ activities
Based on the first measurements a distinction can be made between the more important handling activities and the less important handling activities. This distinction is mainly based on the frequency and the duration of the handling activities. Four activities are carried out for every 2P, while the other activities are at most carried out for 14% of the 2P or for 33% of the order lines. From those four measurements, the activities E1 (separate cardboard and plastic) and E2 (dispose waste) will not be further analyzed. The handling time for activity E2 is a constant and activity E1 is not further analyzed as it is difficult to measure this activity. Further this activity is only influenced by the drivers ‘employee’ (which is kept constant during the measurements) and ‘#SUs/2P’ (this effect is also measured by the activities C1 and D4), besides the controlled handling activity driver of which are already 22 measurements. Those 22 measurements are enough to determine an average handling time for the various values of the controlled handling activity driver.
Thus the activities C1 (open secondary packaging) and D4 (fill new inventory) are further analyzed. This distinction has to be made as the time for carrying out this master thesis project is limited and the complexity of the measurements is high as discussed before. The question that remains is if additional measurements are needed. Those additional needed measurements will be carried out in the same way as the first measurements were carried out.
No additional measurements are needed for activity D4 as already 68 measurements are carried out and both samples are normally distributed. For activity C1 some additional measurements are needed; only two measurements are carried out for opening method ‘strip’ and only six, respectively seven, measurements are carried out for the opening methods ‘hood’ and ‘fixed hood’. Thus more measurements are required for those three opening methods. The goal is to have at least 10 measurements for each population at the end.

5.5 Final results for the more important handling activities
In this paragraph the final results for the processes C1 (open secondary packaging) and D4 (fill new inventory) will be discussed. First the controlled handling activity driver of activity C1 will be analyzed as additional measurements are carried out for this activity. Then regression analyses will be carried out for both activities.

The results of the additional measurements for activity C1 (open secondary packaging) are displayed in figure 16 on the next page. The associated SPSS outputs can be found in appendix K. Eight measurements were carried out for opening method ‘strip’, which was unfortunately less than the goal of ten measurements, but that is due to the limited population of this opening method. Then two
‘extreme’ outliers are excluded from the measurements as the sample of ‘strip’ was not normal distributed. After deletion of those two outliers the standard deviation of this opening method decreased from 10.7 to 0.75 and the sample was normal distributed. During the next analyses all samples are normal distributed, but the standard deviation of ‘perforation’ was still very high and therefore the three outliers for this opening method were removed. Those outliers indicated with a ‘o’ are less divergent than the outliers indicated with a ‘*’, but there are still enough reasons to remove them. After deletion of the three outliers, the standard deviation of ‘perforation’ is reduced from 8.8 to 4.3. As the variances of the various samples are still unequal, the special t Test for analyzing the differences in means for samples with unequal variances is used.

<table>
<thead>
<tr>
<th>Handling activity</th>
<th>Test var.</th>
<th>Values</th>
<th>Duration</th>
<th>± Meas.</th>
<th>Distribution</th>
<th>Difference</th>
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<td>0. Method</td>
<td>Tape</td>
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<td>Glue</td>
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<td>Normal</td>
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<td></td>
<td>Perf.</td>
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<td></td>
<td>Strip</td>
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<td>5</td>
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<tr>
<td></td>
<td></td>
<td>Shrink</td>
<td>33.3</td>
<td>23</td>
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<tr>
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<td></td>
<td>F. Hood</td>
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<td>10</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Hood</td>
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<td>10</td>
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<td>None</td>
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<td>4</td>
<td>-</td>
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</tr>
</tbody>
</table>

Figure 16: Final results for activity ‘opening method’
(The handling times are multiplied with a certain factor due to confidentiality of the data)

The conclusion about the time differences between the various opening methods can be found in figure 17; a cross means that the two opening methods are significantly different. As the mean values are also noted it can be concluded which opening method is the best. A graphical overview of the opening times can be seen in the box plot (figure 18). The area within the quartiles, the brown area, includes 50% of the measurements and the black line indicates the median.

The main conclusion from these figures is that opening method ‘hood’ is significant faster than all the other opening methods. But there should be kept in mind that there is an eighth opening method, which is not displayed in figure 17 and 18; a tray, which requires no opening time at all, and is thus the best.

Figure 17: Significant differences in opening methods
(The handling times are multiplied with a certain factor due to confidentiality of the data)

Figure 18: Box plot opening method
Further, the opening methods ‘strip’ and ‘perforation’ are significant worse than all the other opening methods are. Besides, their variation in the opening times is high. Some of those 2Ps are quite fast to open and even better than 2Ps with another opening method, but some 2Ps with a perforation or strip are really badly designed and very time consuming. This indicates that the quality of the perforation or strip is crucial regarding the required opening time and that this quality varies a lot. The mean as displayed in figure 16 and 17 is the time excluding those outliers.

5.5.1 Regression analyses

In this subparagraph the effect of the number of SUs in a 2P will be measured for the processes C1 (open secondary packaging) and D4 (fill new inventory). The same results are expected for both processes and also for the other activities which are influenced by the number of SUs in a 2P (see Easy Handling Matrix), as the idea is the same; if the activity is carried out per 2P, the time per SU will be shorter if the 2P includes more SUs.

Besides, the impact of the other handling activity drivers on the handling activities will be analyzed as well. The relations to be analyzed are displayed in the Easy Handling Matrix. As enough measurements are carried out for the activities C1 and D4 a regression analysis can be carried out. The only problem regarding a regression analysis is that the variables need to be at least interval scaled. Therefore dummy variables need to be used as most of the independent variables are nominal or ordinal scaled. The dummy variables which are used in the regression analysis are displayed in appendix L1. There are various types of regression analysis, but it is chosen to use stepwise regression. The stepwise method adds or removes independent variables to the model according to their contribution for predicting the dependent variable. This is explained in appendix L2, even as the way the results of the regression analysis should be interpreted. The SPSS outputs for the various regression analyses can be found in appendix M.

C (Open secondary packaging)

Two regression analyses are carried out for this handling activity. In the first regression analysis the handling time of the dependent variable is measured per 2P and in the second analysis per SU. This in order to discover if the handling time per SU will decrease if a 2P entails more SUs. No collinearity among the independent variables exists, thus the regression analysis can be carried out.

The variables for opening method ‘tape’ and ‘glue’ can not be included in the regression model for predicting the time per 2P as those measurements have no value for the variable ‘stability of the tray’. But from this analysis can be concluded that the variable ‘stability of the tray’ has no significant contribution at a 95% confidence level to the regression model. Therefore a new regression analysis is carried out without the independent variable ‘stability of the tray’, so that the values ‘tape’ and ‘glue’ for opening method can be included.

The opening methods ‘strip’, ‘perforation’ and ‘shrink’ are added to the new regression model. The model is valid as indicated by the F statistic and explains 59% of the variance, which is quite good. No other dependent variables, besides the opening method contribute significantly to the time for this handling activity, which means that the type of opening method is the most important factor for predicting the opening time.

