

# **Ergonomic effects of manual parcel handling**

A study of the physical, cognitive and organizational ergonomic effects of manual parcel handling

Master's thesis in Production Engineering

MOA EKDAL



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**CHALMERS**  
UNIVERSITY OF TECHNOLOGY

Division of design and human factors  
*Department of Industrial and Material science*  
CHALMERS UNIVERSITY OF TECHNOLOGY  
Gothenburg, Sweden 2020

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## Abstract

The purpose of this master thesis has been to evaluate the physical, cognitive, and organizational ergonomic effects of parcels that cannot be handled in the normal parcel flow at DB Schenker, called Ugly-parcels. Further the purpose of this master thesis is to suggest improvement suggestions to reduce or remove these effects. To estimate the effects a current state analysis was performed, where terminal visits at six terminals were conducted. At the terminals, KIM I and III evaluation were performed and at least three interviews. During the visits, a statistic study was made to gain information about which type of parcels that could not be handled on the parcel sorting conveyor. It was found that the Ugly-parcels were handled at a straight conveyor belt at the larger terminals, and by the side of the parcel sorter at the smaller terminals. The number of parcels that couldn't be handled in the normal flow was, on average 3,6% of the total volume. The risk rates for physical injury at the largest terminals were high for all three larger terminals and at an acceptable level for the smaller terminals.

It was found that both cognitive and organizational ergonomics could be improved for Ugly-parcel handling. This was revealed by the interviews performed and observations made during the visits. To suggest improvements for physical ergonomics, evaluations have been made for combinations of several enhancements. Based on the evaluations, the thesis suggests that a combination of four improvements should be introduced. Some methods to ensure that all parcels that can be handled at the parcel sorting conveyor are proposed there.

Thin and round parcels should be handled at the parcel sorting conveyor by using a fixture. A cage lifter should be used at the straight conveyor belt. Lastly, especially ungainly parcels, which are; long, big and unstable should be handled as groupage. With these changes, the risk rate in KIM I and III can be lowered to an acceptable level for five of the six terminals. The adequate level has been set to a risk rate of two to maximum four. To support the cognitive ergonomics, the information on what to do with a parcel when the conveyor stops should be made clearer. The noise level should be decreased. The need to memorize the sorting by heart should be minimized. Standardization of work tasks and work introductions should be used. Lastly, the risk of sorting errors should be decreased. It is suggested that the process to leave improvement suggestions should be made clearer to support the organizational ergonomics. The performance demands should be matched to the available resources. The physical environment should be improved. The learning process for new employees should be clarified. It is recommended that the normal parcel handling also should be evaluated from an ergonomic perspective.

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Keywords: parcel handling, physical ergonomics, cognitive ergonomics, organizational ergonomics



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Moa Ekdal, Gothenburg, May 2020





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# Glossary

The list below contains the terms used in this master thesis. The Swedish translation is also included for some glossary's in order to simplify for the reader.

**Groupage "Gods"** All items that don't fit within the product terms for parcels. These items are usually handled on a pallet.

**Parcel "Paket"** All items that fit within the product terms for parcels. E.g. under 30 kilograms and length under 2 m.

**The network "Nätverket"** In order to transport items from A to B DB Schenker has built up a network of several terminals all over the country. This is referred to as the network.

**Departing terminal "Avgående terminal"** Also called T1 or Terminal 1. The first terminal where the parcels arrive after they have collected by a truck. At the departing terminal the parcels are sorted for the first time.

**Arriving terminal "Ankommande terminal"** Also called T2 or Terminal 2. The second terminal where the parcels arrive after having been transported from the departing terminal. At the arriving terminal the parcels are sorted and then distributed to the receiver.

**Sorting concepts "Sorteringsbegrepp"** A sorting concept is a street or destination to which the parcel is sorted.

**Cargo-scanner** A scanner that weighs and measures the parcel while it scans the barcode.

**Inline** The physical place where the parcels are placed on the parcel sorting conveyor. Each parcel sorter conveyor consist of one or more inline.

**Outline** The physical place where the parcels are taken off the parcel sorting conveyor and placed in parcel-cages. Each parcel sorter conveyor consist of one or more outline.

**Ugly-parcel "Ful-paket"** Parcels that cannot be handled at the parcel sorting conveyor.

**Straight conveyor belt *Rakbana*** A parcel sorting conveyor that only consists of a straight conveyor, hence only one inline and one outline.

**HDT "*Handdator*"** Short for hand held computer. Used to scan parcels.

**Departuring terminal "*Avgående terminal*"** The terminal to where the parcels first arrive after they been pick up at the sender.

**Arriving terminal "*Ankommande terminal*"** The terminal to where the parcels arrive for the second sorting after they been transported from the departing terminal. From the arriving terminal are the parcels sent out to the receiver.

**Parcel-cages "*Paketbur*"** The cages which all parcels are placed in order to make the transport of the parcels easier.

**Parcel sorting conveyor "*Paketbana/Soteringsanläggning*"** The equipment, manly conveyors that sorts the parcels on to different outlines depending on the destination of the parcel.

**Telescopic conveyor "*Teleskopiskt transportband*"** A conveyor whose length can be adjusted. It is also possible to move the conveyor along rails in the ground.

**Work leader "*Arbetsledare*"** The first line manager at the terminals.

**Terminal worker "*Terminalarbetare*"** The workers, also called operators, that works on the first line in the terminal.

**Terminal manager "*Terminalchef*"** The manager with the main responsibility for the operative work at the terminal.

**Parcel manager "*Paketchef*"** Department manager for the parcel handling.

**EDI** Electronic identifications for the parcels. Contains all necessary information about the parcel, such as delivery address and invoice information.

**Temporary employees "*Inhyrd personal*"** The personnel that are hired or brought in from DB Schenkers own personnel register when the ordinary personnel is not enough to manage the volumes.

**Long/ Heavy groupage department "*Markplan*"** The department where groupage is handled that are too big to handle as ordinary groupage.

**Customer specific sorting "*Kundspecifik sortering*"** Some customers requires special sorting that deviate's from the normal handling, this is called customer specific sorting.

**Districts** "*Distrikt*" Have the economical responsibility for one or more terminals. Shares administration responsibility between the terminals in the district.

**Terminal** A building where the handling is done.

**Label** "*Etikett*" A label contains information about the sender and the receiver of a certain item. The label also contains a bar-code which is scanned in order to get information about the item.

**Bar-code** "*Streckkod*" A label can contain several bar-codes which has different information for example the postcode or the kolli-number.

**Shipping line** "*Linjeruta*" The physical place where the the groupage and parcel cages are placed before they are loaded onto a truck.

**Delivery window** "*Leveranstidsfönster*" The time from when the parcel arrives to the terminal to when they need to leave the terminal.

**Work Environment Authority** "*Arbetsmiljöverket*" The authority in Sweden that is responsible for ensuring a good work environment in all workplaces in Sweden.

**Cage-lifter** "*Burlyft*" Help equipment that makes it possible to lift and tilt a parcel-cage to different heights in order to make it easier to unload parcels from the cage.

**No-read line** If the parcels for some reason cannot be scanned by the cargo-scanner or if the cargo-scanner detects an error with the parcel will the parcel sorting conveyor return the parcel to a no-read line on the parcel sorter.

**Personnel pool** "*Personalpool*" Some of the terminals have their own personnel pool which they use to employ temporary employees instead of hiring personnel from other companies.

**Ungainly parcel** "*Otympliga paket*" Parcels where the lifting position is significantly affected by the attributes of the parcels when the parcel is lifted.



# 1

## Introduction

The following chapter will contain an introduction to this master thesis. The introduction starts with and a background, which moves on to a problem definition. In this chapter, the purpose and the limitations of the project are also presented.

### 1.1 Background

DB Schenker is a logistics company that is owned by the German company Deutsche Bahn AG since 2002. Schenker & Co. was founded in 1872 by Gottfrid Schenker and has been active in Sweden since 1921. The company has a revenue of 13 billion euros and exists at 2000 locations around the world and has more than 75800 employees. The company consists of four divisions: air, land, sea freight, and contract logistics. This master thesis was performed at the land department in Sweden, whose headquarter is in Gothenburg and handles the land freight. The land department is then divided into several sub-functions, and this master thesis was conducted at the Terminal department, which is responsible for the operative work at the terminals all over Sweden. The country is divided into six areas: south, west, east, center, Stockholm, and north. The areas consist of in total 28 terminals, see figure 1.1.

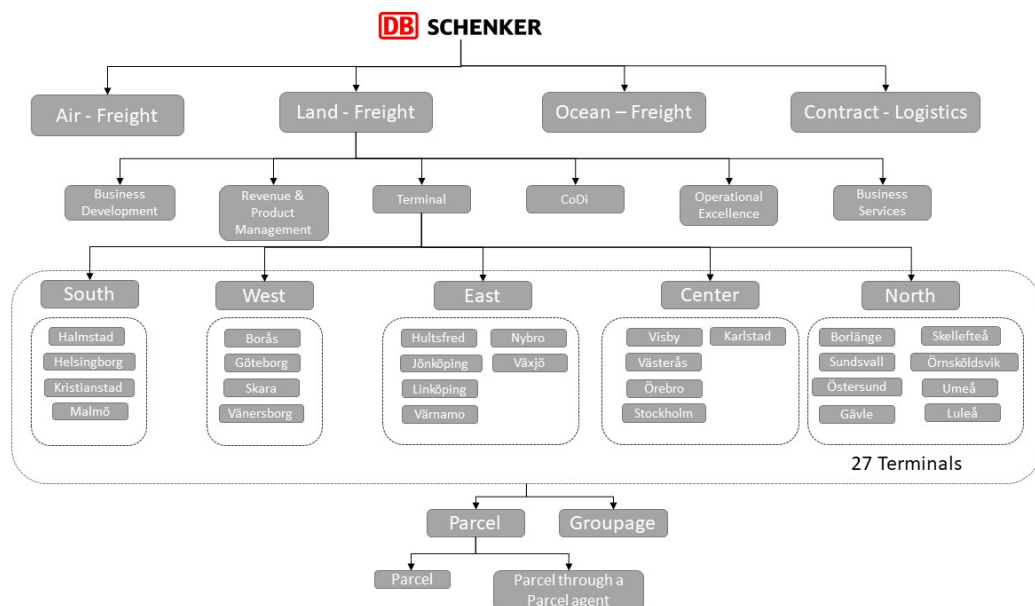


Figure 1.1: Organization at DB Schenker in Sweden

## 1. Introduction

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The areas are then divided into several districts; a district can have the responsibility for one or more terminals. The district has economical responsibility and also contains administrative services e.g., sales that not every terminal needs to have. A map over all the districts and terminals can be found in figure 1.2.



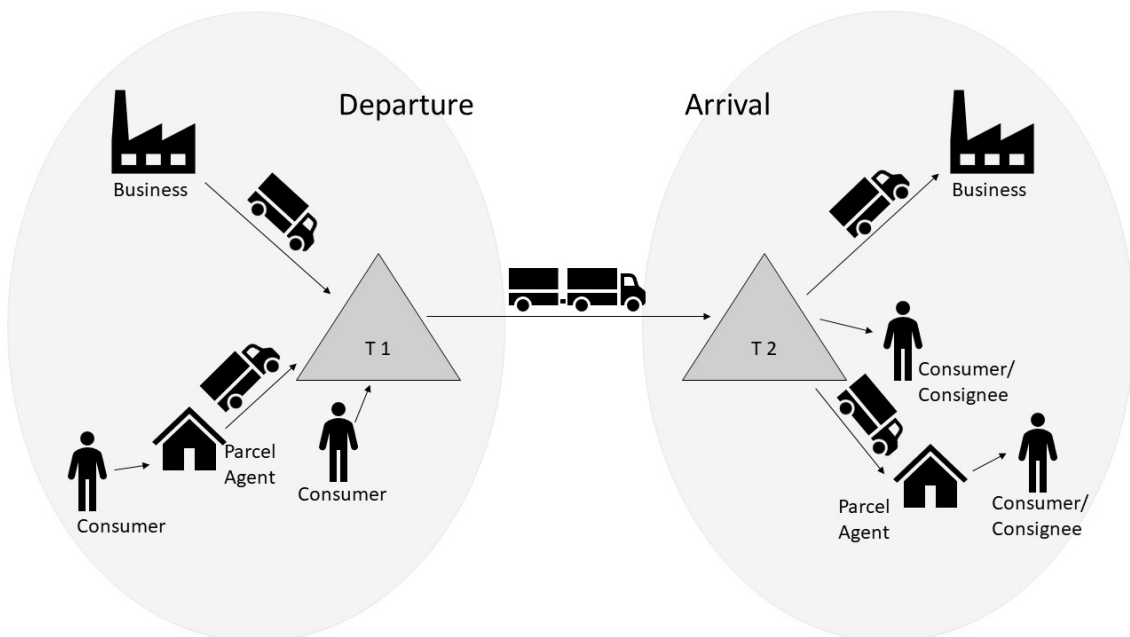
**Figure 1.2:** Maps displaying the districts and terminal network for DB Schenker in Sweden

The terminals handle many different parcels and groupage during the days. DB Schenker define parcels as the items under 30 kilograms and groupage as those over 30 kilograms. The core business for DB Schenker for many years has been the groupage handling from business to business, and parcel handling was a compliment. Over the last ten years has the parcel business developed, and in the previous five years, parcel business is as big as the groupage business. The primary growth the last years has been within business to consumer where DB Schenker deliver through parcel agents. The trend for the future is that the parcel part and delivering to consumers will grow. It is a challenge for DB Schenker since the network will be challenged with the predicted growth. This master thesis will mainly focus on the

parcel handling. Thus the rest of this background and company description will focus on the parcel handling.

The parcels can arrive at the terminals in three different ways: by a truck that has picked it up from a company, through a parcel agent, or that it is handed in by a consumer. The terminal that the parcel arrives at first is called Terminal 1, departing terminal. At terminal 1 (T1) the parcel is sorted depending on where in the country it should be sent. The parcel is then sent to the terminal closest to the delivery address, and this is called terminal 2, arriving terminal. At terminal 2 (T2) the parcel is sorted again, but now depending on where in the area it should be delivered so that sorting can be based both on postcode and street names. So, for example, if a sender wants to send a parcel from Hisings back in Gothenburg to Solna in Stockholm, the parcel is picked up and delivered to the terminal in Gothenburg, at the terminal the parcel is sorted based on that it should be delivered to Stockholm. The parcel is then transported to the terminal in Stockholm, where it is sorted to the postcode area in Solna.

The parcels can be delivered in three different ways after sorting. The parcel can be provided by a truck to the business consignee. The parcels to private consignees can be delivered either through a parcel agent or collected by the consumer at the terminal. Figure 1.3 shows the flow of a parcel from the sender to the recipient.



**Figure 1.3:** The flow of a parcel from sender to recipient for DB Schenker

All terminals are both departing and arriving terminals but at different times during the day. During the day, the terminal is from 12:00 to 21:00 a departing terminal and handles the parcels that come in from businesses and consumers in the district. During the night, the terminal is from about 21:30 to 06:00 an arriving terminal and handles the parcels that come from other areas that should be distributed in

the district. The terminal department at DB Schenker that this master thesis is performed at is responsible for the operational work inside the terminals. Therefore activities at the terminal will only be described further.

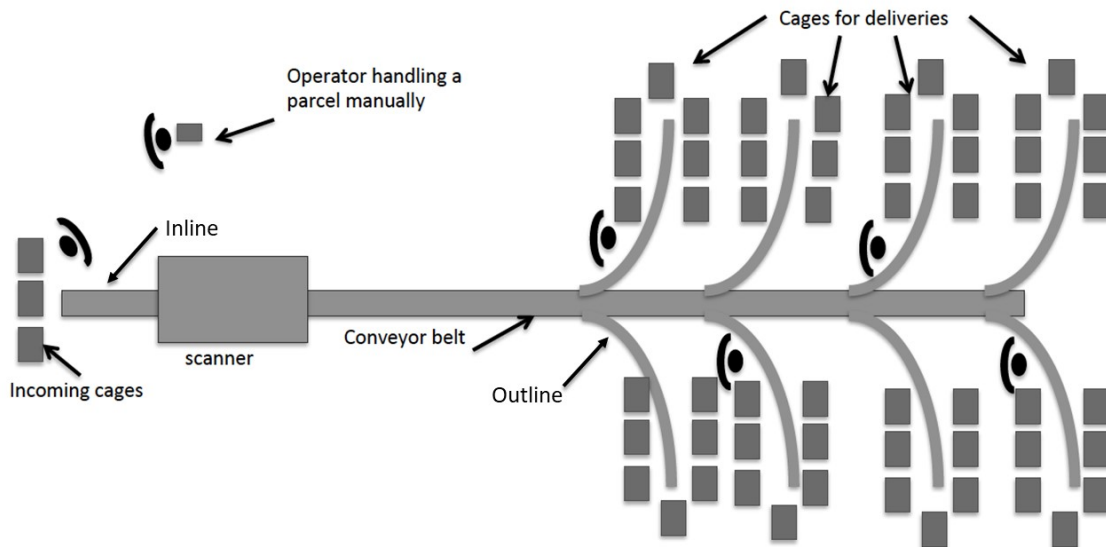
### 1.1.1 Normal handling of parcels inside the terminal

The parcels that arrive at the terminal arrive in cages, see figure 1.4, or on a pallet. The parcel cages are placed in a cage lifter, and the operator takes the parcel and places it on the conveyor belt. A cage lifter can lift and tilt the cage, so it is easier for the operator to handle the parcels at the right working height.



**Figure 1.4:** Picture of a parcel cage used at DB Schenker

The parcels go through a cargo-scanner that weighs and measures each parcel. The scanner also reads the bar-code on the parcel. Based on the postcode the parcel sorting conveyor can then sort the parcels to different outlines depending on where they should be delivered, see figure 1.5. The terminal workers at the outline take the parcel from the outline and sort it into the right cage at the outline (there can be more than one destination at each outline). The parcels at T1 are sorted into 30 different sorting concepts. A sorting concept can either be a place or a postcode area. The parcels at T2 are sorted based on more sorting concepts. The number differs depending on where the terminal is located.



**Figure 1.5:** Schematic picture of a parcel sorting conveyor used at the terminals

#### 1.1.1.1 Size and weight

The maximum length for a parcel to be handled on the conveyor belt is 140 cm and width 120 cm. If a parcel is larger, essentially small, or too heavy, it needs to be handled manually. The product terms for the products can be read in table 1.1 below. Since the product terms in the table allow for longer parcels than 140 cm, not all parcels can be handled on the sorting conveyor.

**Table 1.1:** Product terms for parcel products

Measurements, weight and volume	DB Schenker parcel	DB Schenker Parcel agent parcels
Maximum length per parcel	2,0 m	1,8 m
Maximum volume per parcel	Length + circumference max 3 m	Length + circumference max 3 m
Maximum weight per parcel	30 kg	20 kg
Maximum volume per shipment	0,36 kbm	0,25 kbm
Maximum weight per shipment	99 kg	70 kg

#### 1.1.2 Problem definition

A problem for DB Schenker is that not all parcels that arrive at the terminal can be sorted on the parcel sorting conveyor even though they are within the approved dimensions and weight. Why they can not be sorted on the parcel line can have many reasons e.g., they can be too long or have a strange shape, so they gets stuck on the conveyor; be too light so the cargo checker can not read any weight; round,

so they roll off, etc. An operator can notice these parcels that deviate from the norm before they put them on the conveyor belt, when they stop the conveyor belt, or directly when the cage arrives if there are many ugly-parcels in the cage.

### 1.1.2.1 Handling of ugly-parcels

The ugly-parcels are put to the side by the operator that spots them. These parcels are then handled and sorted manually by the operator. Most of the operators at the terminals need to take these parcels and scan them manually. After the parcel has been scanned, the operator either walks directly to the right cage at the parcel line or sorts it into cages that stand beside the sorting conveyor. These cages are then moved to the right outline, and then the terminal worker by the outline sorts the parcels into the right parcel cage.

While the operator performs this work, the ordinary tasks do not stop, so the operator might experience stress when the work builds up. The operator might also need to carry ungainly parcels that can weigh up to 30 kilograms, which causes physical stress on the body. It can also be hard for the operator to find the right parcel cage for the parcel since the worker needs to remember which postcode goes to which area. So the operator needs to know in their head which postcodes should be sorted to which sorting concept to find the right cage fast. Since this is nearly impossible to know completely, the operator will need to go and look several times for the right cage, which leads to that the operator needs to carry the parcel even longer. All these factors above create the need to improve the ergonomics for the terminal workers.

Since the ugly-parcels need to be handled and sorted manually, this sorting also takes a lot more time than the normal handling of parcels. Therefore it is also important to try to make the process more efficient.

### 1.1.2.2 Parcel market in the future

More and more products are bought online and then delivered to the consumers. Many people decide to order products that are ungainly or heavy, which makes the amount of those parcels increase at DB Schenker. Since not all parcels that are sent can be sorted on the parcel sorting conveyor, the number of products that need to be handled manually will also increase. This creates the need to improve both the ergonomics and productivity for the handling of Ugly-parcels.

## 1.1.3 Purpose

The purpose of the project is to investigate the current extra time and the ergonomic situation while handling Ugly-parcels at the terminals at DB Schenker. The purpose is further to give recommendations on how to improve these processes, both in terms of efficiency and ergonomics for operators. The goal is to suggest how to improve the process with engineering methods so that the handling of parcels can meet the new demands from consumers. In the future the goal will be to make these processes as

cost-effective as possible for the company and to improve ergonomics for operators. The research questions for this master thesis will therefore be the following:

1. Which physical, cognitive, and organizational ergonomic effects do the terminal workers at DB Schenker experience when they handle Ugly-parcels?
2. How could the effects discovered in the previous question be minimized or removed?

#### **1.1.4 Limitations**

The physical limitations for this master thesis will be to only look at the handling of parcel inside the terminals, meaning that only the activities performed from when the parcels come inside T1 to when the parcel leaves T1 and the activities from when the parcel comes inside T2 to when it leaves T2 will be studied. Only the handling at the T1 terminal, departing terminal, has been studied. Due to, the production at the arriving shift is done at night and it was not possible to visit the terminals at night. There will also be several demarcations regarding which processes inside the terminal that are going to be studied. Only the parcel handling will be studied, meaning that the groupage handling will not be a part of this master thesis. Only the handling of ugly-parcels will be studied. The normal handling of parcels will only be studied generally as a reference to Ugly-parcel handling.

Only the ergonomics and efficiency have been studied for Ugly-parcel handling. At the outset, several kinds of ergonomics will be considered: physical, cognitive, and work environmental. But depending on which information can be collected from the terminals, the master thesis might focus on only some of them in a later phase. The efficiency will also be studied broadly at the beginning and later be focused on the time the process takes and the number of resources it requires.