The variables ‘tape’ and ‘glue’ can again not be included in the regression model for predicting the time per SU. Also in this measurement the stability of the tray does not contribute significantly to the model at a 95% confidence level and therefore this independent variable is excluded from the model in order to include the variables ‘tape’ and ‘glue’. The variable ‘number of SUs per 2P’ is added to the new model, followed by the opening method ‘strip’, ‘perforation’ and ‘shrink’ in the second, third and final model. This final model is valid as indicated by the F statistic and explains 62% of the variance, which is quite good.

Those regression analyses indicate that the opening method is the most important predictor for the opening time of a 2P. When the time is measured per SU, the variable ‘# SUs/2P’ has also an influence. This correlation is negative, which means that the opening time per SU will decrease if there are more SUs in a 2P. This is exactly what is expected as discussed in the beginning of this paragraph.
C1  The opening time per 2P for each type of opening method is given in figure 16. Concluded can be that opening of a tray without a hood requires no opening time and this therefore the best opening method. Further, the more SUs in a 2P the better, as the opening time for a 2P will remain the same and the time per SU will decrease. The opening time for the methods ‘strip’ and ‘perforation’ is most time consuming and the variation is very high. This as the opening time is mainly determined by the quality of the strip/perforation, which varies a lot.

D4 (Fill new inventory)
Two regression analyses are carried out for this handling activity. In the first regression analysis the handling time of the dependent variable is measured per 2P and in the second analysis per SU. This in order to discover if the handling time per SU will increase if a 2P contains more SUs. In those regression analyses the independent variables ‘visibility of the SU’ and ‘opening reliability’ are not included. The visibility of the SU is not included as the extra time related to invisibility of the SU is measured separately (appendix J). Furthermore, the opening reliability is excluded as this relation indicates that the products have to be shelved without a tray if the tray is damaged during opening and this relation is thus covered by the availability versus the unavailability of a tray. As no collinearity exists for the independent variables, the regression analysis can be carried out.

The variable ‘availability of a tray’ is added to the first model, for predicting the fill time per 2P, followed by the variables ‘number of SUs in a 2P’ and ‘stacking method behind’ in the second and final model. This final model is valid as indicated by the F statistic and explains 78% of the variance, which is quite high. The standardized coefficient implies that the most important factor is the availability of a tray and the filling goes much faster if the tray is available. Furthermore, it is more time consuming if there are more SUs in a 2P or if the products are shelved behind the ‘old’ inventory. This last effect seems straightforward, but the extra filling time related to number of SUs in a 2P is probably only true if the SUs are shelved without a tray. Thus another analysis is required that distinguishes the samples with a tray and without a tray, but first the same analysis with the time per SU is carried out.

The three variables which were added to the previous model are also added to the model that predicts the filling time per SU, but one extra variable ‘size of the SU’ is added as well. The final model is valid as indicated by the F statistic and explains 83% of the variance, which is very good. The standardized coefficient implies again that the most important factor is the availability of a tray. Furthermore, the time per SU will decrease if there are more SUs in a 2P. This is probably only true if the SUs are shelved on a tray. Besides, the filling time will increase if the products are shelved behind the old inventory and the time per SU will decrease if the product is smaller. The question remains if this is the case when the products are shelved on a tray, as it is expected that more small products do fit on a tray or if it is the case if the SUs are shelved without a tray as it is less time consuming to fill small products, as the employee can hold several of those in one hand.

D4  Filling new inventory goes much faster with a tray, than filling without a tray. Besides, it is more time consuming if the products are stacked behind the ‘old’ inventory than when it is stacked on top or before of the ‘old’ inventory.

Some questions about factors only influencing SUs shelved on a tray or without a tray remain. Therefore four additional regression analyses were carried out; two for the sample without a tray (on 2P and SU level) and two for the sample with a tray (on 2P and SU level).

No collinearity exists for the independent variables, thus the regression analysis for the fill time without a tray can be carried out. The stacking method ‘remove old inventory’ can not be included as an independent variable as this stacking method is only carried out 4 out of the 35 times and is therefore seen as a constant by SPSS.

The variable ‘number of SUs per 2P’ is added to the first model for predicting the fill time without a tray per 2P, followed by the variable ‘stacking method behind’ in the final model. The variable ‘size of
the SU’ was almost added to the model as the significance was 0.067. But as this variable seemed to be important in the two previous models, the significance level for incoming variables is changed from 0.05 to 0.07, so that the variable ‘size of the SU’ is included. The model with the three variables is valid as indicated by the F statistic and explains 93% of the variance, which is very good as almost all variance is explained. The standardized coefficient implies that the most important factor is the ‘number of SUs per 2P’. This is quite logical, as every extra SU in the 2P has to be placed separately on the shelf. Besides, the filling time will increase if the products are stacked behind the old inventory and the time will decrease if the SUs are small. A likely explanation for this is that it is faster to fill small SUs than big SUs as it is easier to grab and fill several small SUs together with one hand, than it is for big SUs. The regression equation is the following;

\[ \text{Fill time without tray per } 2P = 20.4 + 5.7 \times \#\text{SUs}/2P + 33.3 \times \text{Stack M. Behind} – 18.3 \times \text{Size SU} \]

The variable ‘size of the SU’ is the only variable added to the model for predicting the filling time per SU without a tray. The model is valid as indicated by the F statistic and explains 51% of the variance, which is moderate. This leads to the conclusion that the size of the SU is important regarding the shelf filling without a tray, which was also concluded in the previous regression analysis.

When the products are filled without a tray the filling time is mainly determined by the number of SUs in a 2P, followed by the stacking method and the size of the SU. The exact handling time can be computed with the formula as described above.

No collinearity exists for the independent variables, thus the regression analysis for the fill time with a tray can be carried out. The variable stacking method ‘behind’ is not included as only one measurement was carried out for this value.

Only the variable ‘stability of the tray’ is added to the model for predicting the time per 2P when shelved on a tray. The model is valid as the F statistic is 0.49 and explains just 9% of the variance, which is very bad. This leads to the conclusion that besides the impact of the availability of the tray, only the impact of the stability of the tray plays a very small role. The regression equation is the following;

\[ \text{Fill time with tray per } 2P = 19.3 – 5.0 \times \text{Stability tray} \]

The variable ‘number of SUs in a 2P’ is added to the first model for predicting the filling time per SU with a tray, followed by the variable ‘stability of the tray’ to the final model. The final model is valid as indicated by the F statistic and explains 42% of the variance, which is quite low. This leads again to the conclusion that a tray with more SUs leads to a shorter shelving time per SU and the filling time will increase if the tray is unstable.

Furthermore, as discussed in appendix J, invisibility of the SU will lead to additional filling time as well; 1.86 seconds for the orientation of a SU and 14.32 seconds for removing part of the tray.

The filling time for a stable tray is 14.3 seconds compared to 19.3 seconds for an unstable tray. Additional filling time will be added for invisible SUs; 1.86 seconds for each SU that has to be turned and 14.32 seconds if part of the tray has to be removed. Further, the more SUs in a 2P the better, as the filling time for a tray will remain the same and the time per SU will decrease.