# 2

## Theory

In the following chapter the theory used in the study will be presented. The theory is used to support arguments, establish questions for interviews, and to find solutions used by others.

### 2.1 Physical ergonomics

Of all employed people in Sweden, 28% of them get some work-related injury from lifting heavy in manual handling (Statistikmyndigheten SCB, 2018). Therefore the physical ergonomics is interesting to study further for DB Schenker since many parts of the parcel handling involve heavy lifts, and therefore heavy manual handling.

#### 2.1.1 The musculo-skeletal system

The musculoskeletal system consists of the skeleton, muscles, and joints (Berlin & Adams, 2017). These parts function together to translate chemical energy into movement, the possibility to withstand physical loading and recovery.

According to Berlin & Adams (2017), there exist three different types of muscles that have different functions: skeletal muscles, smooth muscles, and cardiac muscles. Many of the muscles function as opposing pairs, meaning that a contraction of one muscle leads to a relaxing in another; these are called antagonists. A known example of this is the biceps and triceps. In order to keep a well-aligned and balanced body, these should have an equal strength. Otherwise, pain might occur. For example, back pain can be due to weak muscles in the stomach. Berlin and Adams (2017) stated that there exist two different types of muscle fibers, type I, and type II. Type I muscle fibers are slow-twitch fibers that are best suited for prolonged work with high duration. Type II muscle fibers are fast-twitch fibers that are best suited for fast, explosive movements.

The skeleton helps the human to stand and carry its own weight without any large impact from the muscles (Berlin & Adams, 2017). The skeleton's function according to Berlin and Adams (2017) is to protect vital organs, break down and regenerate bone, serve as a rigid structure, produce blood cells, help movement, store chemical energy, and store minerals. The body consists of many specialized bones that have different functions and purposes for the human (Berlin & Adams, 2017). Further, they can be suited for strength, flexibility, or mobility.

Joints function to link the bones in the body together (Berlin & Adams, 2017). They are further designed to allow movements. These movements can, according to Berlin and Adams (2017), be one, two, or three dimensional. The one dimensional are usually combining smaller bones, an example of a two dimensional are the knuckles, and an example of a three dimensional are the shoulders. Due to the complexity of joints, they are very sensitive to injuries caused by extreme positions in combination with physical loading. If you, for example, load a joint at a bad angle, the cartilage layer will wear out, which works to reduce the friction between the bones when they move (Berlin & Adams, 2017).

When the body is exposed to increased mechanical forces it is called that the body is placed under strain. If the body no longer can take the strain they will break, called a trauma. Further, when trauma occurs, it will be necessary that the structure gets time to heal before it can perform as normal again. The joints are very complicated, as mentioned before, and might sometimes need months or even years to heal. The bones further have a low blood flow, which leads to that they also take a longer time to heal, not as long as joints but about five to six weeks. The muscles are supported by plenty of blood flow, which helps the transportation of removing unwanted tissue and new nutrients, this means that moderate muscle injuries take a few weeks to heal (Berlin & Adams, 2017). Berlin and Adams (2017), therefore, state that the order in which you should prioritize to avoid risks for injuries are first for joints, then the skeleton and last muscles.

### **2.1.1.1 Musculo-skeletal disorders**

A worker is said to be suffering from a musculoskeletal disorder (MSD) when the workers' ability to move or take loading is affected (Berlin & Adams, 2017). The early symptoms you get from MSDs are pain, discomfort, and fatigue. It is not until later you get loss of function, limited movement range, and loss of muscle power (Berlin & Adams, 2017). It can, therefore, be hard to notice MSDs in an early stage. MSDs likely lead to sick leave if you don't treat them in time. That would lead to costs for the company. The cost associated with MSDs is among many compensation costs, rehabilitation costs, and loss of productivity and quality costs (Berlin & Adams, 2017). Therefore MSD-related injuries are a big waste problem for companies. According to Ekonomifakta (2019) 23% of all sick leaves that resulted in paid out sick pay in Sweden in 2017 were due to musculoskeletal disorders.

The causes of MSDs can be biological, lifestyle, or work-related. According to Berlin and Adams (2017) some of the biological causes of MSD are low muscular strength, low skeletal strength, age, and sex. Further, some of the lifestyle-related causes are prior load history, health, social environment, drugs, and diets. The ones that companies can affect are work-related, according to Berlin and Adams (2017). Companies should, therefore, among many factors, try to minimize the risk of forced working postures, stress, time pressure, static work, and loading weight. The process for minimizing the risk for musculoskeletal disorders is, to evaluate the economic risks and redesign the workplace concerning that result.

Some of the body parts are represented more often among MSD injuries. These are the back, the neck, the shoulders, and the hands (Berlin & Adams, 2017). The spine will, in its natural S-curve shape, not overload the discs since they only are affected by an uneven and asymmetric pressure (Berlin & Adams, 2017). Further, if the back instead is bent, the disc will be compressed with a local high pressure on its edge. It is common when you, for example, are lifting something. If you perform this daily, this might cause the gelatinous disc to rupture, a condition called herniated disc (Berlin & Adams, 2017). This condition will most likely heal by itself within one to six months, but can during the time cause much pain and numbness. Therefore it will be important to avoid rotation in the trunk and loads far away from the trunk to minimize the risk for MSD related injuries. According to Statistiskmyndigheten SCB (2018), 46% of all employed in Sweden have experienced back pain due to work.

Injuries to the neck can occur due to frequent or static bending, extreme extension, or whip-lash injuries. According to Berlin and Adams (2017) the neck is also closely connected to the shoulders, which means that if you have a problem with one of them, that can create problems with the other. Further, these injuries can be very complex and lead to long sick absence. These neck-shoulder injuries are common for work that has static and repetitive loads (Berlin & Adams, 2017).

The shoulders have a complex structure, which allows them to move in three degrees of freedom (Berlin & Adams, 2017). Further, the stability of the shoulders depends on the rotator cuff muscle, and shoulder ligaments, which are both sensitive. The shoulders are therefore vulnerable to being dislocated, inflamed, or worn out (Berlin & Adams, 2017). Also, when a problem in the shoulder starts the surrounding tissue tries to compensate, which leads to tension in that structure. This results in the static loading of the body, which can create neck-shoulder injuries (Berlin & Adams, 2017). Neck injuries can often be caused by forward flexion and arms work outside the body, arms above shoulder height, static loads, raised shoulders, and repetitive work (Berlin & Adams, 2017). According to Statistiskmyndigheten SCB (2018) 57% of all employed in Sweden have experienced pain in the neck, shoulders, or arms due to their work.

The hands have a very complex structure, which makes them sensitive to injuries (Berlin & Adams, 2017). Further, the hands are used in almost all work, which means that injuries in the hands can have severe effects for the worker. The hands should, therefore, be positioned in a relaxed position as much as possible (Berlin & Adams, 2017). According to Statistiskmyndigheten (2018) 29% of all employed in Sweden have experienced pain in the fingers, hand, or carpal due to their work.

### **2.1.2 Physical loading**

The physical loading on the human can simply be said to be affected by three factors: posture, forces, and time (Berlin & Adams, 2017). The posture is the factor for internal loading on the body, depending on which muscles in the body that are

affected and how they are used. Force is the external loading factor and represents the extra load that is added to the body, for example, a box. Last is the time factor that describes how often, how long or how frequently the body is loaded. The time factor is essential since the tissue of the human body only can take specific loads for a limited amount of time (Berlin & Adams, 2017).

The posture that the worker has when performing the work can be affected by the worker or by other factors that the worker cannot affect (Berlin & Adams, 2017). Common factors that can affect the posture are workspace, vision demands, stress, and protective clothing. Berlin and Adams (2017) s.51 define good posture as:

(...) a position where the functional structures of the body are in the best position to exert high-precision movements, as required by the work task. Indications of good posture are balance, symmetrical distribution of forces on the body parts, and skeletal (rather than muscular) loading.

When the factors of force, time, and posture are put together, they interact, which means that they can increase or decrease the effects of the total loading (Berlin & Adams, 2017). For example, lifting a light weight might not be considered as a risk, but if it is done for a long time or in a bad posture, it can be a risk. Berlin and Adams (2017) also mention other factors that affect the physical loading; these are vibrations, environmental factors, non-rigid material handling, and high-precision work.

### 2.1.3 Anthropometry

Anthropometry addresses human body measurements, and these can be a guide to ensure that you design for the majority of the population (Berlin & Adams, 2017). Further anthropometry deals with both static and dynamic measurements. Static measurements are fixed and can be, for example, the height of a human. The dynamic measurements are functional measurements; for example, the range of reach (Berlin & Adams, 2017). The dynamic measurements are harder to obtain since they depend on many different body measurements (Berlin & Adams, 2017). The anthropometry is different from human to human, and that is according to Berlin and Adams (2017) due to:

- Data management - which is not due to the human but instead variations in how the collection of human anthropometrical measures has been made.
- Intra-individual variations - This means that some measurements on a human can vary from day to day.
- Gender
- Nationality
- Age

A common rule and design principle is to design for 5th percentile women up to the 95th percentile man (Berlin & Adams, 2017). In theory, that results in that 10% of the population is excluded. However, since not all humans are in the upper 95th

percentile for all measurements, an example both for height and weight will lead to that more than 10% is excluded. Berlin and Adams (2017) state that you, therefore, need to decide design parameters from case to case.

In this study the measurements collected by Hanson et al. (2009) presented by Högskolan i Skövde (n.d.) will be used. These are summarised in table 2.1 below.

**Table 2.1:** Summary of anthropometrical measurements

<b>Hanson et al. (2009) [mm]</b>	<b>Stature</b>	<b>Shoulder height</b>
5th perc. W	1562,07	1254,77
95th perc. M	1907,21	1562,23
50th perc. W	1673,57	1358,78
50th perc. M	1791,62	1454,78
	<b>Tibial height</b>	<b>Forearm - fingertip length</b>
5th perc. W	363,70	394,45
95th perc. M	507,89	528,41
50th perc. W	405,68	437,6
50th perc. M	451,58	484,24
	<b>Iliac spine height</b>	
5th perc. W	848,16	
95th perc. M	1089,12	
50th perc. W	933,39	
50th perc. M	1001,94	

## 2.2 Cognitive ergonomics

The cognitive process is described by Bohgard et al. (2009) how humans take in the information around them through the senses and then choose which data to pay attention to and which to ignore. The human also processes the information stored in the memory, and after that will, the human gathers a perception that will lead to a decision. This process is done in a loop, and some parts parallel (Bohgard et al., 2009).

### 2.2.1 The senses

The human senses are vision, hearing, taste, smell, and touch (Bohgard et al., 2009). The ones mostly used in a work environment are vision, hearing, and touch.

#### Vision

The vision is the most dominant sense that human has and therefore, the sense that we use the most. Bohgard et al. (2009) states six factors that influence the vision: contrast, color, dark-adapted vision, depth perception, movement detection, and glare. Contrast is the difference between dark and lighter surfaces, and it influences how easy it is to distinguish the information. Further is the color factor, how you

experience different colors. How you see color is very dependent on which light you have. If it is darker, is it harder to distinguish the difference between colors. Important to consider is also that some people are color blind. Bohgard et al. (2009) state that the most common color blindness is that you can not distinguish the difference between green and red. 7-8% of the male population and 0.5-1% of the female population experience this color blindness. The second most common is that you have hard to distinguish yellow and blue; about 1% of the whole population has that problem (Bohgard et al., 2009). Lastly, the colors are limited to only the greyscale for some humans.

Depth-perception is the humans' ability to see how far an object is from you and also to see how fast an object is moving (Bohgard et al., 2009). The movement detection is the humans' ability to see how objects are moving, something you can use it to attract attention. Further is glare when high strength light reflects in the eyes, which takes over the vision for a while.

### **Hearing**

The sound we experience is due to the sound's pitch, loudness, and location (Bohgard et al., 2009). It is common to stimulate the hearing when you want to alert a worker of alarms or warnings. These sounds can, however, be masked or drowned by other sounds in the environment. Bohgard et al. (2009) also states that it is essential to know that the hearing changes with age.

### **Touch**

The tactile sense, also called touch, is the mechanical movement and pressure we feel on the skin (Bohgard et al., 2009). It can also be itching, warmth, cold, pain, and tickling. Some parts of our body are especially sensitive, for example, the hands.

## **2.2.2 Attention**

Attention is about allocating mental resources to a situation, so you focus on some impressions and exclude some (Bohgard et al., 2009). Further, there are two types of attention: selective and divided. Selective attention means that you allocate the mental focus for a short amount of time to something that you especially need to focus on. The divided attention means that you need to take in information from two or more sources at the same time. The split attention becomes more comfortable if you are experienced since then you don't need to allocate so many much resources to perform the tasks (Bohgard et al., 2009).

Further, three things determine how easy it is to focus on several things at the same time. The first is the amount of resources and mental effort that a situation demands. If a task demands more mental resources, it will be harder to focus on more things at the same time. The second thing is the structural similarity of the tasks, meaning if the tasks or attention that is required are stimulating the same sense, it will be harder to focus on both. For example, it will be hard to read two types of information at the same time but more comfortable to read and hear infor-

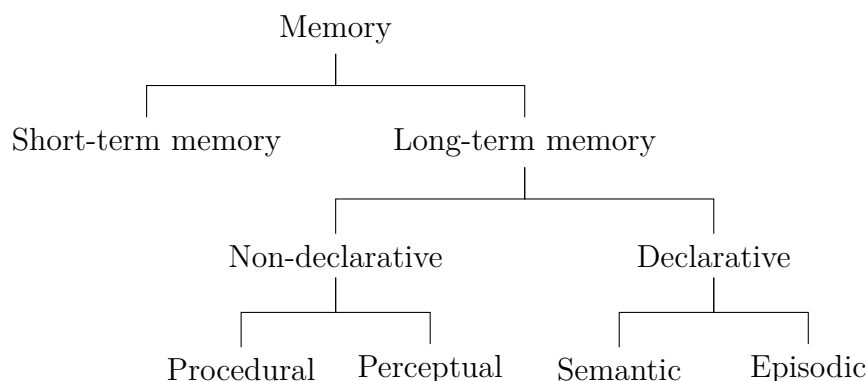
mation at the same time. The third thing is task management, which means how you switch between the tasks (Bohgard et al., 2009).

Bohgard et al. (2009) suggests three design parameters to support attention:

- **Minimise the time and effort to find information** - Meaning that it should be easy to locate the information necessary to perform a task. It should be displayed so it can be found in relation to, and in a logical way to the task.
- **Proximity** - Some information needs to be brought to attention at the same time to grasp the message. For example, if you have an alarm signal, it can be good with a voice that tells what the alarm is alarming for and where the problem is located.
- **Using multiple sources of information** - If it is required that the attention should be divided, then the things that require attention should try to stimulate different senses. It will make it easier to handle more than one piece of information at the same time.

### 2.2.3 Memory

The memory consists of two main parts, the short-term memory and the long-term memory (Bohgard et al., 2009). The overall structure of the memory is presented in figure 2.1. Further, the short-term memory is used to store information before we can see patterns to make sense of the information. This information is then processed, and when it is connected and categorized, it can be stored in the long-term memory. According to Bohgard et al. (2009), this process is not automatic, so it requires an effort to make sense of the information. The ability to process information is affected by stress, disturbances, and age.



**Figure 2.1:** Illustration over the structure for the memory. (Adapted from Bohgard et al. 2009)

The short-term memory holds information that is active for about 30 seconds. Before it requires you to bring attention to it again. Bohgard et al. (2009) state that studies have been made suggesting that we can store  $7 \pm 2$  chunks (units of information) at the time. You can train your short-term memory and increase the

capacity. By learning techniques of how you can group several chunks into one new chunk and then group the new chunks into even bigger chunks (Bohgard et al., 2009).

The long-term memory has unlimited capacity, and the information in the long-term memory will be stored the whole lifetime. Bohgard et al. (2009) said that the challenge is instead to be able to find the information that is needed. The long-term memory also categorizes and saves the memory based on the perception, so the long-term memory is more based on meaning than information (Bohgard, 2009). It is, therefore, necessary to link the information to the right category to be able to use it later (Bohgard, 2009). The long-term memory is divided into two groups, non-declarative and declarative memory.

According to Bohgard (2009) the declarative memory is the reminder of facts that you previously have learned. The declarative memory is divided into semantic and episodic memory. The semantic memory consists of knowledge facts, for example, which years the second world war was and how a table looks. It also helps us to recognize concepts. For instance, even if the table is redesigned, we know that it is a table. Episodic memory contains events that have happen in time and space (Bohgard et al., 2009), for example, the memory of the first day in school. The non-declarative memory is divided into two groups, procedural and perceptual (Bohgard et al., 2009). The procedural memory stores information regarding the motor action. It is our oldest memory, and it contains, for example, information about how to walk, how to ride a bike, and how to swim. The perceptual memory contains information regarding the identification of objects (Bohgard et al., 2009). For example, when we see a book, we know that it is a book.

Bohgard et al. (2009) listed three main design principles that can be useful to consider:

- **Minimise the use of the short-term memory** - The short term memory can only store  $7 \pm 2$  chunks. All the information that should need to be processed should, therefore, be presented together so that you can make sense of the information directly, and the short-term memory will not be loaded.
- **Show anticipated system status** - Show which future state the current parameters will lead to. It is easier to think reactively than proactively, but since the proactive mindset is more effective, that should be supported.
- **Consistent presentation** - When redesigning the current standards should be kept so it will be easier for the operators to adopt the new change. For example, the same color-coding should be used.

### 2.2.4 Perception

Perception means the process to mentally organize, interpret, select, and categorize information from the surroundings (Berlin & Adams, 2017). The information is further processed based on previous knowledge, experiences, and new knowledge. A human develops expectations on what it is that we experience based on the context where the information is displayed (Bohgard, 2009). This quality might lead us to

think that we see something that we don't see. Bohgard (2009) explained that when we read a text, we can read it even though 25% of the text is missing based on our expectations on which letters that should be in the gaps. We create illusions and see things that aren't there. This can be a problem for DB Schenker since if several sorting concepts have similar names, that might lead to that the operator fills in with his or her expectations and believes that it is another sorting concept than it actually is.

Bohgard et al. (2009) have listed five design principles that can be useful to consider to support human perception:

- **Displays should be legible** - The displays should be readable for both visual displays and auditory displays. Therefore you consider contrast, illumination, sound, and speed.
- **Too many levels of information should be avoided** - The recommendation is to avoid more than three levels. So, for example, for colors, you should only use red, green, and yellow or blue, and think about how you display it, so it is manageable for the color blind.
- **Data that requires knowledge to be interpreted should be avoided** - Due to perception, all humans will interpret data differently. Therefore it should be so clearly displayed that interpretation will not affect the outcome.
- **Redundancy should be used** - Try to present the same information in different ways to avoid interpretations and expectations. For example, an information text can both presented in readable and audible text. The instruction text can be clarified with a picture.
- **Similar objects should be avoided** - Similar objects should be avoided since they, due to the expectations, can be confused.

### 2.2.5 Other cognitive aids

Bohgard et al. (2009) has also listed two design principles to support the operator's mental model. These are:

- **Illustrated realism** - Try to represent reality. If a system is measuring the temperature, that information could be presented in terms of a thermometer to make it easier for the operator to understand the information.
- **Showing movable objects** - Movable objects can be used to show in which direction the parameter is going. For example, if a number goes down, then can that be complemented with an arrow down.

Berlin and Adams (2017) list some tools that can be used to support the cognitive process for an operator:

- **Design for assembly** - This means that while designing the product should the designer also considerate how the product can be designed to make it easier to assemble.
- **Fixtures** - A fixture is something that supports and holds a work-object during operations.

- **Kitting** - All components that need to be used on a product are delivered in kits to the workstation.
- **Standardised work** - Use one way to perform the task and all follow that way. It can be changed if a better method is found, but then it should be changed for everyone.
- **Work instructions** - Guidelines and pictures to help the operator to know how to perform the work.
- **Poka yoke** - Some kind of tool, equipment, or system that alerts the operator of errors that have occurred or are about to occur.
- **Pick by bar-codes** - The operator uses bar-code scanning to know how many of a certain object that should be picked. The operator scans the bar-code and gets number on display.
- **Pick by light** - A light is turned on at the location where the operator should pick objects. When the operator resets that light the light at the next position, the operator needs to go to turn on.
- **Pick by voice** - The operator wears a headset where he or she gets information about where to go and how many of a certain item that should be picked.
- **Andon systems** - the system is used to detect and prevent errors. If an operator spots an error, he or she should alert by activating the Andon, and then if the problem is solved, the production will move on as before. If it cannot be solved production will be stopped until the problem is solved.

### 2.3 Organizational ergonomics

This section covers the general factors that affect how the worker feels about the job. These factors can be changes with the organization.

#### 2.3.1 Stress

When a person feels stress is there a chemical reaction that releases hormones from the adrenaline gland, especially adrenalin and noradrenalin (Kroemer & Grandjean, 1997). This reaction causes the heart rate, blood pressure, sugar level, and metabolism to rise. Further, these characteristics which prepare the human to defend himself or herself. Kroemer and Grandjean wrote (1997) that if this stress is temporary, it will not be negative for the human but rather a qualification that we need to survive. But if the human is exposed to stress for a longer time, it will most likely lead to health effects, the most common being gastrointestinal disorders. Kroemer and Grandjean (1997) also wrote that stress is subjective and, therefore, not all humans will experience the same thing as stressful. Usually occupational stress will be defined as the subjective phenomena that a person experiences when he or she cannot deliver results on the same level as the demand (Kroemer & Grandjean, 1997).

Kroemer and Grandjean (1997) define eight factors that can become stress factors:

1. **Job control** - Can the workers in any way determine or affect the work or the routines? Lack of control can lead to physiological and emotional stress.

2. **Social support** - Do the workers have support from supervisors? Support from a supervisor can reduce the stress effects, or it can increase them if it is missing.
3. **Job distress** - How high the workload on the worker is and which content the work has. A high workload can lead to stress.
4. **Performance demands** - How well can the worker meet the performance demands? Deadlines can be stressful. If it is hard to meet the demands, that also increases the stress.
5. **Job security** - Treats of unemployment can create stress for the worker. It is, therefore, important to make sure that all workers feel important.
6. **Responsibility** - Is the responsibility that a person has exceeding the available resources? Is the well-being of others determined by the human? If the person cannot meet the high responsibility demands, that might lead to stress.
7. **Physical environment** - Physical environment at the workplace, noise level, lighting, and climate. For example, high noise levels can aggravate the risk of stress.
8. **Complexity** - Defined as the number of demands or tasks that the worker needs to do. If they are too few, it can lead to boredom, and if they are too many, it can lead to stress since you might feel incompetent.

### 2.3.2 Boredom

When an environment lacks stimuli or repeats the same stimuli the work is monotonous or repetitive, and that can create boredom (Kroemer & Grandjean, 1997). Kroemer and Grandjean (1997) also state that personal factors can affect whether the worker would experience the work as demanding or not. Examples of what can increase boredom are low motivation, little interest, and high fatigue. On the contrary are some people are more resistant to boredom. Examples of this are people that still are learning and those that feel fresh and alert.

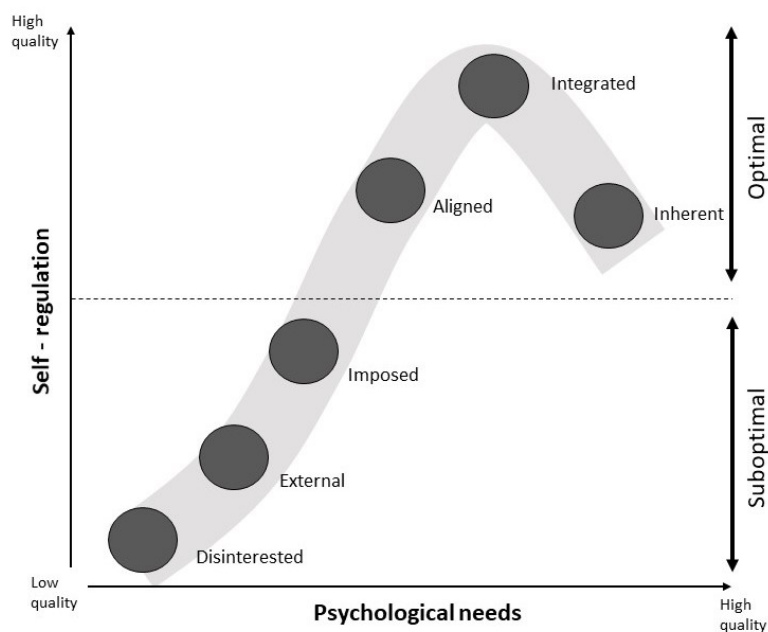
Berlin and Adams (2017) summarised guidelines from Kroemer and Grandjean (1997) regarding how you should design the work tasks to avoid boredom:

- The competence level of the worker should be matched with the competence required for the task.
- The workers should feel fresh and alert by encouraging and giving opportunities for recovery. Fatigue increases the risk of boredom.
- Avoid factors in the factory that increase boredom: dim-light, too-warm, repetitive work, too few parts require decisions and work that does not involve contact with others.
- Simple tasks can be fine during the learning cycle. A learning scheme can be applied where the harder tasks are unlocked when the worker has mastered easier tasks.

### 2.3.3 Motivation

Motivation can be looked at from many different angles and has throughout time been defined in different ways. The most classic illustration of motivation was done by Maslow (1943) he illustrated motivation in terms of a needs pyramid that consisted of five different levels. From the bottom up the levels are: Physiological needs, Safety, Belonging, Self-esteem, and Self-actualization. The needs at the bottom are the basic needs, and those need to be filled for it to be in question to look at the next level. Therefore the safety needs can only be filled if first all physiological needs are filled (Maslow, 1943). According to Maslow's needs pyramid, you achieve different levels of motivation by fulfilling different levels of needs for the workers.

Fowler (2014) also writes about motivation but from another viewpoint. She means that leaders cannot motivate people. The motivation must come from the employee. Fowler (2014) states that there exist different kinds of motivations, so, therefore, is it not as black and white as that you are motivated or not, but rather that you can be motivated on different levels. Fowler (2014) presented a spectrum of motivation to explain this; see figure 2.2.



**Figure 2.2:** Spectrum of motivation model (adapted from Fowler, 2014)

As can be seen from figure 2.2 Fowler (2014) defined six levels of motivation, where three are said to be sub-optimal and three optimal. The sub-optimal levels are imposed motivation, and the optimal levels are the motivation that comes from within. The three levels of sub-optimal motivation are disinterested, external, and imposed. Disinterested means that the worker doesn't see any value in the task; he or she views the tasks as a waste of time. External motivation is when the worker only is motivated to do the task due to external motivation, like money. Lastly is Imposed motivation, which means that the worker feels motivated to do the task due to that

everyone else is doing it. The worker wants to avoid guilt and shame and is, therefore, doing the task due to pressure from others.

The three levels of optimal motivation are aligned, integrated, and inherent (Fowler, 2014). Aligned means that the worker feels motivated to do the task due to that he or she gets something from work, for example, new learning. Further, by integrated it is meant that the worker is motivated since he or she feels that he or she contributes to something bigger. The worker feels a connection with the surroundings and can see how his or her work can affect and improve for the surrounding. Lastly, by inherent it is meant that the worker is motivated since he or she finds the work fun.

Fowler (2014) however, also writes about how you can affect the motivation of the workers. She means that there are three psychological needs that all humans have that need to be filled to feel motivated. These three needs are autonomy, relatedness, and competence (Fowler, 2014). With autonomy she means that all humans need to do the work because we want to do it. We don't want to be forced.

Further, we need to have control over our work and have a choice of how or what to do. Relatedness means that the worker needs to feel that he or she contributes to something bigger. We, as humans, need to feel a connection with the surroundings and see how we are affecting it. Lastly, competence means that we want to use the skills that we have. We want to develop in our work and also be able to use the abilities that we have. We want to be in a learning environment.

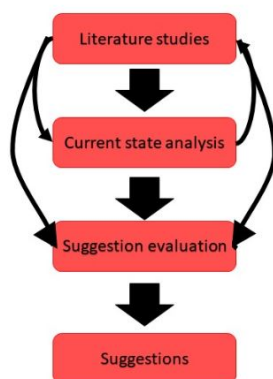


# 3

## Methods

This master thesis has been performed at the headquarter of DB Schenker in Sweden. The thesis was performed at the department responsible for the terminals and operational activities at the terminal.

This master thesis consists of four main steps: literature studies, current state analysis, suggestions evaluation, and final suggestions. This process is illustrated in figure 3.1. The first and the second step were done simultaneously to analyze the current state needed literature on the subject first be collected. Still, the literature then needed to be updated to match the findings in the current state analysis.



**Figure 3.1:** Method

### 3.1 Literature study

In the first step, literature was related to ergonomics studies. The main subjects searched for were physical ergonomics, cognitive ergonomics, and organizational ergonomics. Literature related to musculoskeletal disorders was also collected to explain the consequences related to bad physical ergonomics. To find the information, literature from previous courses studied at Chalmers University of Technology was studied. These courses mainly studied were Production Ergonomics and Work Design studied during Spring 2019, and Lean Production studied during Autumn 2019. The main sources for this thesis have been books and statistics from databases. To find statistics, the databases Statista and Statistics Sweden have been used. Some of the literature studied has been scientific articles as well.

### 3. Methods

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To find the relevant literature, several keywords have been used. The main keywords are summarised in table 3.1 below.

**Table 3.1:** Keywords used in literature study

<b>Keywords Physical ergonomics</b>	
Physical ergonomics	Musculoskeletal disorder
Ergonomics material handling	Physical distress from material handling
Ergonomic evaluation methods material handling	Ergonomic evaluation methods for
<b>Keywords Cognitive ergonomic</b>	
cognitive aids for material handling	Cognitive effects of material handling
cognitive evaluation models	
<b>Keywords organizational ergonomics</b>	
Work-related stress	Boredom
Motivation	Design to reduce stress
Design to increase motivation	

The literature collected was used to establish how the current state analyses should be performed. The literature study was then developed during the current state analysis to establish which literature that would be relevant to estimate the current state at the terminals.

## 3.2 Current state analysis

The current state analysis was performed to estimate the ergonomics at the terminals and the effects on the terminal workers. In the first part of the current state analysis, six terminal visits were performed. The purpose of the terminal visits was to get a good understanding of how it looks like at the terminal and not just rely on the viewpoint of the headquarters. The terminal visits were performed at three larger terminals, two medium-sized terminals, and one smaller terminal. These terminals were selected since they would present the whole network of terminals in a good way since many different sizes of terminals will be represented. It was desirable to study different sizes of terminals since each terminal has different parcel sorting conveyors depending on the size of the terminal. Different parcel sorting conveyors can handle different parcels, which means that depending on the size of the terminal, there will be different kinds of Ugly-parcels.

At the terminal visits three main activities were performed, interviews, observations, and data collections (see figure 3.2). At the terminals at least three interviews were performed, one with the terminal manager, one with a work leader, and one with a terminal worker. These three levels of employees were interviewed since it was desirable to get an understanding of different roles, experiences in terms of the ergonomics in the terminals. The questions asked during the interviews can be found in appendix A. The questions considered the physical, the cognitive, and the organizational ergonomics. The questions focused, during the interviews, on the

workers' own experience about the ergonomics. The answers to the questions could, therefore, only be considered as guidelines and not absolute truth since the answers depend on how the interviewee personally experiences the work.

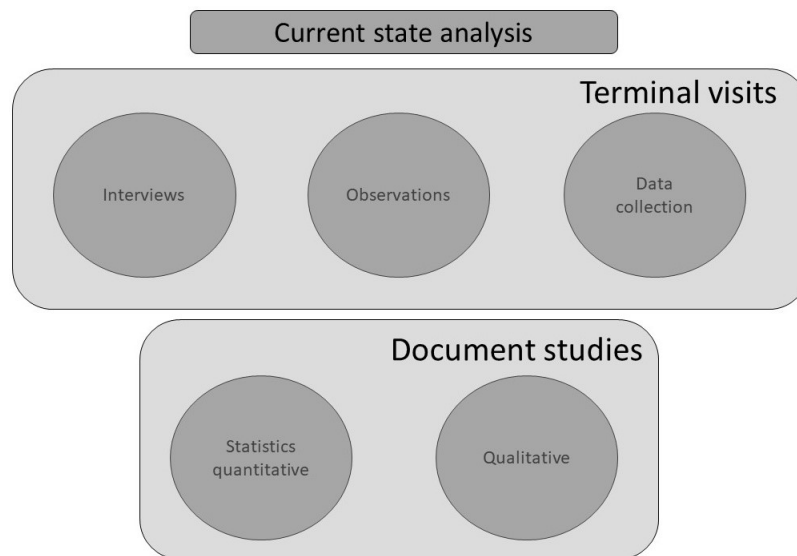
The other activity performed at the terminal visits was to collect data about which parcel that were handled as Ugly-parcels. To perform the data collection were, the handling of the Ugly-parcel flow at the terminal was studied, and each parcel was categorized based on why it couldn't be handled on the parcel sorting conveyor. The purpose of the study was to get an understanding of which parcels that creates the biggest problem at the terminals, and which parcels affect the normal production the most.

Every parcel that needed to be handled outside of the parcel sorting conveyor was studied and categorized based on why it couldn't be handled on the sorting conveyor. The categories used were:

- **Too long**, Meaning that the length of the parcel was still within the product demands. The parcel, however, is longer than the parcel sorting conveyor could handle or estimated by the operator to be longer than the sorting conveyor could handle.
- **Bad or missing packaging**, The customer hasn't packed the item in a good way. This means that the customer not provided sufficient packaging, which might lead to damages on the parcel sorting conveyor or the item shipped.
- **Too long and missing packaging**
- **Round**, The parcel has a round shape, often in the form of a cylinder. These parcels cannot be handled on the sorting conveyor since they risk to roll off the conveyor or roll so that the bar-code cannot be scanned.
- **Too long and round**
- **Unreadable bar-code**, The bar-code is placed on the parcel in such a way so the bar-code cannot be scanned with the cargo-scanner.
- **Round and unreadable bar-code**
- **Too thin**, The parcels pass under the photocells of the cargo-scanner, which sit about two centimeters from the conveyor. So all parcels that are thinner than two centimeters will miss scanned data if placed on the parcel sorting conveyor. These, therefore, need to be scanned with the HDT.
- **Too big volume or area**, The combination of a wide and long parcel makes it impossible to handle on the parcel sorting conveyor since it likely would get stuck in the turns of the conveyor.
- **Unstable**, The parcel would tilt or fall while on the conveyor. This can result in the parcel losing its place, and the sorting conveyor loses the position of the parcel, which results in it ending up in the wrong outline. The parcels also risk falling off the parcel sorting conveyor.
- **Not an Ugly-parcel**, The parcel should not be handled as an Ugly-parcel, it should have been handled on the regular parcel sorting conveyor.
- **Risk to injure other parcels**, The parcel has a hard packaging that might risk damaging other parcels when they are bulking up at the outline.

- **Risk for injury on the parcel**, The parcel in itself is fragile, e.g., a glass item that obviously could be damaged if it was sorted on the parcel sorting conveyor.
- **Sticky packaging**, Some of the parcel sorting conveyors have tilting plates that drop the parcel at the right outline. If the parcel then has sticky packaging, it will stuck at the plate and might not fall when it should.
- **Buckets**, Buckets are a very sensitive type of packaging; there have been problems with breakage when they process it on the sorting conveyor.
- **Bags**, Some of the terminals have problems with items packed in bags. These bags are often thin and might not be read by the cargo-scanner. They also have problems with that the handles of the bags cause the cargo-scanner to feel that it is two parcels instead of one, and the conveyor stops.

The third step at the terminal visits was to carry out observations of when the Ugly-parcels were handled and film the terminal workers while they were handling different parcels. This was done to perform ergonomic evaluations of the physical handling of Ugly-parcels, further described in section 3.2.1 below. It was also done to estimate the time spent on the Ugly-parcel handling compared to the handling of other parcels, further described in section 3.2.2 below.



**Figure 3.2:** Current state analysis

After the terminal visits, document studies were performed on DB Schenker's statistics of the handling of parcels. Both quantitative and qualitative data collected from DB Schenker's systems. The quantitative data that were collected were about the volumes handled at the terminals. The qualitative data collected where the specific number of the hour spent on certain activities the days where the terminal visits where performed. These data where necessary to perform the ergonomic studies of the handling of Ugly-parcels.

### 3.2.1 Selection of evaluation method for physical ergonomics

There exist several methods for analyzing the physical ergonomics for a worker. These methods have different approaches and purposes, so, therefore, is it essential to choose the right method to use. According to Berlin and Adams (2017) there are three main categories: posture based, biomechanics based, and methods including a combination of environmental factors. In this study all factors (time, force, and position) will be of great importance to study, so therefore the most appropriate evaluation method be a combination method. Within this area Berlin and Adams (2017), state that several methods are included: JSI (Job strain index), KIM (Key Indicator Method), EAWS (Ergonomic Assessment Worksheet), and RAMP (Risk assessment and Management tool for manual handling Proactively).

The JSI method was excluded since that method mainly focused on wrist and hands (Berlin & Adams, 2017). The case studied in this thesis demands a broader picture where the whole body is studied. The EWAS and RAMP methods were further studied but excluded since they are very complex and require a lot of data and information. This due to that, it would be hard to collect that data and time consuming to obtain it for all those tasks that were to be studied within this thesis. Therefore the KIM methods were chosen to be the most fitting method to use for this thesis.

The KIM methods were established by the Federal Institute for Occupational Safety and Health in Germany between 1996 and 2007, and their purpose is to bring attention to and remove job design deficits (Steinberg, 2012). According to Berlin and Adams (2017) these methods are targeted to analyze the manual handling of loads. This makes these methods appropriate to use in this thesis since handling of loads is the main thing that the workers do at DB Schenker. The methods are also easy and fast to use, which makes them fit well within this thesis.

#### 3.2.1.1 Key indicator method (KIM)

The KIM method uses so-called key indicators to establish the physical load; these are duration/frequency, load mass, posture, and working conditions (Steinberg, 2012). The method is only a guiding tool to assist and help with little effort and requirements for documentation to guide the user to improve the most important factors (Steinberg, 2012). Further the method, therefore, should not be used in cases that require a more detailed and precise result—the worksheet for KIM I and III can be found in appendix C. To study the ergonomic effects of Ugly-parcels, KIM I and III have been used. KIM I was the primary method used, but KIM III was used as a complement to verify the results from KIM I. KIM I is suited for lifting tasks and KIM III for manual handling, which suits the parcel handling at DB Schenker. KIM I gives a more general understanding of the overall load factor for the handling, and KIM III gives a more specific understanding of the hand and arm effects of the handling (Berlin Adams, 2017).

KIM I gives points for loading, posture, work conditions, and time, which gives a risk score. To estimate the loading points data from DB Schenker's systems have been analyzed. Every parcel that is handled at a terminal will get a registration that tells the system the weight, measurements, and delivery data about the parcel. The system adjusts the weight and measurements if the parcel is scanned through a cargo-checker to ensure that the customer has assigned the right properties to the parcel. These registrations are saved in DB Schenker's systems, making it possible to pick out statistics on how many parcels have been scanned in a certain weight interval. It can also be seen which cargo-checker or HDT that has scanned the parcel.

To get the load point, data were reviewed on the day the statistical study was made at the terminal. Only the parcels that were scanned outside of the normal parcel flow were studied. The parcels in a certain weight interval were then divided with the total amount of parcels scanned on the side of the normal flow to get the percentage distribution of the weights. The load rating point for the specific interval was then multiplied with the percentage for that interval, and when all values for all intervals were summed up a loading point was determined. The following example will give an explanation of the reasoning above. In total 20 parcels have been handled on the side of the normal flow, five parcels under five kilograms, five parcels between five and ten kilograms, five parcels between ten and 15 kilograms, and five between 15 and 20 kilograms. This will result in that the loading point for men will be 1,5 and for women 3,5, see equation 3.1 and 3.2.

$$Men = 0,5 \cdot 1 + 0,5 \cdot 2 = 1,5 \quad (3.1)$$

$$Women = 0,25 \cdot 1 + 0,25 \cdot 2 + 0,25 \cdot 4 + 0,25 \cdot 7 = 3,5 \quad (3.2)$$

The time factor was established by looking at the data collection from the terminal visits. It was found how many parcels were handled on the side of the normal parcel flow and why they were handled on the side. The working conditions were estimated based on observation of the movies.

When KIM III is used to analyze the handling of Ugly-parcels the whole sequence for handling one parcel is studied. To determine the factors a guide for the method was studied. The KIM III method consists of seven factors: type of force, force transfer, hand/arm position, work organization, work condition, posture, and time. The force type factor is determined by the handling done (if it is a movement or holding) and the level of the force. The force transfer factor was established by looking at the manual for the KIM III method. The work condition and work organization factors were established by observations and information from interviews. The posture and time factors were estimated in the same way as for KIM I.

#### 3.2.2 Calculation of productivity at DB Schenker

The productivity is calculated based on all parcels that have been handled in a separate flow independent of whether there were ugly-parcels. Two different ways

of calculating the productivity have been used. The first one was based on the whole volume and all working hours spent on the Ugly-parcel handling, and the second measurement was calculated based on observations and stopwatch studies.

### 3.2.2.1 Productivity measure 1

The first productivity measure that has been analyzed is productivity based on the whole volume. Since three of the terminals have a separate flow for the Ugly-parcel handling, those resources required for that handling can be isolated from the other handling. Therefore, the total number of working hours has been calculated for Ugly-parcel handling based on the terminal visit (HUP). The number of hours spent on the whole parcel handling (HT) has been collected from DB Schenker's systems. The time it takes to handle the Ugly-parcels is removed from that time to get the total time spent on the normal production, equation 3.3.

$$HN = HT - HUP \quad (3.3)$$

The total volume processed and registered as departing parcels are collected from DB Schenker's system (VT). The total volume was collected for the day that the visit was done. The number of parcels processed as Ugly-parcels was received at the terminal visit (VUP). To determine the total volume that was processed on the parcel sorting conveyor, the Ugly-parcel volume (VUP) is removed from the total volume (VT), equation 3.4.

$$VN = VT - VUP \quad (3.4)$$

The volume is then divided with the number of hours spent on the handling. This is done both for Ugly-parcel handling and normal handling. The result is the average amount of parcels processed per worked hour (PN, PUP), equation 3.5, and 3.6.

$$PN = \frac{VN}{HN} \quad (3.5)$$

$$PUP = \frac{VUP}{HUP} \quad (3.6)$$

The number of processed parcels per worked hour for the Ugly-parcel handling is then divided with the number of process parcels per worked hour for the normal handling, and the result is then subtracted with one to get the answer (R). The answer is then multiplied with 100 in other to get the answer as in percentage, equation 3.7.

$$R = \left( \frac{PUP}{PN} - 1 \right) \cdot 100[\%] \quad (3.7)$$

The answer tells how much longer working time is spent on each parcel at the Ugly-parcel handling than the normal handling for all terminals that have a separate flow for the Ugly-parcel handling. The terminals that don't have a separate flow for the Ugly-parcels cannot be analyzed with this calculation.

#### 3.2.2.2 Productivity measure 2

To analyze the productivity for all terminals that have the handling of Ugly-parcels, observations were made. The different parts of the handling of a parcel in the normal flow and the Ugly-parcel flow have been studied. Stopwatch studies have been made based on recorded videos of the handling. At least five parcels for each of the tasks have been studied and then the average time was chosen to give a representative number. The different task times were then added up to give the total time it takes to process one Ugly-parcel and one normal parcel. Transported was excluded from the study, and only the tasks that required the operator to handle a single parcel were studied. The time it took to handle one Ugly-parcel was then divided with the time it took to handle one normal parcel. That was then subtracted with one and multiplied with 100 to get the answer (R2), equation 3.8.

$$R2 = \left( \frac{\text{Time to handle one Ugly-parcel}}{\text{Time to handle one normal parcel}} - 1 \right) \cdot 100[\%] \quad (3.8)$$

The answer shows how much more time one Ugly-parcel takes to process than a normal parcel when a single parcel is studied.

#### 3.2.3 Cognitive and organizational ergonomics

The cognitive and organizational ergonomics were analyzed based on the literature studied performed. The findings from the visits, mainly the interviews, were compared against the recommendations from literature on how to support the cognitive and organizational ergonomics.

### 3.3 Suggestions evaluation

After the current state analyses, improvement suggestion were established through analyzing design recommendations found in the literature study. The suggestions to improve the physical ergonomics were evaluated with KIM I and III to get an understanding of the effects of each suggestion. The suggestions to improve the cognitive and organizational ergonomics were evaluated based on the literature study.

All of the improvement suggestions were also, if possible, estimated regarding how much they would affect the time spent on the Ugly-parcel handling. This was done to get an understanding of whether the improvement also could have an economic benefit for the terminals. Some of the suggestions were also combined with grouped solutions to see how many groups of improvements that are possible to achieve.