Fit of the regression analyses

In this subparagraph, three regression equations, which can be used for prediction of the handling times, have been developed. Ideal those regression equations will be tested on a part of the sample, but as the sample is already quite small (figure 19 on the next page), this is not done. Otherwise the number of measurements per independent variable will decrease even more and in the same time the chance for an over fit of the regression model will increase as well. In order to decrease the chance on over fit, all measurements are used for constructing the model and no test sample is created.
### 5.6 Independence of the handling activity drivers

No multi collinearity exists between the independent variables used in the regression analyses. But as discussed in subparagraph 5.1.2 some handling activity drivers are expected to be related with each other. This will be further analyzed in this paragraph, as it can give some further insights regarding the suitability of products for SRRP. The SPSS outputs can be found in appendix N in the same order as in which the relations are discussed.

**Opening reliability versus the opening method**
When looking at all the measurements for the opening method, including the outliers it seems that ‘perforation’ opened unreliable in 4 of the 13 cases and ‘strip’ in 3 of the 8 cases. The other opening methods never opened unreliable. This relation between opening reliability and opening method is also visible in the correlation matrix, as ‘strip’ and ‘perforation’ correlate respectively on a 0.01 and 0.02 significant level. Again, this proofs that the opening times for those two opening methods are very dependent on the quality of the perforation or strip.

**The stability of the tray versus the size and weight of the SU**
For the light SUs only 3 out of the 25 trays are unstable, while this is 5 out of 16 for the heavy SUs. Besides, 2 out of the 20 trays are unstable for the small products, against 6 out of 21 for the big products. This indicates that the chance on an unstable tray is bigger for heavy and/or big products, than for small and/or light products. This is according the expectations, but unfortunately the correlation can not be statistically proven on a 95% confidence level with the correlation matrix.

**The number of SUs in a tray versus the size and weight of the SU**
The number of SUs in a tray is higher for small products, than for big products. This is less obvious for light versus heavy products as those differences are smaller. Unfortunately none of the relations correlates significantly on a 95% confidence level.

**The visibility of the SU versus the stability of the tray**
The measurements include only three trays which limit the visibility of the SU and those are all stable. Three measurements give doubtful proof that a relation exists, but the conclusion that especially stable trays limit the visibility of the SU is according expectations. This as a stable tray will often be higher than an unstable tray and will therefore more easily limit the visibility of the tray.

**Visibility of the SU versus shelf height**
The measurements include only three trays which limit the visibility of the SU and two of those are stacked on a high shelf and one on a shelf in the middle. Three measurements give doubtful proof that a relation exists, but the conclusion that especially trays on a high shelf will limit the visibility of the SU is according expectations.

**The stability of the SU versus the size and weight of the SU**
None out of the 27 heavy SUs is unstable, while 16 out of the 41 light SUs are unstable. Besides that 3 out of the 35 big SUs are unstable, against 13 out of the 33 small SUs. This implies that especially small and light SUs are unstable. Both relations correlate on a 99% confidence level.

**The stacking method versus the availability of a tray**
The stacking method ‘on top or before of the old inventory’ is used 18 out of 33 times when a tray available. This is quite a lot and this relation correlates on a 97% confidence level. The stacking method ‘behind the old inventory’ is used only once of the 33 times and this relation correlates on a 94% confidence level.
5.7 Conclusions

Most relations in the Easy Handling Matrix are quantified in this chapter. The result is shown in figure 20 on the next page. The handling time per 2P for each activity can be computed based on the values of the handling activity drivers. Unfortunately not all relations have been quantified:

- ‘-‘ indicates that the relation is not statistically proved.
- ‘X’ indicates that those relations are not measured as the activities where assumed to be less important.
- ‘X’ indicates that those relations are only present if the activity is measured per SU. This as the time per SU will increase if a 2P contains more SUs. This is proven for the activities ‘open secondary packaging’ and ‘fill new inventory’, but for the other activities this is assumed to be true as well.

The figures for all activities, except for C1 and D4 are derived from the first measurements. One additional assumption had to be made for the identification time for a ‘difficult’ to identify 2P on the high rack. This time can go up to infinity, but the time is estimated to be 1074 minutes. The times for the activities D2 (remove ‘old’ inventory), D3 (put ‘old’ inventory to the side) and D5 (fill ‘old’ inventory) are divided by three as the times are measured per order line instead of per 2P. It is assumed that an order line contains on average three 2Ps. The time for activity F1 is also divided by three as it is assumed that only 33% of the empty trays will be collected separately. The other empty trays will be collected during filling of the new inventory or during the product availability check in the morning.

Activity D1 is not included in the Easy Handling Matrix as it is assumed that the search time for the product location does not depend on the identification of the 2P. This activity will thus not be influenced by SRRP.

The figures for activity C1 (open secondary packaging) are derived from the additional measurements. As the regression analyses indicated that only the opening method plays an important role for the prediction of the handling time, the results from the One-way Anova are used.

The figures for activity D4 (fill new inventory) are derived from the regression analyses, one for the sample with a tray and one for the sample without a tray. An additional assumption has been made for the time related to stacking method ‘behind’ if the new inventory is stacked with a tray. This could not be measured as there was only one measurement. This time is estimated to be 3.6 second.

The handling time for the activity ‘fill new inventory with tray’ is computed in the following way; the time for filling with a tray will be 14.3 seconds, but additional time (respectively 5.0 and 3.6 seconds) will be added if the tray is unstable or if the stacking method is ‘behind’. Furthermore, additional time will be added if the SUs are invisible; 14.32 seconds if the tray limits the visibility of the SU and 1.86 seconds for each SU that is wrongly faced. This leads to an average time of 29.4 seconds for invisibility of the SU, as it is assumed that an average tray contains 8 SUs.

The handling time for the activity ‘fill new inventory without tray’ is computed in the following way; there is a fixed time of 20.4 seconds and additional time, of 5.7 seconds, is added per SU that is filled. Besides, the handling time can be decreased with 18.3 seconds if the SUs to be filled are small. Additional time of 33.3 seconds is added if the stacking method is ‘behind’.

Regarding activity C1 (open of secondary packaging) it should be kept in mind that the opening times for the methods ‘strip’ and ‘perforation’ are very variable, as they heavily depend on the quality of the strip and perforation. The average time as notated in figure 20 exclude the outliers and is therefore less high; 41.2 instead of 56.2 and 56.6 instead of 65.9.

Except for activity D1, all handling activities are indeed influenced by 2P and it seems that the controlled handling activity drivers are indeed the most important. However, activity D4 (fill new inventory) is also influenced by some other handling activity drivers: stability of the tray, visibility of the SU, size of the SU and the stacking method.
## Easy Handling Matrix