### 3.4 Final suggestions

The last phase of the study was to summarise and discuss the improvements that would give ergonomic improvements for DB Schenker. The final suggestions also include recommendations for further research since some information was found that would require more evaluation before it could be implemented.

### **3.5 Social, ethical and ecological aspects**

During this master thesis, social, ethical, and ecological aspects have been considered, mostly social and ethical. During the master thesis, terminal workers have been studied to determine their ergonomic situation. Therefore it has been essential to consider identity protection, integrity and also to handle their information carefully. During the interviews conducted the identity of the interviewees has been protected since sensitive personal data was shared during the interview. The purpose of studying the workers' situation is to improve their working situation, so thereby, it is justified to analyze their job, but it needs to be done with caution. Ecological aspects has not been considered during this thesis. The focus has been to analyze the human experience of the work and therefore have the ecological aspects been left out.



# 4

## Analysis of current state

In the following chapter, the current state will be studied. The current state represents how the Ugly-parcels currently are handled at the terminals, and which ergonomic effects that has on the workers. The terminals will be called terminal A-F.

### 4.1 Findings from terminal visits

Six different terminals were visited during the study. During the visits, a study was made to gain knowledge about which parcels cannot be handled on the parcel sorting conveyor, and therefore needed to be dealt with as Ugly-parcels. Interviews were also performed to gain knowledge from the different levels at the terminal on how they experience the handling of Ugly-parcels. Lastly the flow of how these Ugly-parcels are handled at the terminals was also studied.

#### 4.1.1 Handling of Ugly-parcels and statistics

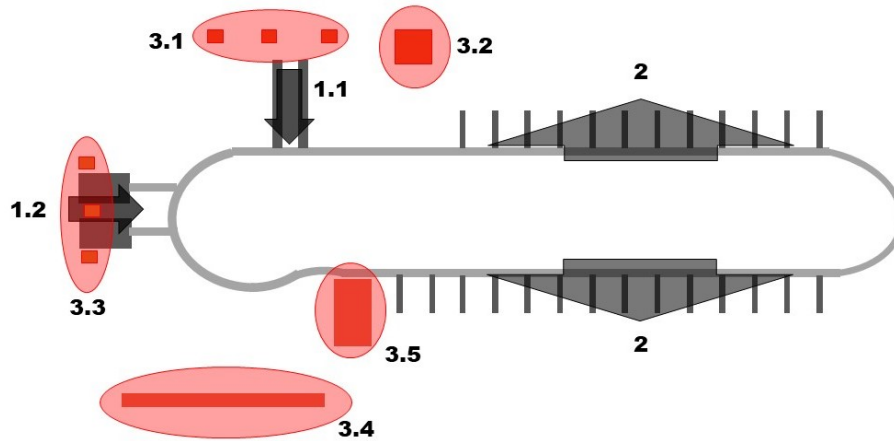
The Ugly-parcels are handled differently at each terminal, much depending on what size the terminal has. Therefore the handling will firstly be presented separately for all terminals and then summarized into different general ways of handling. Only the departing handling has been studied and is, therefore, the main subject of this study. It is also only the departing handling that has been illustrated in figure 4.1-4.14. The handling during the arrival shift is mostly done in the same way and will only be commented on if it deviates from the handling at the departure shift.

The terminals have different kinds of Ugly-parcels depending on the terminals' layout of the parcel sorting conveyor and the customers located in the area. To establish which parcels cannot be handled on the parcel sorting conveyor, the departing production was studied for one day at each terminal.

The statistics of which parcels that couldn't be handled on the parcel sorting conveyor and how these were handled for the six terminals are presented below in sections 4.1.2.1.1-4.1.2.1.6. The data has also been reviewed, and the necessary adjustment has been made. These adjustments are commented on in each section.

#### 4.1.1.1 Terminal A

Figure 4.1 shows the overall layout of the parcels sorting conveyor at terminal A. The layout also includes the handling of the Ugly-parcels. The handling of all parcels



**Figure 4.1:** Layout Terminal A, all red areas represent an area where Ugly-parcels are handled.

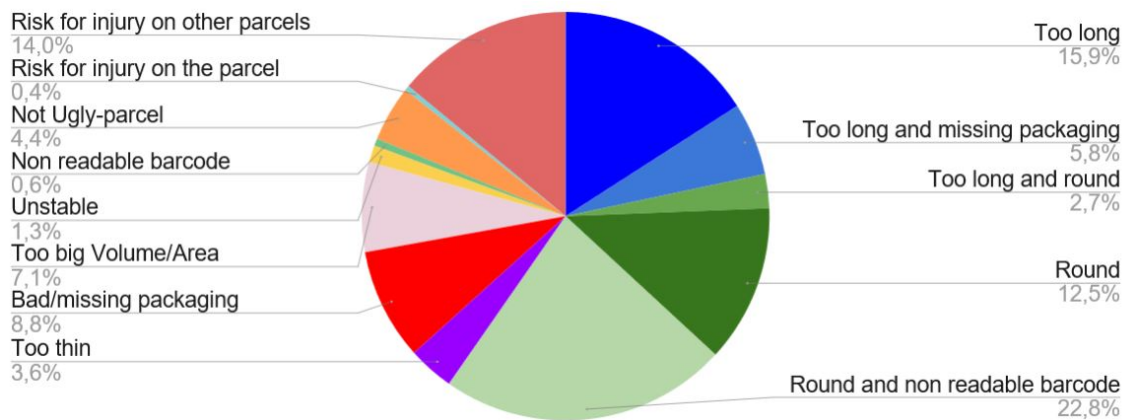
starts either at 1.1 or 1.2 in figure 4.1. The parcels are either placed on the sorting conveyor through a telescopic conveyor directly from the truck or from a parcel-cage that is lifted on a cage-lifter. The Ugly-parcels are at the telescopic conveyors placed at the side of the gate, place 3.1 in figure 4.1. The operator responsible for the Ugly-parcel sorting will get these parcels and place them into a cage, place 3.2 in figure 4.1. The parcel-cage or cages are then transported to the straight conveyor belt, 3.4 in figure 4.1. The parcels that are sorted out at 1.2 are also placed in a parcel-cage on the side of the cage-lifter, place 3.3. Those cages are also transported to the straight conveyor belt place 3.4 in figure 4.1.

At the straight conveyor belt the parcels are placed on the conveyor, then scanned automatically by the cargo-scanner, and lastly placed into a parcel-cage depending on which sorting concept they should be transported to. At the straight conveyor belt the personnel have a high lifting forklift at the inline that they can use to raise the parcels to a good level to lift them. Terminal A also has small parcels that arrive in plastic bags. These bags are transported to place 3.5 in figure 4.1. There are then sorted out into other plastic bags, one for each sorting concept. These bags are then placed into the parcel-cages at the straight conveyor belt, place 3.4. The parcel-cages that are full at the straight conveyor belt are then transported to the right shipping line. The parcel-cages that still have some space left in them are transported to the outlines for the parcel sorting conveyor, place 2 in figure 4.1. If there are no more parcels that need to be processed, the personnel try to fit the Ugly-parcels in the other parcel-cages to ensure a high utility of the parcel-cage.

During the arriving shift terminal A did not use the straight conveyor belt to sort the Ugly-parcels. They said that they didn't have as many Ugly-parcels during that shift, so they instead picked the parcels from the parcel-cage at the inline stations

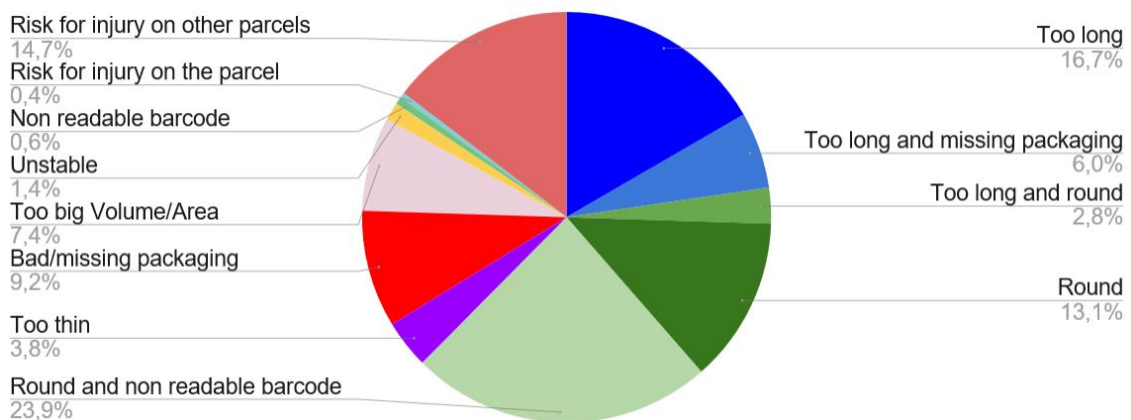
and then transported them to the right outline with a forklift.

In figure 4.2 are the data collected from terminal A visualized. In total was 521 parcels handled on the straight conveyor belt and therefore studied, which was 2,7% of the total volume of parcels processed in the terminal during the departing shift. Terminal A had a separate flow for the small parcels that cannot be handled on the parcel sorting conveyor. Those parcels weren't studied since that handling was physically located in another place. So, therefore, are the category with thin parcels smaller than it is in reality.



**Figure 4.2:** Statistics Terminal A

Some of the parcels that were handled on the straight conveyor belt could have been handled on the parcel sorting conveyor. These parcels are therefore removed from the data, which will result in a new visualization, figure 4.3. This data is now consisting of 498 parcels which are 2,6% of the total production volume.

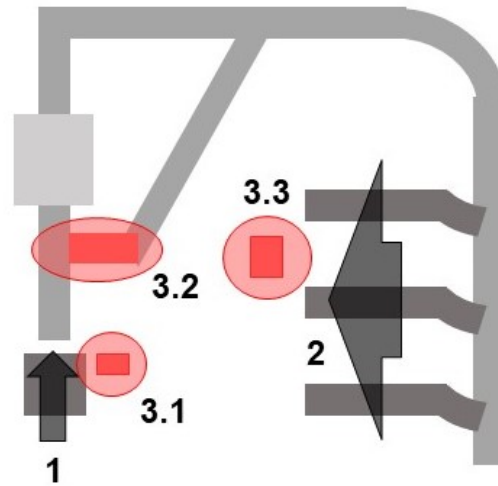


**Figure 4.3:** Reviewed statistics Terminal A

What can be seen in the statistics is that round parcels (too long and round, round and round, and unreadable bar-code) is the biggest category of Ugly-parcels, 39,8 %. The second-biggest category is the long parcels, which is over 1,4 m, 25,5 % of the Ugly-parcels. The long and round are included in both categories.

### 4.1.1.2 Terminal B

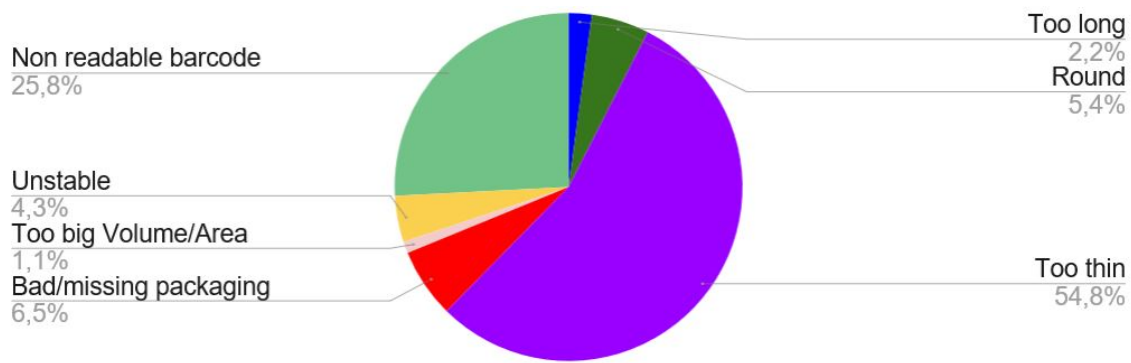
Figure 4.4 shows the overall layout of the parcel sorting conveyor at terminal B. All parcels arrive at place 1 in figure 4.4 the parcels arrive either on pallets or in



**Figure 4.4:** Layout Terminal B, all red areas represent an area where Ugly-parcels are handled.

parcel-cages and are lifted with a cage-lifter. The parcels that cannot be handled by the parcel sorting conveyor are sorted out and placed on the no-read arm, place 3.2 in figure 4.4, or a parcel-cage place 3.1. The Ugly-parcels are then scanned with the HDT and placed on a pallet by the outlines, place 3.3. The personnel at the outline will then pick the parcel from 3.3 and place it in the right parcel-cage at the outline, place 2 in figure 4.4. The terminal handles the too thin parcels on the sorting conveyor as well, but they need to add a plastic or wood plate under the parcel to ensure that the cargo-scanner scans it. These plates travel with the parcel to the outline and at the outline will the operator place the plate in a box which they then carry to the inline station when it is full.

In figure, 4.5 is the data collected from terminal B visualized. In total was 93 parcels handled on the side of the parcel sorting conveyor therefore studied, which was 3,3% of the total volume of parcels processed in the terminal during the departing shift. Since the terminal handles the Ugly-parcels manually are the operators only sorting out those parcels that are Ugly-parcels. Meaning that there are no parcels that they handle as Ugly-parcels that needs to be deleted from the data.

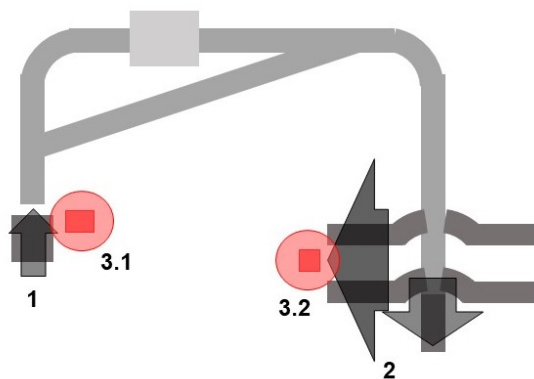


**Figure 4.5:** Statistics Terminal B

To note is that the too thin parcels in figure 4.5 are handled on the parcel sorting conveyor. The operators, however, need to add plastic or wood plate under the parcels so the cargo-scanner can read the parcel. The biggest category of Ugly-parcels at terminal B is the too thin parcels. However, since these could be handled on the parcel sorting conveyor, did they not affect the production much. The second biggest category where the parcels with unreadable bar-code. These parcels were put on the parcels sorting conveyor but came back on the no-read outline. So either where these parcels put on the parcel sorting conveyor again and could be scanned or they where lifted off and placed in the parcel-cage beside the inline station.

#### 4.1.1.3 Terminal C

Figure 4.6 shows the overall layout of the parcel sorting conveyor at terminal C. All parcels arrive at place 1 in figure 4.4 the parcels arrive either on pallets or in parcel-cages and are lifted with a cage-lifter. The parcels that cannot be handled

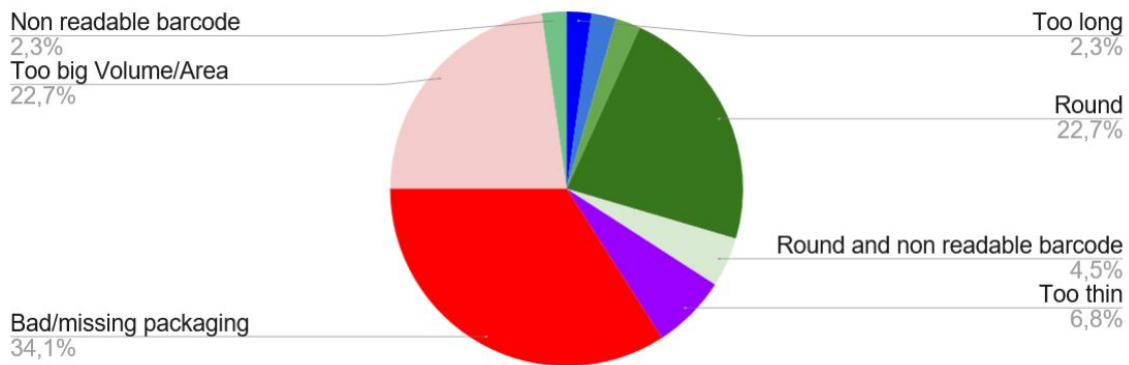


**Figure 4.6:** Layout Terminal C, all red areas represent an area where Ugly-parcels are handled.

on the parcel sorting conveyor are placed in a parcel-cage by the cage-lifter, place 3.1 in figure 4.6. That parcel-cage is then moved to the outlines, place 3.2. There will the personnel at the outline, place 2, pick the parcels, and scan them with the HDT before they place them into the right cage.

#### 4. Analysis of current state

In figure 4.7 are the data collected from terminal A visualized. In total was 44 parcels handled on the side of the parcel sorting conveyor and therefore studied, which was 2,8% of the total volume of parcels processed in the terminal during the departing shift. As for terminal B are the Ugly-parcels manually handled, so the operators are only sorting out those parcels that are Ugly-parcels. This means that there are no parcels that they handle as Ugly-parcels that needs to be deleted from the data.

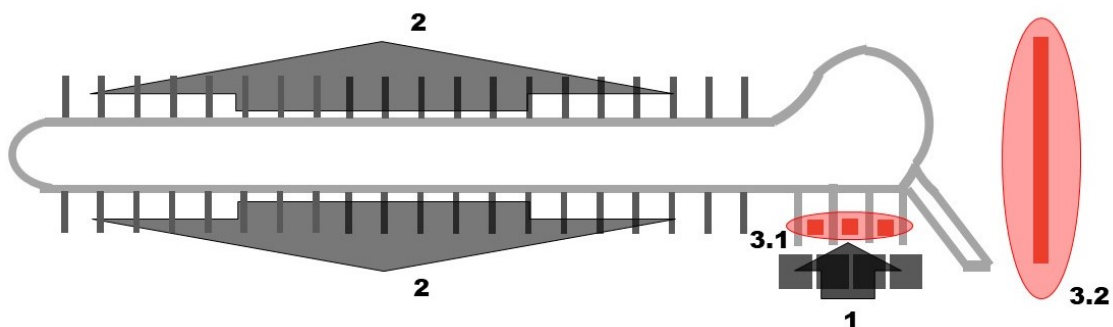


**Figure 4.7:** Statistics Terminal C

At terminal C, is the biggest category of Ugly-parcels the parcel that miss packaging or have bad packaging. The second-biggest category is the parcels that have too big volume/area. Even though the handling is similar at terminal C as for terminal B, is there a big difference in the distribution of parcels. This difference is due to that the terminals have different customers locally, and different customers send different kinds of Ugly-parcels.

##### 4.1.1.4 Terminal D

Figure 4.8 shows the overall layout of the parcel sorting conveyor at terminal D, including the handling of Ugly-parcels. All parcels that arrive at the terminal ar-

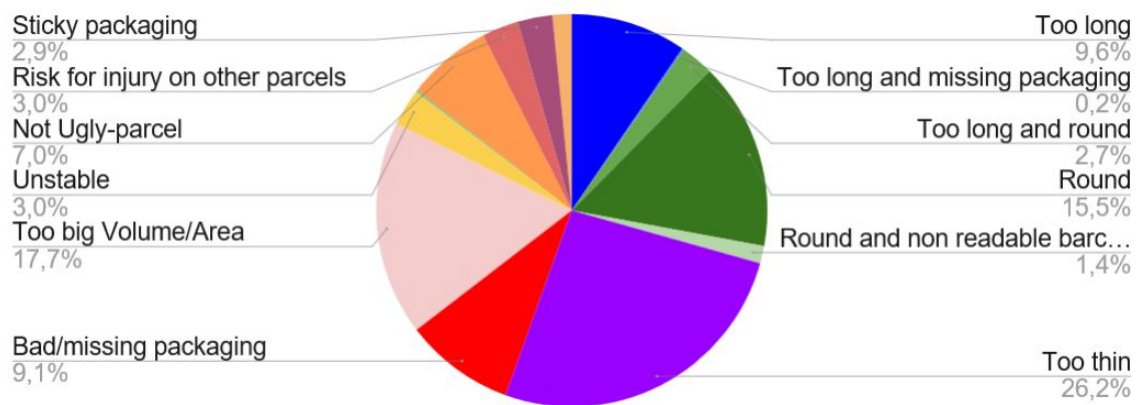


**Figure 4.8:** Layout Terminal D, all red areas represent an area where Ugly-parcels are handled.

rive either on a pallet or in a parcel-cage. The load carrier is placed on one of the cage-lifters when they arrive at the terminal, place 1 in figure 4.8. The parcels

that can't be handled on the parcel sorting conveyor are sorted out and placed in another parcel-cage by the inline station, place 3.1 in figure 4.8. The parcel-cage is then transferred to the straight conveyor belt, place 3.2. At the straight conveyor belt are the parcels lifted on to the conveyor, then scanned automatically by the cargo-scanner. Lastly, they are lifted from the conveyor and placed in the right parcel-cage. At the inline of the straight conveyor belt have the workers a vacuum-lifter there which they can use to place the parcels on the conveyor. If the parcel-cages are full, they are directly moved to the right shipping line. If the cages still have some room left, they will be transferred to the outlines, place 2 in figure 4.8, where the personnel can fill them up with other parcels. If there are no more parcels that need to be processed, the personnel try to fit the Ugly-parcels in the other parcel-cages to ensure a high utility of the parcel-cage.

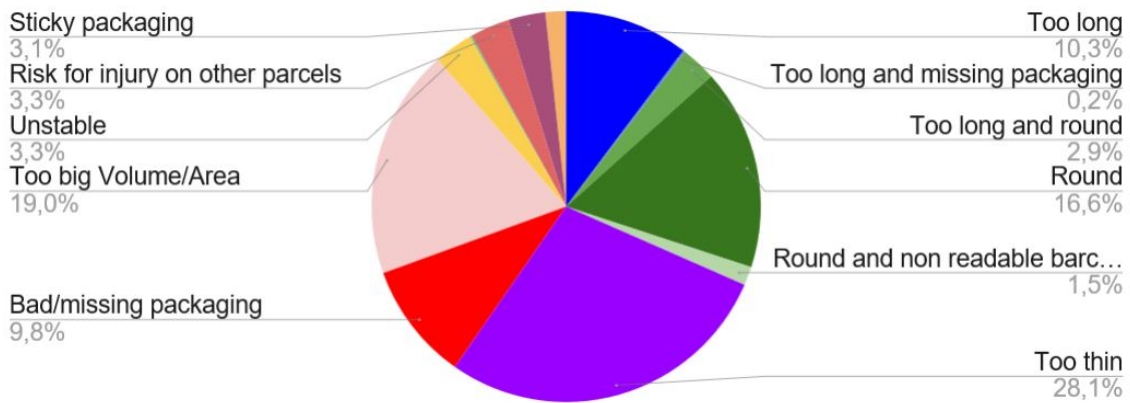
In figure 4.9 are the data collected from terminal D visualized. In total, 627 parcels were handled on the straight conveyor belt and therefore studied, which was 3,3% of the total volume of parcels processed in the terminal during the departing shift.