### Handling activities

<table>
<thead>
<tr>
<th>A</th>
<th>Control of incoming goods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Check differences</td>
</tr>
<tr>
<td></td>
<td>Easy</td>
</tr>
<tr>
<td></td>
<td>Difficult</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B</th>
<th>Identification of goods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Identification of goods on high racks</td>
</tr>
<tr>
<td></td>
<td>Easy</td>
</tr>
<tr>
<td></td>
<td>Difficult</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C</th>
<th>Open secondary packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Open secondary packaging</td>
</tr>
<tr>
<td></td>
<td>Tray</td>
</tr>
<tr>
<td></td>
<td>Hood</td>
</tr>
<tr>
<td></td>
<td>Shrink</td>
</tr>
<tr>
<td></td>
<td>Perforation</td>
</tr>
<tr>
<td></td>
<td>Stop</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D</th>
<th>Stacking of goods on shelves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Remove 'old' inventory</td>
</tr>
<tr>
<td></td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>Unavailable</td>
</tr>
<tr>
<td></td>
<td>3. Put new inventory to the shelf</td>
</tr>
<tr>
<td></td>
<td>Unavailable</td>
</tr>
<tr>
<td></td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>4. Fill new inventory</td>
</tr>
<tr>
<td></td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>Unavailable</td>
</tr>
<tr>
<td></td>
<td>5. Fill 'old' inventory</td>
</tr>
<tr>
<td></td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>Unavailable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E</th>
<th>Disposal of waste</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Separate earth box and plastic</td>
</tr>
<tr>
<td></td>
<td>CB</td>
</tr>
<tr>
<td></td>
<td>Shr or CB+Bhr</td>
</tr>
<tr>
<td></td>
<td>2. Dispose waste</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F</th>
<th>Control of shelves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Removing of empty trays</td>
</tr>
</tbody>
</table>

### Handling activity drivers

<table>
<thead>
<tr>
<th>Secondary packaging items</th>
<th>Handling activity drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Total handling time per secondary packaging for the activities that are influenced by secondary packaging

(The handling times are multiplied with a certain factor due to confidentiality of the data)

---

Figure 20: Quantified Easy Handling Matrix

(31)
6 Handling Efficient Secondary Packaging Tool

In this chapter the development of the Handling Efficient Secondary Packaging Tool in Ms Excel will be described. This tool will provide insight in the potential savings in the handling time for the products of the DF assortment of Metro.

6.1 Development of the HESP Tool

Based on the quantified Easy Handling Matrix (figure 20) and some additional assumptions, the Handling Efficient Secondary Packaging Tool (HESP Tool) has been developed in Ms Excel. The following additional assumptions have been made:

- In 23% of the time the stacking method ‘no old inventory or empty facings’ can be used. This percentage is derived from the measurements in chapter 5 and is assumed to be applicable to the whole DF assortment. In consultation with Metro, the stacking method ‘remove old inventory’ will be used in the other cases, as this method has officially to be used and promotes FIFO in the best way.

- The formula for the filling time per 2P without tray is changed. Originally, the formula was:

\[ \text{Fill time without tray per 2P} = 20.4 + 5.7 \times \#\text{SUs/2P} + 33.3 \times \text{Stack M. Behind} - 18.3 \times \text{Size SU} \]

The factor ‘stacking method behind’ can be excluded as discussed above and the factor ‘size of the SU’ has to be removed as well, as this information can not be obtained for all articles from the Metro Data Warehouse (MDW). Therefore the time factor for a small versus a big SU should be included in the fixed time of 20.4. The fixed factor will be 20.4 for a big SU and 2.1 for a small SU. In the sample were 19 big SUs included and 16 small SUs, thus the weighted average fixed time will be 12.03 seconds. This fixed time will be used regardless if the SU is big or small. The new regression equation, which will be used in the HESP Tool, is:

\[ \text{Fill time without tray per 2P} = 12.03 + 5.7 \times \#\text{SUs/2P} \]

- The value of the driver ‘reliability of opening’ will be registered in the HESP Tool, as the relation is expected to be important. Especially for the opening methods ‘strip’ and ‘perforation’. Unfortunately, no additional time can be related to this driver as the relation has not been statistically proven in chapter 5. But when it is notated it can be assumed that the time for opening will be above average and the issue can be included in the negotiations with the supplier.

After development of the Tool, the Tool is tested by the researcher. Several values of the 2P drivers are imported in the HESP Tool and the returned savings indicated by HESP Tool are compared to the values in the quantified Easy Handling Matrix. It was concluded that all formulas are correctly entered in the Tool. Besides, the future user of the HESP Tool, the supply chain specialist, has also practiced with the tool and that worked well as well.

Besides, the Tool is developed in such a way, that the Tool can easily be updated. This will be necessary as it is very likely that the frequencies, with which the activities are carried out, or the handling times will change in the future.

6.2 Use of the HESP Tool

In the ‘input’ sheet (figure 21, on the next page) Metro can fill in the 2P drivers and additional information. With this input sheet, the data is entered per article. If several articles, with the same values of the 2P drivers, have to be added, this can be done directly in the ‘yellow’ columns of the ‘output’ sheet (figure 22 on the next page).

The ‘grey’ columns of the ‘output’ sheet are filled in by Ms Excel. The article number is linked to Ms Excel. The article number is linked to the data in the MDW system and returns the article description, the supplier number, supplier name, the turnover in SUs a year and the number of SUs in a 2P.
When all 2P drivers are notated in the HESP Tool, the tool will compute the potential savings per 2P for each process. This is presented in the columns with the ‘red’ font (figure 23).

The sum of the computed savings per activity per 2P for each article is transformed in the total potential saving per SU for a certain article. This as the turnover is registered in SUs per year. The savings per SU will be multiplied with the turnover of the SU in order to compute the total potential savings per article per year.
In a separate sheet ‘potential savings per supplier’ the savings are summarised per supplier in such a way that Metro can investigate what the potential savings are per supplier. In this way a priority setting can be made for the negotiations with the various suppliers.

6.3 Generalisation of the HESP Tool

The HESP Tool is developed for the DF assortment, as the focus in this master thesis preparation was on the DF assortment. But that does not mean that the HESP Tool is only applicable to the DF assortment. With some small changes the tool can also be used for the non-food assortment, as the framework will remain the same. The main adjustments that should be made are changed frequencies with which the handling activities are carried out or the handling times. Other changes such as new handling activity drivers or new handling activities can also be incorporated in the model. Thus the framework of the HESP Tool is good starting point for each handling process of which the handling time has to be computed.
7 Application of the HESP Tool

In this chapter the HESP Tool will be applied on a part of the DF assortment. This will result in a potential reduction of the handling cost that can be achieved for that part of the DF assortment if SRRP is implemented. Furthermore, the efficiency gains as proposed by van Zelst et al. (2006) will be compared to the efficiency gains as computed with the HESP Tool.

7.1 Practical application of the HESP Tool on the DF assortment

In order to verify the HESP Tool on a part of the DF assortment, the values of the 2P drivers need to be known for that part of the DF assortment. As MDW contains no data about the 2P drivers, this input data had to be gathered in another way.

The first and most ideal option was to determine the values of the 2P drivers in the backroom of the retail store. Because, there the products arrive in a ‘closed’ 2P and the opening method can be clearly seen and be tested on reliability of opening (this is impossible if the products are already shelved in the store). The values of the drivers could be determined by the employees as they have to open the 2P anyway, but the question remains if this would be reliable as the backroom is a hectic environment and the scoring of the 2P driver is a time consuming job for the employees. Apart from this, it is questionable if the employees will interpret the values in the same manner as they should be interpreted. This is especially an important drawback if many different employees will score the assortment.

The risks for unreliable or missing data could not be permitted, regarding the time line of this master thesis project. Therefore, it was decided, together with the supply chain specialist of Metro, that the scoring of the 2P drivers will be done by the researcher and this supply chain specialist. In order to avoid the hectic backroom of the retail store, it is chosen to score the 2P in a warehouse of Metro.