**Figure 4.9:** Statistics Terminal D

Some of the parcels that were handled on the straight conveyor belt could have been handled on the parcel sorting conveyor. Therefore, these parcels are removed from the data, which will result in a new visualization, figure 4.10. This data is now consisting of 583 parcels which are 3,1% of the total production volume.

#### 4. Analysis of current state

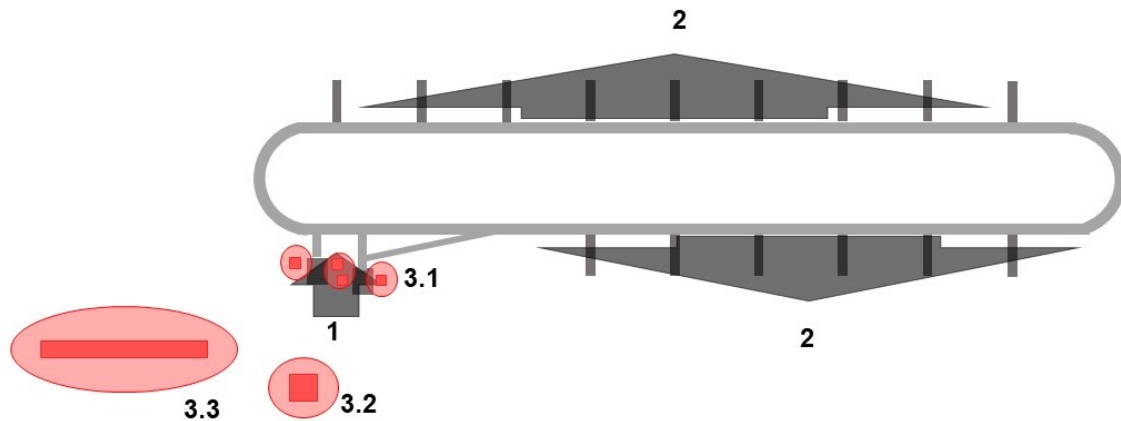


**Figure 4.10:** Reviewed statistics Terminal D

The biggest category of Ugly-parcels is the one consisting of the too-thin parcels. The second-biggest category is the category with round parcels. At terminal A, was the biggest category, the round parcels. The thin parcels were not a big category at terminal A since they were handled in a separate flow. So if that flow would have been studied as well, would that category likely be bigger and the distribution of Ugly-parcels would likely be more alike between the terminals.

##### 4.1.1.5 Terminal E

Figure 4.11 shows the overall layout of the parcel sorting conveyor at terminal E, including the handling of Ugly parcels. The parcels arrive at the terminal either on



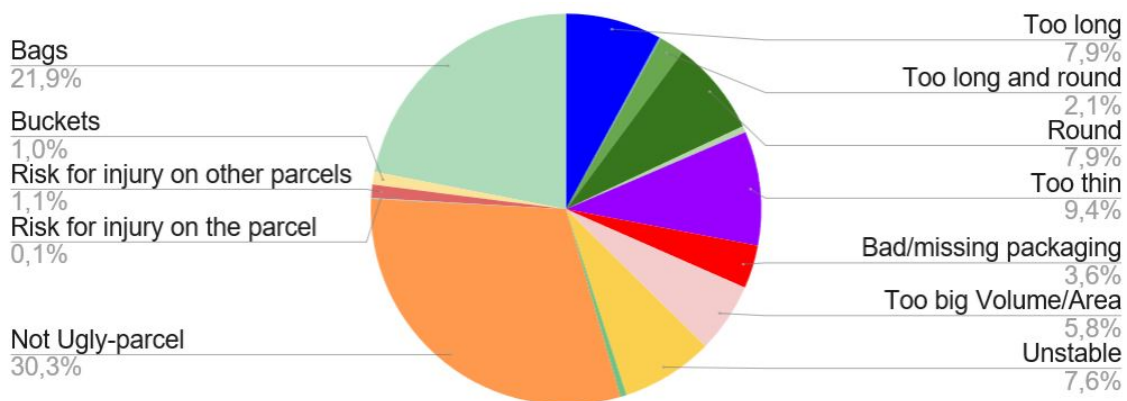
**Figure 4.11:** Layout Terminal E, all red areas represent an area where Ugly-parcels are handled.

pallets or in parcel-cages. These are firstly placed nearby the parcel sorting conveyor, place 3.2 in figure 4.11. The parcels are then transported to the inline station for the parcel sorting conveyor if there are mostly parcels that can be handled by the sorting conveyor on or in the load carrier, place 1. If there is a majority of Ugly-parcels in or on the load carrier, it will be transferred directly to the straight conveyor belt, place 3.3 in figure 4.11. The load carriers that are handled on the

inline station and lifted by a cage-lifter can also contain Ugly-parcels, these parcels are sorted out and placed in a parcel-cage nearby the station, place 3.1. These parcel-cages are then transferred to the straight conveyor belt, place 3.3 in figure 4.11.

At the straight conveyor belt are the parcels lifted on to the conveyor, then scanned automatically by the cargo-scanner. Lastly, they are lifted from the conveyor and placed in the right parcel-cage. At the inline of the straight conveyor belt have the workers a smaller lifting table that they can use to lift the cages or pallets to a good level to unload them. They also have a vacuum-lifter there which they can use. If the parcel-cages are full, they will directly be moved to the right shipping line. If the cages still have some room left, will they be transferred to the outlines, place 2 in figure 4.11, where the personnel can fill them up with other parcels. If there are no more parcels that need to be processed, the personnel will try to fit the Ugly-parcels in the other parcel-cages to ensure a high utility of the parcel-cage.

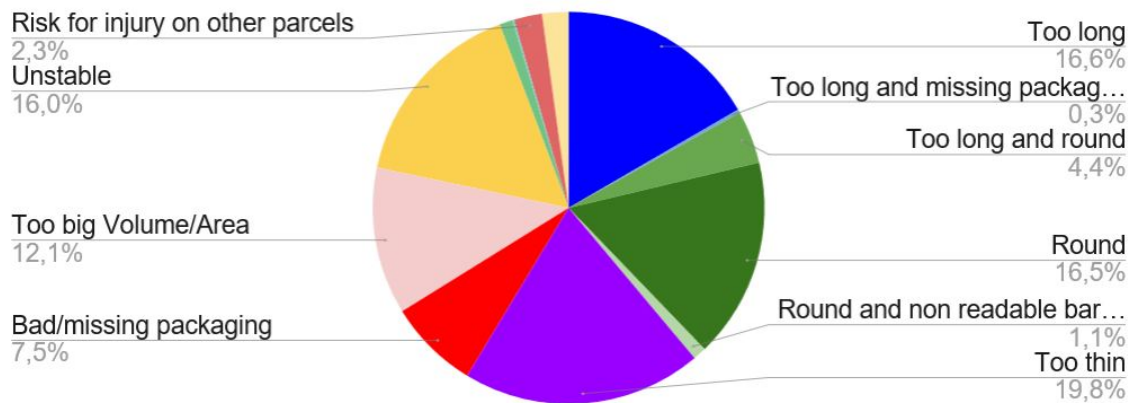
In figure 4.12 are the data collected from terminal E visualized. In total where 1536 parcels handled on the straight conveyor belt and therefore studied, which was 18,9% of the total volume of parcels processed in the terminal during the departing shift.



**Figure 4.12:** Statistics Terminal E

Some of the parcels that were handled on the straight conveyor belt could have been handled on the parcel sorting conveyor. These parcels are therefore removed from the data, which will result in a new visualization, figure 4.13. This data is now consisting of 733 parcels which are 9,0% of the total production volume. At terminal E, they are also sorting bags on the straight conveyor belt since they have problems with the cargo-scanner. It is only terminal E that has that problem, so data is removed from the statistics.

#### 4. Analysis of current state

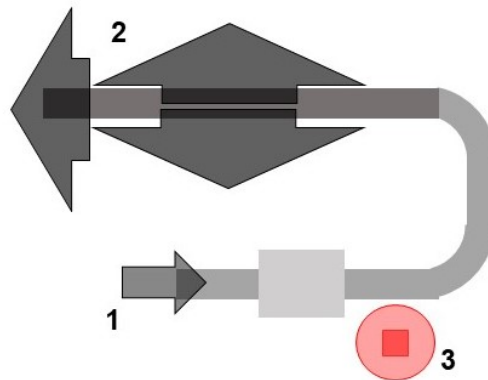


**Figure 4.13:** Reviewed statistics Terminal E

At terminal E, is the biggest category of Ugly-parcels the round ones, 22% of the Ugly parcels. The second-largest category is the parcels that are too thin, 19,8%. These statistics are in line with the distribution of Ugly-parcels at terminal A and terminal D that also have many Ugly-parcels.

##### 4.1.1.6 Terminal F

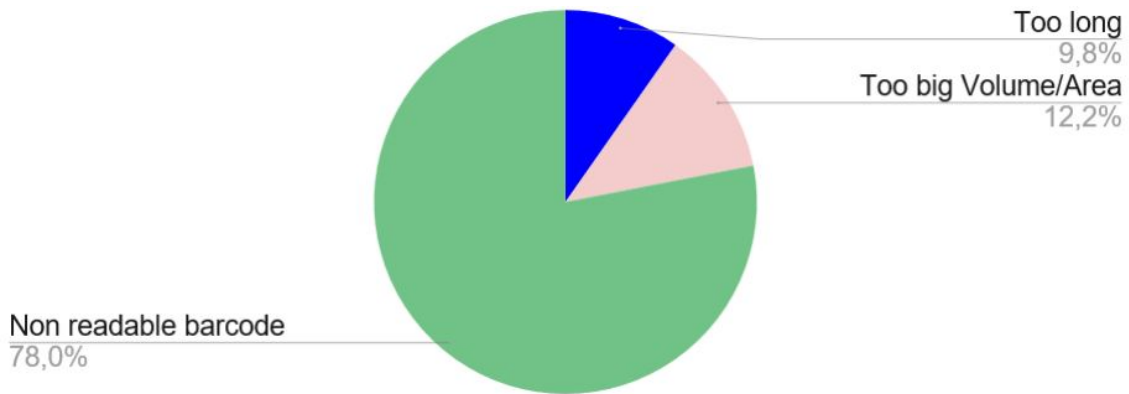
Figure 4.14 shows the overall layout of the parcel sorting conveyor at Terminal F. The terminal only has a straight conveyor belt, which means that all the sorting is



**Figure 4.14:** Layout Terminal F, all red areas represent an area where Ugly-parcels are handled.

done manually without any help from the parcel sorting conveyor. The parcel sorting conveyor that the terminal has can also handle all parcels in the product terms for a parcel. The parcels that require some extra handling are the ones that the cargo-checker stops for, and these can be, for example, that the bar-code couldn't be read. If this is the case, will they stop after the cargo-scanner, place 3, in figure 4.14. Then the operator at the inline station needs to walk there and solve the problem. One thing to note for this terminal is that they don't have a cage-lifter at the inline station. According to the workers at the terminal, they have had a high lifting forklift there, but it was broken for the moment.

In figure 4.15 are the data collected from terminal F visualized. In total was 41 parcels handled on the side of the parcel sorting conveyor therefore studied, which was 2,0% of the total volume of parcels processed in the terminal during the departing shift.



**Figure 4.15:** Statistics Terminal F

To be noted is that all parcels could be handled on the parcel sorting conveyor. The parcels that were included in the statistics just needed some extra handling. The ones that were too long or too big needed to be removed from the parcel sorting conveyor since they were outside of the product terms for parcels. The parcels with nonreadable bar-code required the operator at the inline station to scan them manually, but they could still be processed on the sorting conveyor. So when the data is reviewed, can all data be removed for Terminal F, so 0 parcels are considered as Ugly-parcels. Terminal F will not be analyzed further since the limitation of the project is to focus on the Ugly-parcels.

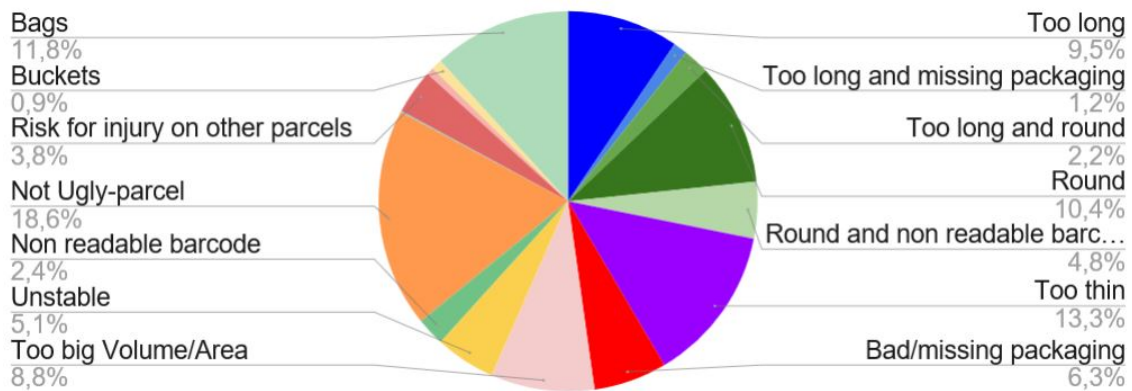
#### 4.1.1.7 Grouping of terminals

After the terminal visits, it is conducted that there are two main ways to handle Ugly-parcels. Either use a straight conveyor belt or handle them on the side of the parcel sorting conveyor. The ones that use a straight conveyor belt to sort the parcels are the terminals that have a higher volume of ugly-parcels. The other terminals all put away the Ugly-parcels at the inline station in a parcel-cage and then move that parcel-cage to the outline stations. The terminals with a higher volume cannot use the same method to handle the Ugly-parcel as the other terminals since the outlines for those terminals cover a larger surface.

#### 4.1.1.8 Summary from statistics

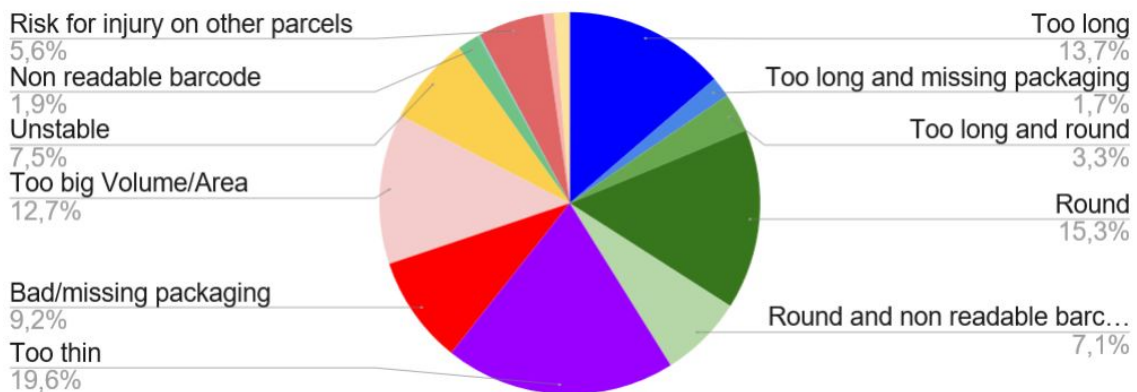
In figure 4.16 the unrefined statistics are presented and summarized.

#### 4. Analysis of current state



**Figure 4.16:** Statistics summarized

In figure 4.17 the reviewed statistics for all six terminals are summarized.



**Figure 4.17:** Reviewed statistics, summarized

As can be seen, in figure 4.17, the biggest groups for Ugly-parcels are the too thin parcels, round parcels, parcels with too big volume, or area and too long parcels. These four categories represent together 73,4% of the total amount of Ugly-parcels. The mean proportion of Ugly-parcels that a terminal has is 3,6% of the total volume of the terminals' whole volume during the departing shift.

At the terminal visits, it could be concluded that some of the ugly-parcels mainly affected productivity, and some mostly affected the lifting conditions for the worker. Lifting conditions mean that the terminal worker needs to lift the parcel a different way due to its shape. The parcels that mainly affect the productivity are the round, the too thin, the ones with bad or missing packaging, the ones with no readable bar-code, the ones that risk to damage other parcels, bags, and buckets. The ones that mainly affect the lifting conditions are the too long, too big, and the unstable parcels. These will further be referred to as the especially ungainly parcels.

#### 4.1.2 Productivity for Ugly-parcels

The productivity is calculated based on all parcels that have been handled in a separate flow independent of whether they are ugly-parcels. The first productivity

measure that has been analyzed is productivity based on the whole volume. Since three of the terminals have a separate flow for the Ugly-parcel handling, those resources required for that handling can be isolated from the other handling.

The answer tells how much longer working time is spent on each parcel at the Ugly-parcel handling than the normal handling for all terminals that has a separate flow for the Ugly-parcel handling. The terminals that don't have a separate flow for the Ugly-parcels cannot be analyzed with this calculation. The results of the calculation are displayed in table 4.1.

**Table 4.1:** Productivity calculations current state based on the total volume processed

<b>Terminal</b>	<b>Difference Ugly-parcel and Normal processing</b>
Terminal A	222% longer
Terminal B	N/A
Terminal C	N/A
Terminal D	73% longer
Terminal E	17% longer
Terminal F	N/A

To analyze the productivity for all terminals that has the handling of Ugly-parcels has observations been made. The different parts of the handling of a parcel in the normal flow and the Ugly-parcel flow have been studied. The answer tells how much more time one Ugly-parcel takes to process than a normal parcel when the single parcel is studied. The result is presented in table 4.2.

**Table 4.2:** Productivity calculations current state when the single parcel is studied

<b>Terminal</b>	<b>Difference Ugly-parcel and Normal processing</b>
Terminal A	570% longer
Terminal B	164% longer
Terminal C	156% longer
Terminal D	393% longer
Terminal E	275% longer
Terminal F	N/A

In table 4.2 can it be seen that terminal A, D, and E all take over 200% longer time to handle the Ugly-parcels, at terminal A is it as much as 570% longer. At terminal D and E takes it around 150% longer times to process the Ugly-parcels. It is therefore clear that to use a straight conveyor belt is not more efficient than to sort them out manually at the outlines. This result is expected since at least one extra lift of each parcel is required when the terminal uses a straight conveyor belt compared to if they don't use it. However, it is not possible for terminal A, D, and E to start to handle the parcels as terminal B and C due to that at terminal A, D and E are there a longer distance between the outlines.

## 4.2 Ergonomic effects of Ugly-parcels

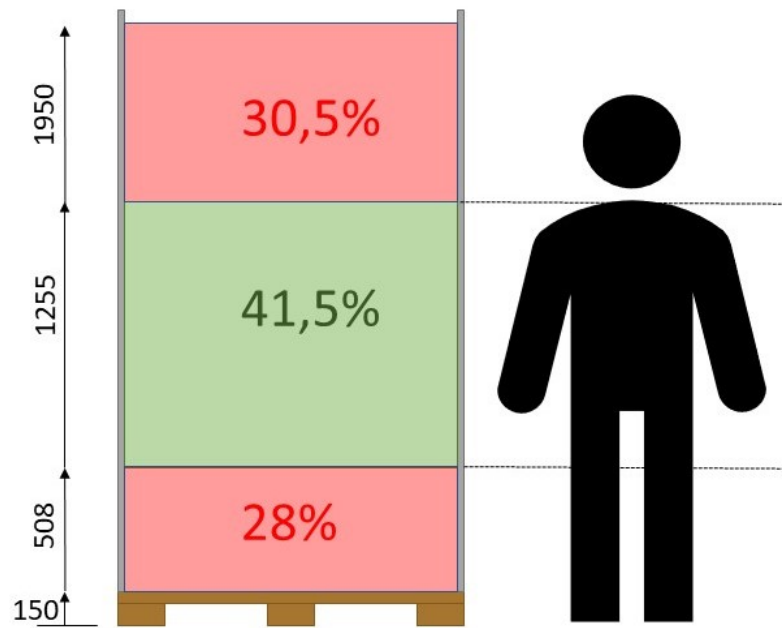
To study the ergonomic effects of Ugly-parcels, three areas of ergonomics have been studied: physical, cognitive, and organizational ergonomics.

### 4.2.1 Physical ergonomic effects

To study the ergonomic effects of Ugly-parcels KIM I and III been used. KIM I was the primary method used, but KIM III was used as a complement to verify the results from KIM I. The results will be presented in the two groups of terminals, the terminals with a straight conveyor belt and those that don't have one.

KIM I depends on four grading areas; time, weight, posture and work conditions. The time factor in KIM I was established by looking at the data collection form the terminal visits. There was found how many parcels were handled on the side of the normal parcel flow and why they were handled on the side. By analyzing the statistic data from DB Schenker could it be determined how many parcels that where handled in each of the weight intervals.

By looking at the movies from the observations could it be determined that the lifting position differed depending on where in the parcel-cage a parcel was located or should be placed. When a parcel was located below the knee level or over shoulder level, it can be seen in the videos from the terminal visits that the posture rating point would be higher. The parcel-cage was therefore divided into zones, see figure 4.18 for an illustration. The postures that the worker had during the lift over shoulder level and under knee level where valued as a four in KIM I. Others were valued as a two. To estimate how many parcels that are located in each of the zones have anthropometrical measurements been used. To include many workers has the knee level for the 95th percentile man and the shoulder level for the 5th percentile women been used. This will give quite hard limits where more parcels are considered as badly placed that it usually is for a worker since one person probably not have both the knee level as the 95th percentile man and the shoulder level as the 5th percentile women. The measurement for the knee level is 508mm and for shoulder level 1255mm (Hanson et al. 2009).



**Figure 4.18:** Zones in a parcel-cage

It is assumed that the amount of parcels that are in a zone only depends on the volume of the cage. This is not absolutely accurate since some parcel is bigger than others, but these assumptions make it possible to do the analysis.

Based on the videos recorded, could it be seen that the operator's lifting position was affected when he or she lifted some kind of parcels. The three shapes that affected the lifting position were long parcels, parcels with big volume and unstable parcels. Since the ungainly parcels changed, the lifting posture was this posture graded with a four.

The work condition is mostly depending on how easy it is to perform the lift if it is any space restrictions or not. Therefore will this parameter be 0 for all parcels that are not especially ungainly. The parcels that are long, have especially big volume or that are unstable are considered as ungainly parcels. From the videos for the operator, it can be seen that the operators are somewhat restricted when they lift the parcels with a big volume and even more restricted when they lift the parcels that are unstable. Hence, these get the work condition factors one respective two.

When KIM III is used to analyze the handling of Ugly-parcels is the whole sequence for handling one parcel studied. To determine the factors was a guide for the method studied. The filled-in worksheets for all terminals can be found in appendix D. The KIM III method consists of seven factors: type of force, force transfer, hand/arm position, work organization, work condition, posture, and time. The force type factor is determined by the handling done (if it is a movement or holding) and the level of the force. This was for all terminals estimated to one holding sequence and two moving sequences. How many movements or holdings that where done depended on the total amount of hour a person spends on parcel handling divided by the volume

handled on the side of the normal parcel flow.

The force transfer factor was established by looking at the manual for the KIM III method. The grip on a parcel was estimated to a two, which means that the force transfer is restricted. The reason for that was due to the fact that the parcel doesn't fit in the palm of the operator and that there are no well-shaped handles on the parcels. The hand and arm position factors were estimated to a one, which means that the position and movement are restricted in occasional positions or movements since the joints are at the limit of the movement of range. It was done since occasionally; the operator needs to stretch to reach parcel or to be able to place them in the parcel-cage.

The work organization was given rating one since few work positions limit the possible rotations. This was established since nearly all work station, or tasks involve parcel lifting, either to lift them on to the parcel sorting conveyor or to lift them off. It is very few operations that don't consist of any lifting. The work condition rating was established to be a one since many of the workers and managers complained over dust, noise, and temperature irregularities in the terminal during the interviews. The posture factor was established to be a three for the parcels that were located in the green zone in the parcel-cage and a five for those that were located in the red zone. Lastly was the time rating point established by analyzing how many hours of a shift that the Ugly-parcels was handled.

Below will the results of the analysis for each terminal be presented.

### 4.2.1.1 Terminal A, D and E

Terminal A, D, and E all use a straight conveyor belt to sort the Ugly-parcels. In the calculations, it has been used that each parcel is lifted two times by the operators, one time on to the conveyor and one time off the conveyor. The terminal worker does the task when the parcels are placed in a cage by the inline station at that station, and that has not been analyzed. The focus had been to analyze just the Ugly-parcel flow.

The results of the analysis with KIM I and III are presented in figure 4.19, 4.20, and 4.21.

#### **Terminal A**

The results from the analysis for terminal A are presented in figure 4.19 below. The KIM I study results show that the risk rate is three for men and four for women. The risk rate for men is on the limit for being a four since the limit is 50. Risk rate four is the highest risk rate, according to the KIM study. It means that it is a high load situation, where physical overload is likely to appear. It means that a workplace redesign is necessary.

KIM I		KIM III	
TERMINAL A	Summary	TERMINAL A	Summary
INLINE/ OUTLINE		INLINE/ OUTLINE	
Number of handlings	521	Time rating	4
Time rating	8	Type of force	6
Load rating (W)	5,3119266	Force transfer	2
Load rating (M)	2,4587156	Hand/arm position and movement	1
Position rating	3,498215	Work organisation	1
Work condition	0,0978887	Working conditions	1
Total (W)	71,264242	Posture	4,498214971
Risk rate (W)	4	Total	61,99285988
Total (M)	48,438554	Risk rate	4
Risk rate (M)	3		

(a) KIM I

(b) KIM III

**Figure 4.19:** Ergonomic analyses with KIM I and III at Terminal A

The risk rate, according to the KIM III study, is also a four. The results, therefore, indicate that it is problems with the physical ergonomics at terminal A.

### Terminal D

The results from the ergonomic analysis for terminal D is presented in figure 4.20. The results show that according to KIM I is the risk rate three for men and four from women. The results from KIM III give and risk rate four. The results show the same effects as for terminal A.

KIM I		KIM III	
TERMINAL D	Summary	TERMINAL D	Summary
INLINE/ OUTLINE		INLINE/ OUTLINE	
Number of handlings	940,5	Time rating	4,5
Time rating	8	Type of force	6
Load rating (W)	2,61734694	Force transfer	2
Load rating (M)	1,34863946	Hand/arm position and movement	1
Position rating	3,50173844	Work organisation	1
Work condition	0,23763955	Working conditions	1
Total (W)	50,8537994	Posture	4,501738437
Risk rate (W)	4	Total	69,75782297
Total (M)	40,7041396	Risk rate	4
Risk rate (M)	3		

(a) KIM I

(b) KIM III

**Figure 4.20:** Ergonomic analyses with KIM I and III at Terminal D

### Terminal E

According to KIM I, the risk rate is three for men and four for women at terminal E. The risk rate for men is on the limit for being a four as well. The risk rate, according to KIM II, is a four. The results can be seen in figure 4.21.

#### 4. Analysis of current state

KIM I		KIM III	
TERMINAL E	Summary	TERMINAL E	Summary
INLINE/ OUTLINE		INLINE/ OUTLINE	
Number of handlings	1536	Time rating	3
Time rating	10	Type of force	8
Load rating (W)	1,713107997	Force transfer	2
Load rating (M)	1,169002473	Hand/arm position and movement	1
Position rating	3,405677083	Work organisation	1
Work condition	0,210286458	Working conditions	1
Total (W)	53,29071538	Posture	4,405677083
Risk rate (W)	4	Total	52,21703125
Total (M)	47,84966015	Risk rate	4
Risk rate (M)	3		

(a) KIM I

(b) KIM III

**Figure 4.21:** Ergonomic analyses with KIM I and III at Terminal E

According to KIM III, all results from the ergonomic studies at terminals that use a straight conveyor belt for sorting the Ugly-parcels have a risk rate of four. All analyses also show that according to KIM I have all terminals and risk rate of three for men and four for women. This means that a redesign of the straight conveyor belts is necessary. The results from the interviews also support the results from the ergonomic study, see figure 4.3.

**Table 4.3:** Summary of interviews about physical overload

Area	TW	WL
Have you (the workers) experienced any physical overload?	5/7 Yes, 2/7 No	3/6 Yes, 3/6 No
	<b>TM</b> 4/7 Yes, 3/7 No, 1/7 Don't know	<b>Total</b> 11/20 Yes, 8/20 No, 1/20 Don't know

In the interviews were in total 11/20, stating that they or the workers have gotten any physical overload from work. In total said 5/7 workers that themselves have suffered from physical overload from work.

#### 4.2.1.2 Terminal B and C

Terminal B and C don't use any straight conveyor belt to sort the Ugly-parcels. These terminals are instead placing the parcels in a parcel-cage by the inline station and then drive that parcel-cage with a forklift to the outlines where the parcels are sorted out. These terminals can use this method to sort the Ugly-parcels since they have smaller parcel sorting conveyor where the distances between the outlines are small. Two tasks will be studied with KIM I, both the lifts at the inline and outline and the carrying.

#### Terminal B

The result from the ergonomic studies at terminal B is presented in figure 4.22. The results from KIM I for the lifts give a risk rate of two for both men and women,

and for the carrying sequence and risk rate of two for men and women. A risk rate of two in KIM represents an increased loading situation, which means that physical overload is possible for less resilient people.

KIM I		KIM I		KIM III	
TERMINAL B	Summary	TERMINAL B	Summary	TERMINAL B	Summary
INLINE / OUTLINE		CARRYING		INLINE/ OUTLINE	
Number of handlings	23	Number of handlings	23	Time rating	1
Time rating	2	Distance	345	Type of force	6
Load rating (W)	1,535714286	Time rating	2	Force transfer	2
Load rating (M)	1,071428571	Load rating (W)	1,535714286	Hand/arm position and movement	1
Position rating	3,69173913	Load rating (M)	1,071428571	Work organisation	1
Work condition	0,608695652	Position rating	3,69173913	Working conditions	1
Total (W)	11,67229814	Work condition	0,608695652	Posture	4,69173913
Risk rate (W)	2	Total (W)	11,67229814	Total	15,69173913
Total (M)	10,74372671	Risk rate (W)	2	Risk rate	2
Risk rate (M)	2	Total (M)	10,74372671		
		Risk rate (M)	2		

(a) KIM I Inline and outline (b) KIM I Carrying (c) KIM III

Figure 4.22: Ergonomic analyses with KIM I and III at Terminal B

The risk rate in KIM III was also calculated too two. This risk rate is considered acceptable since it is physical work, so it will be hard to remove all risks.

Terminal C

The results for KIM I gave a risk rate of three for women and two for men. The risk rate for women is just over the border to be three. The risk rate, according to KIM III two. The results are presented in figure 4.23 below.

KIM I		KIM I		KIM III	
TERMINAL C	Summary	TERMINAL C	Summary	TERMINAL C	Summary
OUTLINE		CARRYING		INLINE/ OUTLINE	
Number of handlings	44	Number of handlings	44	Time rating	1
Time rating	4	Distance	220	Type of force	6
Load rating (W)	3,384615	Time rating	1	Force transfer	2
Load rating (M)	1,6	Load rating (W)	3,38461538	Hand/arm position and movement	1
Position rating	3,465455	Load rating (M)	1,6	Work organisation	1
Work condition	0,227273	Position rating	3,46545455	Working conditions	1
Total (W)	28,30937	Work condition	0,22727273	Posture	4,465454545
Risk rate (W)	3	Total (W)	7,07734266	Total	15,46545455
Total (M)	21,17091	Risk rate (W)	1	Risk rate	2
Risk rate (M)	2	Total (M)	5,29272727		
		Risk rate (M)	1		

(a) KIM I Inline and outline (b) KIM I Carrying (c) KIM III

Figure 4.23: Ergonomic analyses with KIM I and III at Terminal C

The results show as for terminal B that the risk rate slightly increases for the less resilient people on the limit to be a three where there is a possibility for a physical overload for all people. The risk rate is slightly higher for terminal C compared to terminal D because the volume is slightly higher at terminal C and that there are more ungainly parcels at terminal C.

However, if the volume would increase of Ugly-parcels to a volume similar to the one at terminal A, D, or E, would the risk rate increase to a three or even a four depending how much ungainly parcels that are handled. So if the volumes would drastically increase, would it be necessary to redesign the workplace. However, if the volumes increase, will it problem also require a bigger parcel sorting conveyor, which will make the Ugly-parcel handling without any separate flow very hard. If the volume would increase, would most likely a straight conveyor belt be installed. Due to that will the focus for improving the physical ergonomics aims to improve the work at the straight conveyor belts.

During the interviews, the interviewees mention that they have experienced pain in the back, the shoulders, and the feet. The back and the shoulders are commonly represented within the musculoskeletal disorders (MSD). Since most of the workers now only experienced pain, it is important to try to improve the work situation before they get more severe symptoms like loss of function, limited movement range, and loss of muscle power. MSD, often in the long term, leads to sick leave, which is associated with high costs for the company.

There is a lot of improvement potential regarding physical ergonomics. Some of the problem areas are more severe than others and will be discussed in detail in the report. The problem areas that will be covered further in the report are:

- Decrease the number of manual lifts of Ugly-parcels.
- Improve the lifting position for Ugly-parcels.
- Minimise the risk of MSD injuries for the workers.

#### **4.2.2 Cognitive ergonomic effects**

The cognitive ergonomics for the workers at the terminals will be considered both with background from the answers from the interviews and observations during the terminal visits. The answers that will be considered from the interviews are summarized in table 4.4.

The main areas that will be covered are the amount of support for attention, memory, and perception. To start more generally it was said by in total 9/20 that they consider the parcel handling as mentally demanding. Four out of the eleven where terminal workers.

To support the attention, the time and effort to find information be minimized. Only 1/20 said that they experienced that there were any obstacles to reading or finding information in the terminal, see table 4.4. It is, therefore, unlikely that it is any problem to find information. However, at the terminal visits, it was observed that when the workers needed to look at the signs at the straight conveyor belt, they needed to look up, which means that the sign probably is placed a bit too high.

DB Schenker can also try to consider if there is any information that needs to be presented at the same time in order to make sense of it. Regarding the sorting,

only the sorting concepts and in which cage each sorting concept should be placed are necessary information for the operator. This information is presented at the same time since the sign of which destinations that should be placed at a certain sorting concept are located over the cage for the sorting concept. However when the cargo-checker stops due to problems with the reading of the parcel, or with the parcel itself, there is some potential for improvements. When the cargo-checker stops it will be displayed on the computer what is wrong with the parcel, but depending on what is wrong the operator should handle it differently. The information of what should be done is not displayed anywhere. At terminal F they have put up a sign by the computer explaining what to do for certain errors. This helped so that all workers could understand what to do without asking the more experienced personnel. This made it possible for the managers to put all workers at the station where the computer was handled.

**Table 4.4:** Summary of interviews about cognitive overload

<b>Area</b>	<b>TW</b>	<b>WL</b>
Are any parts of the handling mentally demanding?	4/7 Yes, 3/7 No	2/6 Yes, 4/6 No
	<b>TM</b>	<b>Total</b>
	3/7 Yes, 4/7 No	9/20 Yes, 11/20 No
	<b>TW</b>	<b>WL</b>
Are there any obstacles for reading/see the information in the terminal?	1/7 Yes, 6/7 No	0/6 Yes, 6/6 No
	<b>TM</b>	<b>Total</b>
	0/7 Yes, 7/7 No	1/20 Yes, 19/20 No
	<b>TW</b>	<b>WL</b>
Are there any noises in the terminal?	5/7 Yes, 2/7 No	5/6 Yes, 1/6 No
	<b>TM</b>	<b>Total</b>
	4/7 Yes, 3/7 No	14/20 Yes, 6/20 No
	<b>TW</b>	<b>WL</b>
Do the workers need to focus on several things at the same time?	4/7 Yes, 3/7 No	2/6 Yes, 4/6 No
	<b>TM</b>	<b>Total</b>
	2/7 Yes, 3/7 No, 2/7 Don't know	8/20 Yes, 10/20 No, 2/20 Don't know
	<b>TW</b>	<b>WL</b>
Do the workers need to remember the sorting by heart?	7/7 Yes, 0/7 No	1/6 Yes, 4/6 No, 1/6 Don't know
	<b>TM</b>	<b>Total</b>
	2/7 Yes, 4/7 No, 1/7 Don't know	10/20 Yes, 8/20 No, 2/20 Don't know
	<b>TW</b>	<b>WL</b>
Is it easy to make errors?	6/7 Yes, 1/7 No	3/6 Yes, 3/6 No
	<b>TM</b>	<b>Total</b>
	7/7 Yes, 0/7 No	16/20 Yes, 4/20 No
	<b>TW</b>	<b>WL</b>
Are there any similar sorting concepts?	7/7 Yes, 0/7 No	3/6 Yes, 2/6 No, 1/6 Don't know
	<b>TM</b>	<b>Total</b>
	3/7 Yes, 0/7 No, 4/7 Don't know	13/20 Yes, 2/20 No, 5/20 Don't know
	<b>TW</b>	<b>WL</b>
Do you have any standardised working procedure?	4/7 Yes, 3/7 No	3/6 Yes, 3/6 No
	<b>TM</b>	<b>Total</b>
	3/7 Yes, 4/7 No	10/20 Yes, 10/20 No
	<b>TW</b>	<b>WL</b>
Do you have any work-instructions?	1/7 Yes, 6/7 No	1/6 Yes, 5/6 No
	<b>TM</b>	<b>Total</b>
	1/7 Yes, 6/7 No	3/20 Yes, 17/20 No

Lastly is it recommended to use multiple sources of information to stimulate more senses. All the information regarding how to do the sorting is presented and are

brought to attention by stimulating the vision. In order to minimise the cognitive work load more senses could be stimulated when the sorting is done. Some of the interviewees stated that they also use their hearing a lot and therefore are they not using earplugs even though it would be good to protect their hearing. The interviewees said that they wanted to be able to hear the forklifts around them since that made them feel safer.

The interviewees were also asked if they experienced any noises in the terminal, and if those noises were disturbing their focus. In total, 14/20 experienced a lot of noise in the terminal. They stated that the noises mostly came from the parcel sorting conveyor or the forklifts. They didn't perceive the sounds as disturbing. The only sound that could get them to react was if a pallet was dropped, which created a very high sudden sound. In total, 8/20 of the interviewees said they needed to focus on several things simultaneously. The interviewees stated that those that needed to focus on several things simultaneously were those that were more experienced. This since they needed to cover for the more inexperienced personnel and also provide them with information on what to do and how.

To support the memory, the use of the short term memory should be minimized. In total, 10/20 interviewees (of which 7 were terminal workers) stated that you needed to remember the sorting by heart to manage. This means that only 3/20 manager stated that you need to remember the sorting by heart, which indicates that the manager might lack understanding of what the workers need to remember, which can make them think that the information provided is enough. The terminal workers said that it takes too long time to read the signs with all sorting concepts and places. They said that in the beginning, before you have learned, it is tough to do the sorting, and you are very mentally tired when you go home from work. This means that in the beginning the workers are required to keep a lot of information in their short term memory before they have worked for a while, and the information has been transferred to the long term memory. To categorize the information and "place" it into the long term memory requires that the terminal worker makes sense of the information and understands its context. This means that if the worker has good geographic knowledge, it might be easier to learn the sorting faster since he or she will have an easier time making sense of the information faster. Some of the workers that newly have moved to Sweden, therefore, are more likely to think it is harder to learn the sorting since it is harder for them to make sense of the information. So to minimize the use of the short term memory, either the learning process could be stimulated or the need to remember a lot of information minimized.

To support the memory the anticipated system status can also be shown. This would help the workers to understand what the current state would lead to in the future. The need to have experience and remember old events and characteristics is, therefore, decreased. This is not done today at any of the terminals visited. You can also use the consistent presentation of information to support the memory when you redesign the workplace. It will help the worker to remember what to do without having to relearn everything again. This is not something that has been used

at the terminals since not any major redesign of the workplaces have been performed.

To support the perceptions several things can be considered. The first one is to have legible displays. Since 19/20 said that there is no problem with reading the information, this is not a big problem for the terminals. However, it could be observed at the terminal visits that the text and information at the labels on the parcels have a quite small text. This might lead to people with bad vision have it harder to read that information. Too many levels of information should also be avoided. At the terminals is the information not presented at several levels, so that is not a problem. Another support recommendation is that data requiring knowledge to be interpreted should be avoided. The information mentioned before about what is wrong when the cargo-checker stops requires the operator to interpret the information and act on it. Since only 10/20 mention that they use standardized working and 3/20 that they have work instructions, it is also required from the terminals workers to interpret what to do during the shift.

To support the perception similar objects should be avoided. In the interviews, 13/20 said that some of the sorting concepts are similar and easy to mix up. 7/7 terminal workers said that they have similar sorting concepts. According to the interviewees, it could either be that the name of the places is similar or that the postcodes are similar. 16/20 also said that it is easy to make errors and put the parcel in the wrong parcel-cage. It should, therefore, be considered whether a new method could decrease the risk of making errors.

Lastly, it is recommended to use multiple sources of information to stimulate more senses. All the information regarding how to do the sorting is presented and are brought to attention by stimulating the vision. To minimize the cognitive workload could more senses be stimulated when the sorting is done. Some of the interviewees stated that they also use the hearing a lot and, therefore, are not using earplugs even though it would be good to protect their hearing. The interviewees said that they wanted to be able to hear the forklifts around them since that made them feel safer.

Other supporting aids for decreasing the cognitive workload is to illustrate the realism and show movable objects. Meaning that the information should be shown in such a way that it is logical to see it. At the terminal visits were some of the workers mentioning that they try to put the sorting signs in a geographical order to make it easier to find the right parcel-cage.

There is some improvement potential regarding the cognitive ergonomics. Some of the problem areas are more severe than others and will be discussed more in detail further in the report. The problem areas that will be covered further in the report are:

- Clearer information of what to do with certain parcels.
- Decrease the noise level.
- Minimise the need to remember the sorting by heart.

- Support standardise work and work instructions.
- Decrease the risk for sorting errors.

### **4.2.3 Organizational ergonomic effects**

The organizational ergonomic effects for the workers at the terminals will as the cognitive be considered both with background from the interviews and from observations during the terminal visits. The main areas that will be covered are stress, boredom, motivation and learning. In order to get an understanding of the stress level for the workers have all interviewees been asked questions regarding areas that can cause stress. This eight stress factors is described in detail in the theory of this thesis 2.3.1. The answers from the interviews are summarised in table 4.5.

#### 4. Analysis of current state

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**Table 4.5:** Summary of interviews about stress

<b>Area</b>	<b>TW</b>	<b>WL</b>
Can the workers affect the work or the routines?	4/7 Yes, 3/7 No	4/6 Yes, 2/6 No
	<b>TM</b>	<b>Total</b>
	6/7 Yes, 1/7 No	14/20 Yes, 6/20 No
	<b>TW</b>	<b>WL</b>
Can the workers leave improvement suggestions?	5/7 Yes, 2/7 No	6/6 Yes, 0/6 No
	<b>TM</b>	<b>Total</b>
	7/7 Yes, 0/7 No	18/20 Yes, 2/20 No
	<b>TW</b>	<b>WL</b>
Do you feel that you have support from you boss?	7/7 Yes, 0/7 No	6/6 Yes, 0/6 No
	<b>TM</b>	<b>Total</b>
	Was not asked	13/13 Yes, 0/13 No
	<b>TW</b>	<b>WL</b>
How high is the workload for the terminal workers?	3/7 High, 4/7 Medium	3/6 High, 3/6 Medium
	<b>TM</b>	<b>Total</b>
	6/7 High, 1/7 Medium	12/20 High, 8/20 Medium
	<b>TW</b>	<b>WL</b>
Is it easy to meet the performance demands?	3/7 Yes, 4/7 No	4/6 Yes, 2/6 No
	<b>TM</b>	<b>Total</b>
	4/7 Yes, 3/7 No	11/20 Yes, 9/20 No
	<b>TW</b>	<b>WL</b>
Do you feel that you have a good job security?	7/7 Yes, 0/7 No	6/6 Yes, 0/6 No
	<b>TM</b>	<b>Total</b>
	7/7 Yes, 0/7 No	20/20 Yes, 0/20 No
	<b>TW</b>	<b>WL</b>
What are you thought about the climate in the terminal?	- Weather dependent heat 5/7 - Dusty 3/7 - Noisy 1/7 - Good 1/7	- Weather dependent heat 4/6 - Dusty 1/6 - Noisy 1/6 - Good 1/6
	<b>TM</b>	<b>Total</b>
	- Weather dependent heat 6/7 - Dusty 2/7 - Noisy 0/7 - Good 1/7 - Bad lightning 2/7	- Weather dependent heat 15/20 - Dusty 6/20 - Noisy 2/20 - Good 3/20 - Bad lightning 2/20

In order to estimate the level of job control the terminal workers have was it asked if they could effect the routines and if they could leave improvement suggestions. In total 14/20 said that the workers could affect the work and the work routines and 18/20 said that the workers could leave improvement suggestions. However worth noting is that the ones who said that you cannot leave improvement suggestions was all terminal workers. This means that even though that the managers are open

for improvement suggestions have this not be communicated or organized in such a way that all terminal workers feel that they can leave improvement suggestions. However since so many said that they can affect and control their own work so is it most likely so that the workers at least have some job control. In order to estimate whether the employees have any social support in their work have the terminal workers and the work leaders been asked if they feel that they have support from their boss. 13/13 felt that they have support from their boss which indicates that the social support is good for the workers.