A disadvantage of scoring the 2P in the warehouse is that the 2P can not be opened, thus the drivers 1.3 (reliability of opening), 1.5 (stability of the tray) and 1.6 (visibility of the SU within the tray) can not be measured. But it should be kept in mind that those drivers are less important than for example the drivers 1.2 (opening method) and 1.4 (availability of a tray) regarding the time differences of those values and the frequencies with which they are executed.

Together with the supply chain specialist of Metro all articles from one warehouse are scored on the 2P drivers (excluding the drivers 1.3, 1.5 and 1.6, as discussed above). An advantage of choosing this warehouse was the “easy access” to the warehouse due to the fact that the supply chain specialist is responsible for this warehouse. As a result, the total number of articles scored is 536 cosmetic articles and 612 non-perishables.

7.1.1 Potential reduction in handling cost for the DF assortment

The scorings data for the 1148 articles are put in the HESP Tool and the potential reduction in handling cost for each article is computed (figure 24). The total potential reduction in handling cost per year for the 536 cosmetic articles is €39,826 and is €29,936 for the 612 non-perishable articles.

<table>
<thead>
<tr>
<th>Type of articles</th>
<th>Measurement results</th>
<th>DF Assortment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Articles (€/year)</td>
<td>Savings (€/SU)</td>
</tr>
<tr>
<td>Non-perishables</td>
<td>621 e29,936</td>
<td>20,07</td>
</tr>
<tr>
<td>Cosmetics</td>
<td>536 e39,826</td>
<td>15,83</td>
</tr>
<tr>
<td>Total</td>
<td>1146 e69,762</td>
<td>35,90</td>
</tr>
</tbody>
</table>

Figure 24: Potential reduction in handling cost for the DF assortment

(All numbers are multiplied with a certain factor due to confidentiality of the data)

The question that remains is what the potential reduction in handling cost is for the whole DF assortment. Therefore, first the average savings per SU have been computed (based on the measurements of the 1148 articles). This is €0.07 for a non-perishable article and €0.14 for a cosmetic article. Besides, the turnover, in SUs a year, for all the articles of the DF assortment is derived from MDW. The case packs and the articles of the product groups beers and soft drinks are excluded. This
as SRRP, a tray with separate SUs on the shelf, will not lead to advantages for a case pack or for beers or soft drink which are mostly stored in crates.

The savings per SU are multiplied with the turnover in SUs a year and result in the following savings; €901,945 for 10,031 non perishable articles and €65,491 for 2,535 cosmetic articles. Thus the total potential savings of SRRP for the DF assortment is €967,436. This is 7.2% of the total costs, excluding purchasing costs (appendix B).

Another interesting issue is in which part of the handling process, the most reduction in handling cost can be achieved. This is displayed in figure 25. It seems that 70% of the overall reduction in handling cost can be achieved by the processes ‘open secondary packaging’ and ‘fill new inventory’. The reduction in cost related to better identification of the 2P is also computed as this change is more easily implemented by the supplier, but that reduction is only 1.3% of the overall reduction that can be achieved in the handling cost.

![Figure 25; Reduction in handling costs for the different 2P drivers](image)

(All numbers are multiplied with a certain factor due to confidentiality of the data)

There are some factors that can influence the final reduction in handling cost. Additional reduction in the handling cost can be achieved by the following factors;

- Stability of the tray; as this factor is not included during the application of the tool, it is assumed that all trays are stable.
- Visibility of the SU; as this factor is not included during the application of the tool, it is assumed that all SUs are visible.
- Reliability of opening; the outliers (often the unreliable openings) for the opening methods ‘strip’ and ‘perforation’ are excluded from the measurements. Therefore the mean value for these opening methods as used in the HESP Tool are less high than when the outliers would be included.

There is also a very important factor that can decrease the reduction in handling cost;

- Use of the tray; if the tray is available, it does not mean that the tray is or can be used. If the tray is not used all reductions related to the availability of the tray are diminished.

During the measurements, 8 of the 41 trays where not used during the shelving. This can have several reasons: the planogram is not adapted to the size or the number of facings of the tray, the employees do not know that they have to shelf the products in the tray or they do not want to shelf the SUs in the tray when the tray is ugly or unstable or when the products in the tray are invisible.

There are also some factors which can have a negative or a positive effect on the reduction in handling cost;

- The stacking method; it is assumed that in 23% of the cases there is no old inventory on the shelf or that some of the facings are empty. In the other 77% of the cases, the stacking method ‘remove old inventory’ is used. This stacking method leads to a reduction of 2.9 seconds in the handling time if the tray is available. It is assumed that this stacking method has to be used as it is the official method and as it promotes FIFO in the best way, but during the measurements it seemed that other stacking methods are used as well. The effect of the stacking methods on the handling times is displayed in figure 26 on the next page.
Application of the HESP Tool

Figure 26; Stacking method
(The handling times are multiplied with a certain factor due to confidentiality of the data)

It can be concluded that if stacking method ‘old inventory to the side’ or ‘new inventory before or on old inventory’ is used the reduction in handling cost will be decreased. The reduction in handling cost will be increased if stacking method ‘new inventory behind old inventory’ is used, but use of this stacking method is quite rare.

- Collecting of the empty trays; it is assumed that 67% of the empty trays are collected during stacking of the new inventory or during the product availability check in the morning. This factor will have a big impact on the final reductions in the handling time as will be discussed in paragraph 7.2.

7.1.2 Reflection on the application method

The scorings data was not complete as the following three 2P drivers: 1.3 (reliability of opening), 1.5 (stability of the tray) and 1.6 (visibility of the SU within the tray) were not included. In order to include this data the scoring of the 2P should take place in the backroom of the retail store, but it should be kept in mind that it is a very time consuming method. Another less time consuming option is to hold regular feedback meetings with the ‘aisle responsible employees’, as they know exactly which 2P are ‘badly’ executed regarding invisibility of the SU, instabiliy of the tray and unreliable opening.

7.2 Scientific comparison

Van Zelst et al. (2006) propose the following efficiency gains for the stacking regime;

- Choose a tray or loose stacking regime for as much items as possible; an efficiency gain of 12% can be realised if changed from unit to tray and one of 42% if changed from tray to loose.
- Increase all unit/case pack sizes as large as possible.
- Increase the number of units/case packs that are stacked simultaneously.
- Training for the workers should be considered as important as the effect of the worker on the shelf replenishment shouldn’t be neglected.

Especially the first efficiency gain is analyzed in this master thesis project as with SRRP the stacking regime is changed from unit to tray. But driver 2.1 , number of SUs in a 2P, is closely related to the second and third proposed efficiency gain as it has been concluded that the handling time per SU will decrease if more SUs are included in 2P for the activities that are carried out on 2P level. For the same reason will the handling time per 2P decrease, if more 2P are included in an order (line) for the activities that are carried out on order (line) level.

The results regarding the first proposed efficiency gain, stacking regime ‘unit’ versus stacking regime ‘tray’ are displayed in figure 27 on the next page. Stacking regime ‘unit’ implies that the SUs are shelved without a tray and stacking regime ‘tray’ implies that the SUs are shelved with a tray.