To estimate if the workers feel and job distress have all interviewees been asked how high they estimate the terminal workers' workload. 12/20 estimate the workload to be high and 8/20 estimate the workload to be medium. It means that some might experience the workload as high and some as medium or a decent workload. During the interview was it said by many that it could be high when they have late trucks since they have a small delivery window, which means that they have little time between when the parcel arrives at the terminal and when they need to depart. So the workload is quite high for the terminal workers. The interviewees were asked if they felt that they could meet the performance demands to estimate how high the performance demands are. 11/20 felt that they could meet the performance demands, and 9/20 felt that they rarely could meet the performance demands. Many of the interviewees brought up that it can be hard with the small delivery window and if any disorders accrued, could they not deliver and had to leave parcels for the next day. It can, therefore, be said that it can be hard to meet the performance demands, and often, it is in combination with the high workload that can create problems.

The interviewees were also asked if they felt good job security at DB Schenker, and 20/20 felt that they had that. The responsibility parameter and the complexity parameter were areas that can be allocated to specific questions but rather answered through other questions. The responsibility factors can increase the stress if the demands or task exceeds the available resources. Since many of the interviewees, as mentioned before, felt they had a hard time meeting the performance demands, so can it be said that they also have demands that exceed the available resources. The complexity means the number of tasks or responsibilities that a worker has. This could, if they are too few, lead to boredom and too many to stress. From observations during the terminal visits, it could be seen that some tasks had many responsibilities and some very few. So depending on where the worker was placed, so could it vary. Since it can vary, it can also be considered a good level since you can switch to another position if it is too high or too low one day can you have it higher or lower the other day.

Lastly, where the interviewees asked how they experience their physical work environment. A few complaints came up several times: weather dependent heat, dusty, noisy, and bad lightning. 15/20 mentions that the heat in the terminal was weather-dependent, meaning that if it is hot outside, is it hot in the terminal, and if it is cold, it is cold in the terminal. They have this problem since the gates to the terminal

open and closes when the trucks arrive or depart. They have installed weather seal that they experience has helped a lot, but they still have problems. The interviewees experienced heat as the biggest problem since they could put on more clothes when it was cold. The cold would, therefore, lead to some decreased performance due to more clothing that can limit the range of movement for the workers. The heat can be higher than moderate, leading to decreased performance and alertness (Berlin & Adams, 2017), which leads to a higher risk for mistakes and errors. As previously mentions, it is easy that errors occur and, therefore, can be very bad if that risk increases.

To summarise the stress for the workers, can it be said that the workload and the performance demands can be very high on the workers. This results in that parcels need to be left for the next day if there is any problem in the production. However, the interviewees' answers indicate that the support behind the workers is good, which leads to the workers being better suited to handle that increased workload.

Boredom and motivation will be discussed together since they are closely related. To analyze the motivation for the workers have several questions regarding that area been ask during the interviews, the summary is presented in table 4.6. The interviewees where ask about their general feelings about the work. 11/20 felt motivated, and 7/20 felt mostly motivated, but it variates from day today. This results in that the workers are satisfied with the work. Based on answers during the interview and from observations at the terminal visits where the terminal workers mostly motivate since they had good pay and also that they felt a responsibility towards the customers. If Fowler's spectrum of motivation is looked at, the pay is considered sub-optimal motivation, and the responsibility is feeling an optimal motivation. So dependent on what motivated the worker, he or she will be sub-optimal, motivate, or optimal motivate. Since the terminal workers never will experience the work, in the same way, this will be considered as acceptable levels of motivation. However, it is, of course, favorable if the motivation can be increased.

The interviewees where also ask how they or they think that the terminal workers feel after a work day. 14/20 thought that the terminal workers feel physical and/or mentally tired after a work day. This questions gives and general indication of that the work is demanding and it is therefore important that the organization gives good tools for the workers so they can mange the work. Lastly where the interviewees ask what characteristics a good work day have. This question was ask in order to get an understanding on what is important for the terminal workers and the managers. Many talked about that a good day is when they are finished with a margin. This means that all parcels are loaded on the trucks and they get sufficient time to clean after the production. Often mentioned was also that a good day is when there is no disturbances in terms of strange parcels and equipment problems. This means that for the workers and the manager is it important that the production flow. If there is any problems will it create stress and that will affect the workers.

**Table 4.6:** Summary of interviews about motivation and boredom

<b>Area</b>	<b>TW</b>	<b>WL</b>
What are your general feelings about the work?	- Routine 1/7 - Positive 1/7 - From day to day 1/7 - Motivated 4/7	- Motivated 3/6 - From day to day 3/6
	<b>TM</b>	<b>Total</b>
	- Motivated 4/7 - From day to day 3/7	- Motivated 11/20 - From day to day 7/20 - Routine 1/20 - Positive 1/20
Are the workers physical or mentally tired after a working day?	<b>TW</b>	<b>WL</b>
	- Physical 3/7 - Mentally 0/7 - Both 3/7 - No 1/7	- Physical 1/5 - Mentally 1/5 - Both 1/5 - No 2/5
	<b>TM</b>	<b>Total</b>
	- Physical 2/7 - Mentally 0/7 - Both 3/7 - No 2/7	- Physical 6/20 - Mentally 1/20 - Both 7/20 - No 6/20
What are the main factors that indicates a good working day?	<b>TW</b>	<b>WL</b>
	- Less Ugly-parcel 1/7 - Everyone helps 1/7 - Finished with a margin 5/7 - No pain in the back 1/7	- Less Ugly-parcel 1/5 - Finished with a margin 3/5 - No problems 1/5
	<b>TM</b>	<b>Total</b>
	- No problems 1/7 - Even flow 3/7 - Finished with a margin 2/7 - Everyone is safe 2/7 - High work load 1/7 - Trucks arrive in time 1/7	

The last organization parameter that will be discussed is the employee training. The interviewees were asked how they learned the work and how long time it took for them before they felt that they could perform in the expected speed. All interviewees said that they learn the work by going on the side of someone else and then asked them what to do. They didn't have any specific learning program or learning sequence. They learn the most basic tasks in the beginning and then later if they were interested could they learn the harder tasks. The interviewees said that the learning can take a couple of weeks up to two months depending on how easy it is for the worker to learn. At the terminal visits could it be observed that there were a lot of temporary workers in the production as well that were working with the parcel sorting. DB Schenker could therefore benefit from introducing a more formalised

#### 4. Analysis of current state

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introduction for the workers since they get in new temporary personnel often.

There is some improvement potential regarding the organizational ergonomics as well. Some of the problem areas are more severe than others and will be discussed more in detail further in the report. The problem areas that will be covered further in the report are:

- Make the process to leave improvement suggestions clearer.
- Match the performance demands to the available resources to minimize stress.
- Improve the physical environment.
- Improve the learning process for new employees.

# 5

## Results improvement suggestions

The improvements will be suggested based on a hierarchical structure. Therefore both smaller improvements that are easier to do but have smaller effects will be presented as well as bigger changes that completely remove the problems.

### 5.1 Physical ergonomics

Three main areas for improvement were mentioned in the current state analysis: decreasing the number of manual lifts of Ugly-parcels, improving the lifting position of Ugly-parcels, and minimizing the risk for MSD injuries. These problem areas will be discussed in the following sections, and improvement suggestions on different hierarchical levels will be presented. Solutions that can be evaluated with KIM I and III will be evaluated. If possible, it will also be evaluated if more or less time needs to be allocated to handling the parcels. This will indicate whether there is an economic benefit with the solution. If the solutions cannot be evaluated with KIM I, or III, they will be discussed with regards to the literature presented in the theory sections.

#### 5.1.1 Decrease the number of manual lifts of Ugly-parcels

To decrease the number of manual lifts of Ugly-parcels, several solutions be presented. The first change is to ensure that only Ugly-parcels are handled as Ugly-parcels. Terminal A, D, and E all handle parcels that could have been sorted on the parcel sorting conveyor as Ugly-parcels. The ergonomic effect of this change is presented in table 5.1. The first four columns presents the result in KIM I and the other in KIM III. The "Impr" column shows the percentage change with the improvement in risk rate in the analyze. The column "Impr Tot" shows the total change with all improvements made, so for improvement one will this be the same as "Impr". The colour green means a positive change, red a negative and yellow a neutral.

Terminal	Improvement 1							
	KIM I [RR W/M value(W/M)]				KIM III [RR (Value)]			
	Before	New	Impr	Impr Tot	before	New	Impr	Impr Tot
A	71/48 (4/3)	54/36 (4/3)	24%/25%	24%/25%	62 (4)	62 (4)	0%	0%
B	11/10 (2/1)	11/10 (2/1)	0%	0%	16 (2)	16 (2)	0%	0%
C	28/21 (3/2)	28/21 (3/2)	0%	0%	16 (2)	16 (2)	0%	0%
D	51/41 (4/3)	51/41 (4/3)	0%	0%	70 (4)	70 (4)	0%	0%
E	53/48 (4/3)	47/42 (3/3)	11%/13%	11%/13%	52 (4)	35 (3)	33%	33%
Average			7%/8%	7%/8%			7%	7%

Figure 5.1: Improvement 1, shows an improvement for terminal A and E

## 5. Results improvement suggestions

As can be seen in table 5.1 the values from KIM I will on average be improved with 7% for women and 8% for men. For terminal, E is also the risk rate changed from a four for women to a three with KIM I and to a four to a three with KIM III. There is none improvement for terminal B and C since they only handle Ugly-parcels as Ugly-parcels. For terminal D, is there a change in the number of parcels handled as Ugly-parcels, but that change is small, so it doesn't give any change for the values in KIM I or III. Since more of the parcels are handled as normal parcels, it will also require fewer resources since the handling of normal parcels goes faster than for Ugly-parcel. This change is presented in table 5.2. The first two columns shows the amount of parcels that need to be handled. The third and fourth column shows the time it takes for the different terminals to handle an Ugly-parcel and normal parcels respectively. The fifth and sixth column sums up the total amount of time spent on the handling for the terminal. The last two columns shows the change, column "Improvement" shows the result for the single improvement, and column "Total" the result for all improvement's made, so for improvement one will these be that same.

Efficiency improvement, Improvement 1								
Terminal	Amount bef.	Amount new	Time UP	Time Norm	Before	New	Improvement	Total
A	521	498	36,2	5,4	18860,2	18151,8	4%	4%
B	18	18	45	9,7	810	810	0%	0%
C	44	44	41,5	16,2	1826	1826	0%	0%
D	627	496	26,6	5,4	16678,2	13901	17%	17%
E	1536	733	22,5	6	34560	21310,5	38%	38%
<b>Average</b>							12%	12%

**Figure 5.2:** Improvement 1 Efficiency, shows an improvement for terminal A, D and E

From table 5.2 it can be seen that the change will lead to a productivity improvement of 12% compared to before, meaning that the same amount of parcels will be handled in 12% less time. So if ten hours were spent on the Ugly-parcel handling before, only nine hours would be spent on the Ugly-parcel handling with this change, including the time it takes to handle the regular parcels on the parcel sorting conveyor. Many of these parcels are today according to the interviewees handled on the side since they are on the limit for being Ugly-parcels. It would, therefore, be important to clarify for the terminal workers what parcels are Ugly-parcels. It could be done with an information sign at the inline station about which parcels that should be sorted out and also with a marking on which length is acceptable where the terminal worker quickly can measure the parcel.

To further decrease the number of parcels that are handled as Ugly-parcels, fixtures could also be developed to make it possible to handle thin and round parcels on the parcel sorting conveyor. Terminal B is already using a fixture to handle the thin parcels on the parcel sorting conveyor so that fixture could just be implemented on the other terminals. A fixture to handle round parcels must be developed. However, the round parcels with a nonreadable bar-code will not be handled on the parcel sorting conveyor anyway, so they will still be handled as Ugly-parcels. If this improvement would be implemented, the thin and the round parcels are removed from the Ugly-parcel handling. The result from this change is presented in table 5.3. The column "Impr Tot" shows the total change with all improvements made (improvement 1 and 2).

Improvement 2								
Terminal	KIM I [RR W/M value(W/M)]		KIM III [RR (Value)]		before	New	Impr	Impr Tot
	Before	New	Impr	Impr Tot				
A	54/36 (4/3)	54/36 (4/3)	0%	24%/25%	62 (4)	55 (4)	11%	11%
B	11/10 (2/1)	12/11 (2/2)	+9%/+10%	+9%/+10%	16 (2)	16 (2)	0%	0%
C	28/21 (3/2)	15/11 (2/2)	46%/48%	46%/48%	16 (2)	16 (2)	0%	0%
D	51/41 (4/3)	41/34 (3/3)	20%/17%	20%/17%	70 (4)	47 (3)	33%	33%
E	47/42 (3/3)	38/35 (3/3)	19%/17%	28%/27%	35 (3)	27 (3)	23%	48%
Average			15%/14%	22%/21%			13%	18%

Figure 5.3: Improvement 2, shows an improvement for terminal C, D and E, also an impairment for terminal B

In table 5.3, it can be seen that this change will result in a further decrease with 15% in risk score for women and 14% for men in KIM I in KIM III will the risk score decrease with 13%. In total, together with improvement one will lead to a decrease of 18% in KIM III. However, this change leads to a little increase in Terminal B’s risk factor since a bigger portion is especially ungainly parcels. The change would lead to that more parcels could be handle on the parcel sorting conveyor, which leads to an efficiency improvement, see table 5.4.

Efficiency improvement, Improvement 2								
Terminal	Amount bef.	Amount new	Time UP	Time Norm	Before	New	Improvement	Total
A	498	414	36,2	5,4	18151,8	15564,6	14%	17%
B	18	13	45	9,7	810	633,5	22%	22%
C	44	31	41,5	16,2	1826	1497,1	18%	18%
D	496	322	26,6	5,4	13901	10212,2	27%	39%
E	733	467	22,5	6	21310,5	16921,5	21%	51%
Average							20%	29%

Figure 5.4: Improvement 2 Efficiency, shows and improvement for all terminals.

In the table, it can be seen that the change leads to an improvement of 20%, and together with improvement, one an improvement of 29%. However important to note is that this calculation doesn’t include the extra time for handling the fixtures. To fully establish the consequences of introducing these fixtures, it will be necessary to test it at a terminal and evaluate its consequences. This is necessary since the fixtures will require a flow of returning the fixtures to the inline station. Also, depending on how the parcel sorting conveyor is built, can the fixtures work or not.

To further decrease the number of parcels that need to be handled as Ugly-parcels could the parcel sorting conveyors be redesigned to handle more of the parcels. The parcels that then also could be handled on the parcel sorting conveyor are the long, the big, and the ungainly parcels. Other Ugly-parcels would be harder to handle on the parcel sorting conveyor even though the parcel sorting conveyor is redesign. The result of this improvement is presented in table 5.5.

Improvement 3								
Terminal	KIM I [RR W/M value(W/M)]		KIM III [RR (Value)]		before	New	Impr	Impr Tot
	Before	New	Impr	Impr Tot				
A	54/36 (4/3)	51/34 (4/3)	6%/6%	28%/25%	55 (4)	38 (3)	31%	39%
B	12/11 (2/2)	12/11 (2/2)	0%	+9%/+10%	16 (2)	16 (2)	0%	0%
C	15/11 (2/2)	13/10 (2/1)	13%/9%	54%/48%	16 (2)	16 (2)	0%	0%
D	41/34 (3/3)	25/20 (2/2)	39%/41%	51%/51%	47 (3)	23 (2)	51%	67%
E	38/35 (3/3)	38/35 (3/3)	0%	28%/27%	27 (3)	18 (2)	33%	65%
Average			12%/11%	30%/28%			23%	34%

Figure 5.5: Improvement 3, shows an improvement for terminal A, C and D.

This change would lead to a further decrease of the risk score in KIM I with 12% for women and 11% for men. It will also lead to a decrease with 23% in KIM III. If all these three changes were implemented, it would lead to a decrease in the risk score with 30% for women and 28% in men and 34% in KIM III. The risk rate has also been improved for terminal B, C, D, and E. But even though the risk rate hasn't improved for terminal A have there been an improvement in the risk score, which means that the loading situation is improved for the terminal workers. The efficiency effects of improvement three and all the improvements are presented in table 5.6.

Efficiency improvement, Improvement 3								
Terminal	Amount bef.	Amount new	Time UP	Time Norm	Before	New	Improvement	Total
A	414	250	36,2	5,4	15564,6	10513,4	32%	44%
B	13	10	45	9,7	633,5	527,6	17%	35%
C	31	18	41,5	16,2	1497,1	1168,2	22%	36%
D	322	133	26,6	5,4	10212,2	6205,4	39%	63%
E	467	222	22,5	6	16921,5	12879	24%	63%
Average							27%	48%

Figure 5.6: Improvement 3 Efficiency, shows an improvement for all terminals.

As can be seen, by the table, there is an average improvement of 27% for the third improvement and 48% improvement for all improvements. The improvements result in this efficiency improvement since fewer parcels need to be handled as Ugly-parcels. Instead, they can be handled at the parcel sorting conveyor where the handling requires less time.

Another alternative would be to change the product terms so that none of the Ugly-parcels are considered as parcels and, therefore, not needs to be handled manually. The effects of this would be that all the ergonomic risks associated with the Ugly-parcels are removed and also that all time that today is spent on the Ugly-parcel handling can be spent on other activities. Many of the terminals that use a straight conveyor belt to handle the Ugly-parcels could save a lot of space since they don't need a straight conveyor belt anymore. However, this change could affect the sales since some customers would be forced to pay more to send some of the items as groupage instead of parcels, which might lead them to switch to another transport company. A solution could maybe be that existing customers would get the opportunity to send these parcels as groupage to the same price as parcels to keep them. But that solution would cost DB Schenker money, but maybe that cost would be defendable compared to how much time they save and how much they save the terminal workers. That solution, therefore, needs to be evaluated further by the company.

### 5.1.2 Improve the lifting position for Ugly-parcels

To improve the physical ergonomics, will it also be tested to improve the lifting position of ugly-parcels. The improvements that will be tested are to remove the especially ungainly parcels, to use a cage-lifter, and to use two people to lift the especially ungainly parcels.

First, it is tested to completely remove the especially ungainly parcels that cause

the worst lifting position. These are the long, the big, and the unstable parcels. Removing the parcels means that DB Schenker would change the product terms for parcels so that customers aren't allowed to send parcels that are too long, too big, or unstable to run on the parcel sorting conveyor. The ergonomic effects of this change are presented in table 5.7.

Improvement 4								
	KIM I [RR W/M value(W/M)]				KIM III [RR (Value)]			
Terminal	Before	New	Impr	Impr Tot	before	New	Impr	Impr Tot
A	71/48 (4/3)	51/34 (4/3)	28%/29%	28%/29%	62 (4)	46(3)	26%	26%
B	11/10 (2/1)	9/8 (1/1)	18%/20%	18%/20%	16 (2)	15(2)	6%	6%
C	28/21 (3/2)	13/9 (2/1)	54%/57%	54%/57%	16 (2)	15(2)	6%	6%
D	51/41 (4/3)	46/36 (3/3)	10%/12%	10%/12%	70 (4)	53(4)	24%	24%
E	53/48 (4/3)	49/43 (3/3)	8%/10%	8%/10%	52 (4)	43(3)	17%	17%
<b>Average</b>			<b>24%/26%</b>	<b>24%/26%</b>			<b>16%</b>	<b>16%</b>

**Figure 5.7:** Improvement 4, shows an improvement for all terminals.

The change will result in an improvement in KIM I's risk score with 24% for women and 26% for men and KIM III with 16%. For terminal B, D, and E, the risk rate for women improved one step in KIM I, and at terminal C, the risk rate improved one step for both men and women. I KIM III is the risk rate improved one step at terminal A and E. So, this change has large positive ergonomic effects compared to how the situation for the terminal workers is today. Since some parcels are removed, less time will be spent on the parcel handling of Ugly-parcels, which can be seen in table 5.8.

Efficiency improvement, Improvement 4								
Terminal	Amount bef.	Amount new	Time UP	Time Norm	Before	New	Improvement	Total
A	521	350	36,2	5,4	18860,2	12670	33%	33%
B	18	11	45	9,7	810	495	39%	39%
C	44	31	41,5	16,2	1826	1286,5	30%	30%
D	627	419	26,6	5,4	16678,2	11145,4	33%	33%
E	1536	1174	22,5	6	34560	26415	24%	24%
<b>Average</b>							<b>32%</b>	<b>32%</b>

**Figure 5.8:** Improvement 4 Efficiency, shows an improvement for all terminals.

The results give and reduction of 32% of the time spent on Ugly-parcel handling. Since only the especially ungainly parcels are removed, there are still many parcels that are handled as ugly parcels. To improve the lifting position of these parcels could cage-lifters be installed, like the ones used at the parcel sorting conveyor. These cage-lifters make it possible to lift the cage into a proper lifting height and tilt the cage, making it easier for the terminal worker to reach the parcels. The ergonomic results of this change are presented in table 5.9.