The frequency of 25% for the activity ‘remove and fill old inventory’ is derived in the following way; in 77% of the cases this method has been applied (in the other cases there is an empty shelf or there are empty facings) and there is assumed that an order line consists on average out of three 2P.
Application of the HESP Tool

A import frequency, which determines the efficiency gain, of the use of a tray, for a large part, is the frequency with which the activity ‘removing of empty trays’ can be incorporated in the regular process, i.e. during filling of the new inventory or during the product availability check in the morning. In this master thesis project it is assumed that 67% of the empty trays is removed during the regular activities and than it implies no additional time. In that case an efficiency gain of 45% is realized. If this frequency is raised to the optimum, 100%, the efficiency gain will be 67%. But if this frequency is lowered to for example 33% or 0%, the efficiency gain will decrease to respectively 22% and 0%. Thus the efficiency gain that is derived by stacking with a tray, versus without a tray, is for a large part determined by the frequency that the activity ‘removing of empty trays’ can be incorporated in the regular process.

The difference in efficiency gain between this research and the research of Van Zelst et al. (2006) is quite big, 12% versus 45%. This can be due to (one of) the following reasons;

- The frequencies, with which the empty trays are removed in the regular process, are smaller in the research of Van Zelst et al.
- Less case packs are stacked simultaneously in the research of Van Zelst et al. This leads to a smaller efficiency gain for the activity ‘remove and fill old inventory’.
- Van Zelst et al. computed the efficiency over the total stacking time, while in this research the times for travelling in the aisle, opening of the 2P and searching for product location are not incorporated during the computation of the efficiency gain. These three activities determine 34% of the total stacking time in the research of Van Zelst et al. If the efficiency gain in this research would be computed over the current time as depicted in figure 27 plus 34%, the efficiency gain will decrease from 45% to 30%.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Unit</th>
<th>Tray (I)</th>
<th>Tray (II)</th>
<th>Tray (III)</th>
<th>Tray (IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill new inventory</td>
<td>58.7</td>
<td>100%</td>
<td>14.3</td>
<td>100%</td>
<td>14.3</td>
</tr>
<tr>
<td>Remove and fill ‘old inventory’</td>
<td>78.8</td>
<td>25%</td>
<td>46.9</td>
<td>25%</td>
<td>46.9</td>
</tr>
<tr>
<td>Removing of empty trays</td>
<td>0.0</td>
<td>52.3</td>
<td>33%</td>
<td>0%</td>
<td>52.3</td>
</tr>
<tr>
<td>Total time</td>
<td>78.4</td>
<td>43.3</td>
<td>26.0</td>
<td>61.1</td>
<td>78.3</td>
</tr>
</tbody>
</table>

**Efficiency gain**

45% 67% 22% 0%

Figure 27: Efficiency gain if changed from unit to tray
(The handling times are multiplied with a certain factor due to confidentiality of the data)
8 Implementation issues

The efficiency gains which can be realised with SRRP are almost 1 million euro. But there are some critical internal and external success factors that have to be fulfilled for a successful implementation of SRRP. Besides, the big question remains; why is SRRP not already widely implemented?

8.1 Internal success factors

The following adjustments should take place in the internal organization in order to realize the efficiency gains of SRRP;

Spaceman
Spaceman, the system that develops the planograms, should adjust the planograms of the retail stores to the dimensions and number of facings of the trays. Otherwise the tray does not fit on the shelves and can therefore not be used.

At the moment it occurs frequently that the number of facings in spaceman is 3 while the tray has 4 facings, which means that the tray can not be used. The other way around is also possible; the tray has 3 facings and the number of facings in spaceman is 4. This means that one facing has to be shelved separately and that results in a time consuming stacking process. Besides the loss of time, this solution does not look appealing to the customer.

It is also possible that spaceman does not include the space for the tray itself, which may result in lack of space on the shelf when the planogram, made by spaceman, is followed. Another problem is that spaceman in some cases prescribes the use of shelf presentation materials, such as dividers or racks, which make the use of a tray often impossible.

Purchasing
The purchasing department should be made aware of the importance of SRRP because of their intense contact with the supplier. Currently, this department focuses mainly on price and quantity agreements, as that are the main issues the department is responsible for. But the department should also include the quality of the 2P in the negotiations with the suppliers. Therefore this aspect should be made part of their responsibilities. In order to stimulate the purchasing department they should be made aware of the advantages of SRRP.

Communication with the shelf fillers
Communication is an important issue regarding the implementation of SRRP; especially the small practical issues are critical for a successful implementation of SRRP. Therefore the feedback from the shelf fillers in the retail store is very important. This was also mentioned with respect to the issues of stability of the tray, visibility of the SU and opening reliability. Other issues are for example the issues related to spaceman, as discussed above. Further, agreements should be made with all shelf fillers about the following issues;

- If it is possible to present the products in a tray, they should be presented in a tray. If this is not possible according to a shelf filler, this should be reported to the ‘aisle responsible’ with a valid reason. The ‘aisle responsible’ will stay in regular contact with one of the supply chain specialists, so that the problem can be solved.
- All employees should handle the invisibility of a SU in the same way; the SUs should be turned if it is not faced correctly and a part of the tray should be removed if the tray limits the visibility of the SUs. The problem should again be reported to the ‘aisle responsible’.
- Empty trays should be removed on time in order to avoid a mess in the store and this should be incorporated in the regular process if possible.
- All shelf fillers should use the stacking method ‘remove and fill old inventory’, as this is the official stacking method, which promotes FIFO in the best way. Currently, the shelf fillers determine the stacking method themselves and this can lead to out dated articles. Besides, another stacking method can lead to a reduction of the benefits of SRRP as discussed in paragraph 7.1.
- Empty cardboard boxes should not be flattened by the employees as this is a time consuming handling. This can easily be done by the press container, which is available in every store.
8.2 **External success factors**

The advantages of SRRP seem to be big and the required internal success factors are achievable, thus the question arises “why is SRRP still not widely introduced?” Three plausible reasons are:

**Cost structure in the supply chain**

The main advantages of SRRP are gained in the retail stores, as discussed in this master thesis report. The warehouse will only gain the advantage of better identification, which is small compared to the total advantage that is gained in the retail stores. The supplier who produces the products and the associated 2P is responsible for the costs of the 2P. The advantage of the supplier can be higher turnover of the products as the products are better promoted when displayed in a tray. But it is questionable if this counterbalances the extra costs related to producing products in SRRP. This as the 2P with a tray may require another packaging machine than a ‘normal’ cardboard box and those packaging machines are very expensive. Changes such as better identification of the 2P are more easily and cheaper to implement for the supplier.

**Diversity among the retailers**

During the ECR meetings it seemed that a supplier prefers one type of 2P for all its customers, but in reality those customers are all different from each other and have large variety in their requirements regarding the 2P. The differences are mainly caused by two factors;

- **Image:** presenting products in a tray is often associated with a discount store and not all retailers want to be associated with a discount store. As Metro promotes itself as a wholesaler this is not a problem, but an advantage. This may be different for other retailers, such as Ahold, the market leader of the food market in the Netherlands.
- **Assortment and rotation speed:** if the tray can be used depends on the shelf space. E.g. the number of products per metre is 14 in England, while 35 in the Netherlands. Metro is an exception to this rule as it has more shelf space than a regular supermarket. This problem can be solved by adapting the size of the tray to the requirements from the retailer with the fewest shelf space.

**Priority setting of the retailers**

In order to save money in the stacking process, discount stores present their products already for years within boxes in the store. However, the concept of SRRP, an attractive tray, is a relatively new concept within Europe. As the effects, costs and benefits of SRRP are relatively unknown, the topic does not have much priority among the retailers. This is discovered during the meetings with ECR Netherlands. Next to this, the purchasing department, as discussed in the previous paragraph, has all the contacts with the supplier and spends no attention to SRRP as they are solely responsible for the prices and quantities. Especially due to the fact that the competition in the retail environment is high and the margins are decreasing over time.

The awareness of SRRP within the supply chain department of Metro is enlarged due to their participation in the SRRP project of ECR. It is also the goal of ECR to create awareness of the benefits of SRRP among the various suppliers and retailers.
9 Conclusions and recommendations

In this chapter the final conclusions and recommendations regarding SRRP and the effect on the handling cost will be discussed.

9.1 Conclusions

The conclusions are fourfold and will be discussed in this paragraph.

Most important handling activities influenced by secondary packaging

From all the handling activities that are influenced by 2P, the activities ‘open secondary packaging’ and ‘fill new inventory’ are the most important ones. These activities are executed for each 2P that arrives in the retail store and determine together 70% of the reduction that can be achieved for the handling cost.

Ideal type of secondary packaging

The most ideal type of 2P is a tray without a hood, at least when it is accomplished correctly. This opening method is the best as the time for opening of the 2P is zero seconds. Besides, the 2P contains a tray and filling the new inventory with a tray is faster than filling it without a tray. Furthermore, this type of 2P consists of solely cardboard, which is faster to dispose of than a 2P that contains plastic.

The handling times for all types of 2P are displayed in figure 28 on the next page. For each opening method, three types are distinguished; ‘tray ‘good’ quality’, tray ‘bad’ quality and tray not used.

A very important conclusion regarding the 2P with a tray is that the advantage of a tray is diminished if the tray is from a ‘bad’ quality or when it is not or can not be used. A ‘bad’ accomplished tray means that the tray is unstable and that the products in the tray are invisible, due to wrong orientation of the products or due to the fact that the tray is too high in the front.

Regarding the opening method it can be concluded that the opening methods ‘strip’ and ‘perforation’ are more time consuming than the other opening methods. This is as these opening times are heavily depending on the quality of the strip or perforation. This quality varies a lot and results in extremely long opening times. It should be kept in mind that the average values, as displayed in figure 28, are less high than the average values when also the outliers are included; 41.2 instead of 56.2 and 56.6 instead of 65.9.

Ideal type of product

The most ideal type of product for SRRP is a product with a high sales volume; “products with a high sales volume require much handling time as those products have to be replenished more often than other products” (ECR Europe, 2007). Furthermore, small and light products are ideal regarding SRRP for the following reasons;

- It is easier to develop a stable tray for small and light SUs, than it is for big and heavy SUs.
- There fit more SUs in a 2P, when the SUs are small and light. And the more SUs in a 2P, the higher the efficiency gain is for the activities ‘open secondary packaging’, ‘remove and fill old inventory’, ‘fill new inventory’, ‘disposal of waste’ and ‘removing of empty trays’.
- Small and light SUs are often unstable and will therefore especially benefit from shelving in a tray, as the tray offers stability to the SUs.
- Small and light SUs are more difficult to grab, especially when shelved in the back of the shelf. The tray makes it easier to grab those products.

Potential reduction in handling cost

SRRP can lead to a significant reduction in the handling cost at the retailer. The yearly reduction in handling cost that can be achieved at the DF department of Metro is € 967,436. This reduction in handling cost will be achieved if all the products of the DF assortment will be delivered in a ‘good’ quality tray without a hood. 70% of the reduction is achieved by better opening methods of the 2P and the availability of a tray during shelving of the products.
### Conclusions and recommendations

<table>
<thead>
<tr>
<th>Type of 2P</th>
<th>Handling time per type of 2P</th>
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<tbody>
<tr>
<td>Tray 'good' quality</td>
<td></td>
</tr>
<tr>
<td>Hood 'good' quality</td>
<td></td>
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<tr>
<td>F-Hood 'good' quality</td>
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<tr>
<td>Tray 'bad' quality</td>
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<tr>
<td>Tray - not used</td>
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<tr>
<td>Perforation 'good' quality</td>
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<tr>
<td>Hood 'bad' quality</td>
<td></td>
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<tr>
<td>Tray with shrink 'good' quality</td>
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<tr>
<td>Hood - Tray not used</td>
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<tr>
<td>Glue</td>
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<tr>
<td>F-Hood 'bad' quality</td>
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<tr>
<td>F-Hood - Tray not used</td>
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<tr>
<td>Strip 'good' quality</td>
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<td>Tape</td>
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<td>Perforation 'bad' quality</td>
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<td>Perforation - Tray not used</td>
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<td>Tray with shrink 'bad' quality</td>
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<td>Shrink</td>
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<td>Tray with shrink - not used</td>
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<tr>
<td>Strip 'bad' quality</td>
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<td>Strip - Tray not used</td>
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</table>

**Figure 28:** Handling times for the different types of secondary packaging
Two factors are crucial in order to achieve this reduction in handling cost;

- The use of the tray; if a 2P has a tray, it should always be used as the advantages of SRRP will otherwise be negligible.
- Collecting of the empty trays; this factor has a very important influence on the efficiency gain that will be derived by using of a tray. The benefits of shelving with a tray will be negligible if the collecting of the empty trays can not be incorporated in the regular handling process, e.g. during filling of the new inventory or the product availability check in the morning.

Besides reduced handling cost, some other benefits are expected as well;

- Reduced cost for presentation materials, such as dividers and racks. These presentation materials will become unnecessary if the products are shelved on a tray.
- Higher sales volume, due to marketing opportunities of the tray.
- Enhanced customer satisfaction, as SRRP supports easy shopping.

9.2 Recommendations

Most recommendations concern a successful implementation of SRRP, but other recommendations in order to improve the handling efficiency in general are given as well.

9.2.1 Successful implementation of SRRP

Several recommendations regarding a successful introduction of SRRP are given in this subparagraph.

**Apply HESP Tool on fast movers**

It is recommended that the supply chain specialists of Metro will start with scoring the articles, which have the highest turnover on a yearly base. These articles are already selected by the researcher, based on the 20/80 rule, and linked to the HESP Tool.

Furthermore, it is recommended that the 2Ps are scored in the retail store, as in this way issues such as ‘reliability of opening’, ‘stability of the tray’ and ‘visibility of the SU’ can also be included. Another option is that this information is derived from the ‘aisle responsibles’.

In a later stadium the other products of the DF assortment and even the non-food assortment should be scored and analyzed with the HESP Tool.

**Negotiate with suppliers**

After scoring of the articles, the HESP Tool will indicate the potential savings for each supplier. The tool will also indicate which changes in the 2P will lead to the highest reduction in handling cost. Based on this information from the HESP Tool, the supply chain specialists can start the negotiation with the supplier. Key points in this negotiation will be issues as: other opening methods and the availability of a tray, because the largest part of the reduction in handling cost can be achieved by these issues. The objections from the supplier will be that these kinds of changes in the 2P will require adaptations in the production process, which will go along with additional cost. To overcome this issue, Metro can offer compensation to the supplier for the additional costs. As the savings due to SRRP are known, the height of the compensation can be determined. Another, easier issue that can be discussed with the supplier is the identification of the 2P. A change in the production process that leads to easier to identify 2P is quite easy to implement for the supplier. But the reduction that can be achieved in the handling cost at the retailer is only 1.3% of the total potential reduction in a year.

Next to that, attention should be paid to the number of SUs in a 2P. More SUs in a 2P will lead to higher efficiency gains for the following handling activities; ‘open secondary packaging’, ‘remove and fill old inventory’, ‘fill new inventory’, ‘disposal of waste’ and ‘removing of empty trays’.
Conclusions and recommendations

Collaborate with other retailers
In order to convince the suppliers for delivery in SRRP, Metro should collaborate with the other retailers. This as the market position of Metro in the Dutch food market is small, although varying from product group to product group and from supplier to supplier. But it is more likely that the suppliers will adapt the 2P, if other retailers require SRRP as well.
As described by Koehorst et al (1999) both organizational and technical coordination should be achieved. Technical coordination means that all retailers should be able to use SRRP. Organizational coordination implies that Metro should collaborate with the other players in the supply network. Participation in the ECR project was a good start, but this collaboration should be maintained. Agreement among the retailers should be achieved about the most optimal type of SRRP. An important aspect in this agreement is the number of the SUs in a tray and the number of facings of the tray. When a common implementation approach towards SRRP is derived, the retailers should negotiate with the suppliers collectively.

Adjust internal organization
In order to achieve the reduction in handling costs, awareness of SRRP should be created in the internal organization.
- Spaceman should adjust the planograms to the dimensions and number of facings of the tray.
- The purchasing department should incorporate the design and quality of the 2P in the negotiations with the suppliers, as they have contact with the suppliers on a regular base. In order to motivate the department, SRRP can be incorporated in the available suppliers scoring tool. At the moment no issues regarding 2P are included in this tool.
- The shelf fillers should use SRRP if possible and they should use it in the right way. Training of the shelf fillers should therefore be regarded as very important.

The promotion materials from ECR, such as the movie and brochure, are a good starting point for creating the awareness of the importance of SRRP.

Execute store audits
In order to maximize the reduction in handling costs, some issues should be checked by the supply chain specialist on a regular base in the retail store;
- Are the trays used by the shelf fillers if possible?
- Are the empty trays removed during the regular process if possible? The ideal situation is that all empty trays are removed during stacking of the new inventory or during the product availability in the morning. Besides, the employee should collect the empty trays on his way, whenever he goes to the backroom.
- Is the new inventory stacked according to the stacking method ‘remove old inventory’? This stacking method promotes FIFO in the best way and the reduction in handling cost can be diminished if other stacking methods are used.

During the audits the supply chain specialist should ask for feedback from the shelf fillers and ‘aisle responsibilities’ regarding the implementation of SRRP. Practical implementation issues that obstruct the use of SRRP should be discussed, for example; problems with spaceman, instability of trays, unreliable openings or invisible SUs.

Maintain and further develop the HESP Tool
The supply chain specialists will become the owners of the HESP Tool and should regularly update the HESP Tool. For example if the frequencies, with which the handling activities are carried out, change.
Besides, small adjustments should be made in the HESP Tool, so that it can also be used for the non-food assortment.
9.2.2 Other possible reductions of the handling time in the retail store

Other factors that influence the handling time, but are out of scope of this master thesis project are:

- Reduction of the number of mixed pallets. Most pallets contain different kinds of products which belong to different aisles and that leads to long transportation times.
- St. Vincent et al. (2005) states that incompatibility between arriving products and shelf space will often lead to additional handling activities. This is exactly what happens at Metro; a lot of time is lost with stacking of ‘left over’s’ on the high racks. Inconvenience and lost time increases due to: picking up the fork lift truck from the backroom, closing of the aisle for customers, taking down of the pallet, stacking of the ‘left over’s’ on the pallet, putting the pallet back on the high rack, opening the aisle again and bringing back of the fork lift truck to the backroom. Furthermore, a lot of additional time is spent as the products have to be searched on the high racks and stacked on the shelves. Therefore it should be investigated if it is possible to change the order method in such a way that less products need to be stored on the high racks.
Reflection

Reflection on the research question
The research question was twofold, on the one hand Metro wanted to know which products are suitable for delivery in SRRP and on the other hand they wanted to know the potential reduction in handling cost for the DF assortment that can be achieved with SRRP. The first question is fulfilled as the ideal type of 2P for SRRP is described, even as the ideal type of product for this type of 2P. Further, the HESP Tool is developed, which computes the potential savings for each article compared to the ideal type of 2P. The second question is fulfilled as well, as the potential reduction in handling cost for the DF assortment at the Metro retail stores is computed. Thus it can be concluded that the research question is fulfilled.

Contribution to scientific research
The contribution to scientific research was threefold. First, defined activities within the retail stores were required. This is fulfilled as the handling activities are described based on literature. Secondly, more insight in the effects of 2P on the handling time was required. This is also fulfilled as the relations between 2P drivers and the handling process are determined and quantified. Third, the master thesis project should function as a case study in the research area of SRRP and the efficiency gains, as proposed by Van Zelst et al. (2006), regarding shelving in a tray instead of shelving separate units should be verified. This last contribution is also completed as the efficiency gains of SRRP for Metro are computed and are compared to the efficiency gains as proposed by Van Zelst et al. (2006).

Strengths and weaknesses of the research
It would have been better if more measurements could have been carried out, in order to quantify the relations between the handling activity drivers and the handling process. The amount of measurements was too low for executing some of the statistical analyses, e.g. there was no test sample available for testing of the regression equations.
Another weakness of the research is that only the handling costs at the retailer are investigated. Other benefits and costs of SRRP for the retailer and the benefits and costs for the other members in the supply chain are not investigated. This was not done in order to achieve enough depth in the research.
A strong point of the research is that the developed HESP Tool can be used for the DF assortment, but that it can also be applied for the non-food assortment, as the framework will remain the same.
Another strength of the research is that the supply chain specialist, who will take over the SRRP project, has already been involved in the master thesis project in May. This improves the transfer of the SRRP project.

Implementation issues
SRRP is a relatively new concept within Metro and in order to succeed the implementation of SRRP, awareness of the potential benefits of SRRP should be obtained in the whole organization. The purchasing department should incorporate SRRP in the negotiations with the supplier and spaceman should adjust the planograms to SRRP. Moreover, Metro should collaborate with other retailers in order to achieve a common implementation approach towards SRRP. The collaboration between the retailers and a common implementation approach will make the position of the retailers, regarding the negotiations with the supplier, stronger. These are the main implementation issues regarding a successful introduction of SRRP and if implemented well, SRRP can lead to a huge reduction in the handling cost for the retailer.
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