Improvement 5								
	KIM I [RR W/M value(W/M)]				KIM III [RR (Value)]			
Terminal	Before	New	Impr	Impr Tot	before	New	Impr	Impr Tot
A	51/34 (4/3)	44/27 (3/3)	14%/21%	38%/44%	46(3)	42(3)	9%	32%
B	9/8 (1/1)	7/6 (1/1)	22%/25%	36%/40%	15(2)	14 (2)	7%	13%
C	13/9 (2/1)	11/7 (2/1)	15%/22%	61%/67%	15(2)	14 (2)	7%	13%
D	46/36 (3/3)	37/27 (3/3)	20%/25%	27%/34%	53(4)	49 (3)	8%	30%
E	49/43 (3/3)	37/32 (3/3)	24%/26%	30%/33%	43(3)	40 (3)	7%	23%
<b>Average</b>			<b>19%/24%</b>	<b>38%/44%</b>			<b>8%</b>	<b>22%</b>

**Figure 5.9:** Improvement 5, shows an improvement for all terminals.

## 5. Results improvement suggestions

As can be seen in the table, would this change lead to and further reduction of the risk score in KIM I with 19% for women and 24% for men. In KIM III, is there a reduction of 8%. Together with the change to remove the especially ungainly parcels will lead to a reduction of 38% for women and 44% for men in KIM I and 22% in KIM III. The changes together lead to a decrease in the risk rate for terminal A, B, D, and E for women, and for terminal C, the risk rate for both women and men decreased in KIM I. In KIM III is the risk rate for terminal A, D and E decreased. The introduction of a cage-lifter would also lead to a decreased risk of MSD injuries in the shoulders. Some of the workers said in the interviewees that they experienced pain in the shoulders, which is over-represented among the MSD related injuries. Therefore it would be favorable to decrease that risk. The risk is decreased if the number of lift above shoulder level is decreased and if the reaching length is decreased. The reaching length would be decreased with a cage-lifter since it can be tilted so that the workers don't need to reach as much. However, lifts above shoulder levels will still be done, so the risk will still be there for MSD injuries in the shoulders, but it will at least decrease. The introduction of a cage-lifter would not lead to a reduction or addition of the time spent on the ugly-parcel handling, so that is not analyzed for this change.

These two changes give a great improvement in the ergonomic and reduction of the time spent on ugly-parcels. However, it is not certain that DB Schenker is willing to change the product terms for parcels since that could affect the sales volume to certain customers. Therefore is an alternative to only implement the cage-lifter to improve the lifting position. The ergonomic effects of this change are presented in table 5.10.

Improvement 6								
Terminal	KIM I [RR W/M value(W/M)]		KIM III [RR (Value)]		KIM III [RR (Value)]		Impr	Impr Tot
	Before	New	Impr	Impr Tot	before	New		
A	71/48 (4/3)	65/42 (4/3)	8%/13%	8%/13%	62 (4)	59 (4)	5%	5%
B	11/10 (2/1)	10/9 (1/1)	9%/10%	9%/10%	16 (2)	15 (2)	6%	6%
C	28/21 (3/2)	25/18 (2/2)	11%/14%	11%/14%	16 (2)	15 (2)	6%	6%
D	51/41 (4/3)	44/34 (3/3)	14%/17%	14%/17%	70 (4)	66 (4)	6%	6%
E	53/48 (4/3)	44/39 (3/3)	17%/19%	17%/19%	52 (4)	49 (3)	6%	6%
Average			12%/15%	12%/15%			6%	6%

**Figure 5.10:** Improvement 6, shows an improvement for all terminals.

The ergonomic risk score in KIM I is decreased with 12% for women and 15% for men, and in KIM III in the risk score decreased with 6%. The risk rate is also decreased one step for women at terminal B, C, D, and E in KIM I. So even though the same parcels are handled would there be a great improvement of the risk rate in KIM I. However the risk rate in KIM III is not changed since that method not consider the position of the body as big part of the risk rate. KIM III focuses more on the wrist and hand movements, and those are not affected by the use of a cage-lifter. In KIM III is, therefore, only the risk score changed a bit, and that change is not big enough to lead to a change in the risk rate. To improve the ergonomics even more without removing the ungainly parcels, it would be an alternative to use two terminal workers to lift the especially ungainly parcels. This would lead to that the terminal workers only need to lift half of the weight for these parcels. The ergonomic effects of these changes are presented in table 5.11.

Improvement 7								
Terminal	KIM I [RR W/M value(W/M)]		Impr		KIM III [RR (Value)]		Impr	Impr Tot
	Before	New	Impr	Impr Tot	before	New		
A	65/42 (4/3)	47/35 (3/3)	28%/17%	34%/27%	59 (4)	59 (4)	0%	5%
B	10/9 (1/1)	9/9 (1/1)	10%/0%	18%/10%	15 (2)	15 (2)	0%	6%
C	25/18 (2/2)	21/17 (2/2)	16%/6%	25%/19%	15 (2)	15 (2)	0%	6%
D	44/34 (3/3)	36/32 (3/3)	18%/6%	29%/22%	66 (4)	66 (4)	0%	6%
E	44/39 (3/3)	39/37 (3/3)	11%/5%	26%/23%	49 (3)	49 (3)	0%	6%
Average			17%/7%	26%/20%			0%	6%

**Figure 5.11:** Improvement 7, shows an improvement for all terminals in KIM I and no change in KIM III.

The change would lead to a further reduction of the risk score in KIM I with 17% for women and 7% for men. In KIM III, is there a reduction of 0% since the weight of the parcels is not included in that analysis. The total reduction with these two changes is 26% for women and 20% for men in KIM I, which can be compared with improvements four and five together, which reduced the risk score of 38% for women and 44% for men. This means that the positive ergonomic effects of removing the ungainly parcels are bigger than if two terminal workers lift them, which is an effected result. Since improvement seven requires that two terminal workers lift the ungainly parcels are more resources required for the Ugly-parcel handling. The effects of this are presented in table 5.12.

Efficiency improvement, Improvement 7								
Terminal	Amount bef.	Amount new	Time UP	Time Norm	Before	New	Improvement	Total
A	521	521 (171)	36,2	5,4	18860,2	25050,4	-33%	-33%
B	18	18 (7)	45	9,7	810	1125	-39%	-39%
C	44	44 (13)	41,5	16,2	1826	2365,5	-30%	-30%
D	627	627 (208)	26,6	5,4	16678,2	22211	-33%	-33%
E	1536	1536 (362)	22,5	6	34560	42705	-24%	-24%
Average							-32%	-32%

**Figure 5.12:** Improvement 7 Efficiency, shows and impairment for all terminals.

From the table, it can be seen that the improvements would lead to that, on average, would 32% for the time be spent on Ugly-parcel handling. This can be compared with the change to remove the ungainly parcels that would lead to a reduction of 32%. It can, therefore, be conducted that it has the most positive ergonomic effects and reduction of time spent on Ugly-parcels if the especially ungainly parcels are removed compared to if two terminal workers lift them.

### 5.1.3 Other changes and combinations

Other alternatives could be considered to implement. Today have or had some of the terminals a vacuum-lifter that lifts the parcels. During the interviews, it was said that all that have had them or have them, that they are not used. They were not used since they were considered to take too much time to use or couldn't be used on the Ugly-parcels since they required that one surface be flat. After some searching after lifting devices for material handling, these vacuum-lifters or similar technologies are the most commercial ones found. Since DB Schenker already has tested these and don't succeed with them, would they not be analyzed further in this study. However, for future studies, could it be analyzed more in detail why these weren't used and if that could be changed in some way. But since that hasn't

been the main focus for this study has the time limit limited the possibilities to investigate that within this study.

Another solution alternative that cannot be analyzed with the ergonomic methods or by time studies is to inform and educate the employees. If the terminal workers are informed about the risk with the Ugly-parcel handling and also informed about how they should think and how they should lift when they handle them, could possibly the lifting positions for the Ugly-parcels be improved. It is also important to, at the same time, educate the managers in ergonomic analysis so they can perform basic analysis on the task in the terminal. Then it would be more likely that the manager and the terminal workers get the same understanding of the risks with lifting certain parcels. The same methodology used in this study could also be used at the terminals so the managers could continuously improve the ergonomics. If they establish their models to evaluate the ergonomics, can they see the effects of certain changes and evaluate them before they implement them to see the ergonomic effects. This would make it possible for the terminals to work more strategically around the ergonomic problems at the terminals and improve step by step. However, this requires that DB Schenker supports the manager in this work, so they get the right tools to do the evaluations and use the tools in the right way.

The personnel can also be informed about the risk of MSD injuries in the back and shoulders and how they can reduce that risk. One example of preventive actions against MSD injuries is training. There would, therefore, be an alternative to start to arrange voluntary training's that the workers can attend to and which focus on preventing MSD injuries.

During the interviews, some of the workers also said they had experienced pain in the feet when they worked with the parcel handling. To solve this problem, the terminals could install rubber mats that make it softer to walk and stand on the floor. This change could be a thing to do to show the workers that their comfort at work is important, and that focus on the ergonomics will be of great interest. It is also a simple way to fast get and improvement for the terminal workers.

Many solutions to improve physical ergonomics have been presented and analyzed above. To get a better understanding of the total effects of these changes have two combination solutions been established below and analyzed with KIM I and III. The combinations have also been analyzed based on the time that it takes to handle the parcels with the solutions.

The first combination is consisting of improvement 1, 2, and 7, which means that only Ugly-parcels are handled as Ugly-parcels, that thin and round parcels are handled on the parcel sorting conveyor, that a cage-lifter is used and that two operators lift especially ungainly parcels. The ergonomic results of this combination are presented in table 5.13.

Improvement Combination 1						
Terminal	KIM I [RR W/M value(W/M)]			KIM III [RR (Value)]		
	Before	New	Impr	before	New	Impr
A	71/48 (4/3)	36/27 (3/3)	49%/44%	62 (4)	52 (4)	16%
B	11/10 (2/1)	9/9 (1/1)	18%/10%	16 (2)	15 (2)	6%
C	28/21 (3/2)	11/9 (2/1)	61%/57%	16 (2)	15 (2)	6%
D	51/41 (4/3)	32/29 (3/3)	37%/29%	70 (4)	46 (3)	34%
E	53/48 (4/3)	33/32 (3/3)	38%/33%	52 (4)	26 (3)	50%
Average			41%/35%			22%

Figure 5.13: Improvement combination 1

As can be seen, by the table, the combination solution would decrease the risk score in KIM I with 41% for women and 35% for men. There is also a decrease of the risk rate for terminal A, B, D, and E for women and both women and men for terminal C. However the decrease is only to a three for the terminals that use a straight conveyor belt to sort the Ugly-parcels which still means that it is an increased loading situation where physical overload is possible for all workers. In KIM I was a decrease of 22% of the risk score established. The risk rate decreased for terminal D and E. The time spent on the Ugly-parcel handling will also be increased, as shown in table 5.14.

Effectivity improvement, Combination 1							
Terminal	Amount bef.	Amount new	Time UP	Time Norm	Before	New	Improvement
A	521	414	36,2	5,4	18860,2	23983,6	-27%
B	18	13	45	9,7	810	1173,5	-45%
C	44	31	41,5	16,2	1826	2451,6	-34%
D	627	322	26,6	5,4	16678,2	18087,6	-8%
E	1536	467	22,5	6	34560	22971	34%
Average							-16%

Figure 5.14: Improvement combination 1 Efficiency

The time is increased by an average of 16%. There will be an increase since the ungainly parcels need to be handled by two operators.

The second combination is consisting of improvements 1, 2, and 5, which means that only Ugly-parcels are handled as Ugly-parcels, that thin and round parcels are handled on the parcel sorting conveyor, that a cage-lifter is used and that especially ungainly parcels are removed. The ergonomics results of this combination are shown in table 5.15.

Improvement Combination 2						
Terminal	KIM I [RR W/M value(W/M)]			KIM III [RR (Value)]		
	Before	New	Impr	before	New	Impr
A	71/48 (4/3)	44/27 (3/3)	38%/44%	62 (4)	35 (3)	44%
B	11/10 (2/1)	3/3 (1/1)	73%/70%	16 (2)	14 (2)	13%
C	28/21 (3/2)	11/7 (2/1)	61%/67%	16 (2)	14 (2)	13%
D	51/41 (4/3)	18/13 (2/2)	65%/68%	70 (4)	21 (2)	70%
E	53/48 (4/3)	15/13 (2/2)	72%/73%	52 (4)	16 (2)	69%
Average			62%/64%			42%

Figure 5.15: Improvement combination 2

The table shows a reduction of the risk score with 62% for women and 64% for men in KIM I and 42% in KIM III. In KIM I is the risk rate decreased for terminal A and B for women and both men and women at terminal C, D and E. the risk rate is

decreased to at least a two for all terminals except terminal A. A decrease to a risk rate of two means that there is a moderate load situation where physical overload only is likely for the less resilient people. This study has a risk rate of two been consider as an acceptable level. For terminal A, it will be necessary to make more specific improvements for that specific terminal to get down the risk rate to a two. This combination of solutions will also lead to a decrease in the time required for handling the Ugly-parcels shown in table 5.16.

Effectivity improvement, Combination 2							
Terminal	Amount bef.	Amount new	Time UP	Time Norm	Before	New	Improvement
A	521	243	36,2	5,4	18860,2	9250,2	51%
B	18	6	45	9,7	810	318,5	61%
C	44	18	41,5	16,2	1826	957,6	48%
D	627	114	26,6	5,4	16678,2	4441,8	73%
E	1536	105	22,5	6	34560	3958,5	89%
Average							64%

**Figure 5.16:** Improvement combination 2 Efficiency

The time required for Ugly-parcel handling is decreased with 64% if combination two is implemented. The results of implementing combination two are better than combination one since some of the worst Ugly-parcels, the ungainly parcels, are removed. It is only if these parcels are removed that a risk rate of two can be accomplished at the terminals. If all ugly-parcels should be handled, it will be necessary to future investigate how the number of lifts can be decreased and how the lifting of the ungainly parcels could be improved to accomplish a risk rate of two.

However, form the results above, it can be seen that to change the product terms of parcels could decrease the amount of Ugly-parcels that also would lead to positive ergonomic and time effects for the terminals. In the best-case scenario, as discussed before, would all Ugly-parcels be considered as groupage instead, but that is a scenario that needs to be investigated further.

## 5.2 Cognitive ergonomics

Five main areas for improvement were mentioned in the current state analysis of cognitive ergonomics. To have clearer information on what to do with which parcels, decrease the noise level, minimize the need to remember the sorting by heart, support standardized work and work instructions and decrease the risk for sorting errors. These areas will be further discussed below, and improvements on different levels will be suggested as for the physical ergonomics.

### 5.2.1 Clearer information on what to do with the parcels

When a parcel stops by the cargo-checker the computer will display what's wrong with the parcel, but it doesn't say what the terminal worker should do with it. It is, therefore, up to the terminal worker to remember what to do. One of the terminals, terminal F, has a list of instructions about what to do with the parcel and the computer if the cargo-checker stops. This list made it possible to place any

of the terminal workers at the inline station since all could know what to do if there were any problems with the cargo-checker. The list was, therefore, a cognitive aid for the terminal workers. A first step could, therefore, be to use the same type of list to support all terminal workers. A further step could be to integrate the instruction in the computer by the cargo-checker. Then it could be possible for the workers to see what to do with the parcels directly. It would also be possible to integrate information if a customer has any specific customer solution that needs to be considered so that it is ensured that all parcels are handled correctly.

### **5.2.2 Decrease the noise level**

During the interviews, all interviewees said they could use earplugs to protect the hearing when they work at the terminal. However, most of the terminal workers expressed that they preferred not to use them since they feel that it is a safety risk. They feel so since there is a lot of forklift traffic in the terminals that could be a danger if they are not aware of it, and many expressed that they wanted to be able to hear it to feel safe. The noise in the terminal comes mostly from the forklifts when they are driving and the parcel sorting conveyor, but some loud sounds come from when someone drops a pallet on the floor. Many of the managers said that they try to remind the workers about not dropping the pallets, but they feel that some ignore them. A good start could, therefore, be to start with trying to reduce the loud sounds. If the terminal workers get better information about why they shouldn't drop the pallets and what effects dropping the pallet could cause for them or their colleagues, perhaps they could think about it more, and the drop of pallets would decrease. However, since the collected data showed some experiences from workers resisting listening to the manager, it will be important to get everyone handling pallets on board so that it would be the norm not to drop pallets.

To decrease the effects of the general noise in the terminal, it is logical to focus on the noise that comes from the forklifts and the parcel sorting conveyor. Therefore, a first step would be to make the personnel use the hearing protection that is supplied, earplugs. To get the workers to use them, it will be necessary to make it possible for the employees to feel safe while using the earplugs. It could, therefore, be an idea to mark which zones that the forklifts cannot drive. These zones should preferably be where the terminal workers work while they are sorting parcels. If it is implemented in a good way, it would be possible for the terminal workers to work with earplugs without worrying about forklifts driving around. It could also be investigated if there is any hearing protection on the market that doesn't cancel out all sounds but rather the sound that is dangerous for the hearing. If there exist alternatives, these could be tested in a terminal and then evaluated by the terminal workers.

Actions could also be taken to decrease the noise level in the terminal. For example, the terminals could put up sound-absorbing panels that absorb some of the sounds. During the interviews, it was also expressed that the floor was one of the reasons for a high sound level. When the floor is worn out the unevenness of the

floor may cause the forklifts to rumble when they drive over it. Therefore, it should be investigated if there is some kind of paint or other that can level out this unevenness in the floor so that the forklifts' sounds will decrease. It will be harder to decrease the sound from the parcel sorting conveyor. However, with good preventive maintenance, the sound from the parcel sorting conveyor caused by wear would probably be decreased. In some of the interviews, it was said that the old straight conveyor belts used for the Ugly-parcel handling make more noise than the new parcel sorting conveyors. This could be due to a new design of the conveyors, but it can also most likely be due to the conveyors' getting worn out. A schedule for preventive maintenance would, therefore, most likely help to decrease the noise level.

### **5.2.3 Minimise the need to memorize the sorting by heart**

All the terminal workers interviewed expressed that it was necessary to remember the sorting by heart to sort the parcel within the allocated time. Since the operators need to remember the sorting, it will take a lot of time before they can perform at the expected pace. The interviewees expressed that the learning time can be from some weeks up to two months before you can perform as expected. All terminals are also using temporary workers at the parcel sorting, which will lead to that some of the personnel won't be able to perform in the expected phase, and the production will go slower than expected. It will also be very mentally demanding for the workers to remember all destinations and especially to learn.

DB Schenker is currently updating their system, which will lead to the sorting concept displayed on the label, which will minimize the need to remember which destinations should go to a certain sorting concept. It would, therefore, be desirable to evaluate how this solution will help the terminal workers. If the destination is displayed on every parcel, the terminal worker will not need to remember any sorting concepts, but if some parcel doesn't have it, it will be more difficult. If there will be a need to develop a system to minimize the need for the terminal worker to remember, the sorting by heart could pick by voice or pick by light be implemented. Some of these systems could either be light above the parcel cage where the parcel should be placed light up, or a voice in a headset would tell the worker where to place the parcel.

The change to the new system would most likely take some time, so in the meantime, to improve for the terminal workers could the signs with the sorting concepts be put up in such an order that the postcode as much as possible are placed in numerical order. This will help the operator find the right cage easier if there is a parcel that he or she won't know where it should be placed without looking at the signs.

### **5.2.4 Support standardized work and work instructions**

Today is it very varying if the workers know that they have standards to follow or not. DB Schenker has standards on its internal platforms, but not all terminal

workers have access to them and can read the instructions. Today's instructions can only be read on the computer, which means that the terminal worker needs to leave the work to find the standards. The standards are also written as standards and not work instructions, which sometimes can be hard to understand. It should, therefore, be wanted to have more standards and work instructions available for the workers to help them in their daily work. Some of the work that the terminal workers do is very repetitive and might not be necessary to have work instructions for but can rather be thought from mouth to mouth between the workers. However, some of the handlings are more demanding and require more knowledge from the terminal worker. For example, it could be how to handle the parcels that should be changed to groupage or how to handle customer-specific parcels. Since the worker only works with these tasks some of the working days, it will be harder for the terminal worker to learn how to do it quickly; therefore, it could be helpful to implement work instructions that the worker can follow.

A first step to introduce work instructions for the terminal workers could be to print out the already existing standards for the tasks that are harder or is harder to learn. The terminal workers should also be informed about the existing standards and where they can find them if necessary. The terminal worker should also, during the learning process, be informed about the standards, and the standards should be a part of the learning. For example, when the terminal workers are taught how to handle the parcels that should be changed to groupage should the terminal worker get information about why the parcels are sorted out according to the standards and how it should be handled according to the standards.

A further step would be to develop the standards to work instructions with step by step instructions on how the sorting should be performed. These instructions could then be printed out and located next to the place where the task is performed. The work instructions can also include reminders, which will help the terminal worker to focus on the right things. Once the work instructions are established, would it be a development to include them within the HDT that the terminal worker use. This will make it possible for the terminal worker to see what needs to be done with that certain parcel when they scan a parcel. All these changes will help the terminal worker do the right thing and help decrease the need for the operator to remember how to do everything. This could be especially helpful if there is a new worker.

### **5.2.5 Decrease the risk for sorting errors**

In total, 16 out of 20 said that it is easy to make errors while you sort the parcels, especially for the Ugly parcels, since there are more sorting concepts to consider at the same time. Many said that it was easy to make errors since many of the names or the postcodes to certain sorting concepts were alike. At the normal handling at the parcel sorting conveyor, is it often possible to have several outlines, which means that it is possible to separate the sorting concepts with similar places or postcodes on different outlines. However, at the Ugly-parcel handling, will that not be possible. To decrease the risk for errors could instead, some kind of system is

implemented. It could be pick by light or pick by voice. If a pick by voice or pick by light system would be implemented, it could be so that the cargo-checker scans that parcel and then a light is turned on over the cage where the parcels should be placed, or a voice in a headset says where it should be placed. This, however, requires that the parcel comes in the right order at the outline since if the order is mixed up, the sorting would also be wrong.

These solutions would require a lot of advanced technology and would also take some time to test and develop it could, therefore, be good to start with some smaller changes to get an improvement directly. The terminal workers could get feedback on how many parcels were sorted incorrectly at the handling and which outline had the wrong sorting. Therefore would it be possible for the terminal worker to follow his or her improvement so that he or she knows if the improvement is necessary or if it is on a good level.

### **5.3 Organizational ergonomics**

Suggestions for improvements for the organizational ergonomics will, as for the cognitive and physical, be suggestions at different levels. Some of the areas for improvements will require that further evaluation and investigation are done to establish if the solution is beneficial. In this study will four different improvements be discussed below.

#### **5.3.1 Make the process for leaving improvement suggestions clear**

Some of the terminal workers said that they couldn't leave improvement suggestions or influence the working routines. However, the manager said that they could. So it could be a good idea to make the process for leaving improvement suggestions clearer so that all workers know how they can leave suggestions whether they are new or experienced workers. The manager could clearly explain to the terminal workers how they can leave improvement suggestions and include that in the introduction of new workers. To get in improvement suggestions from the terminal workers, managers will give the workers the possibility to affect their work, which will decrease the stress level for the workers. In the long term, the improvements would also be a part of the daily meetings to make the process clear and also signal to the workers that their opinions matter. This could also help to increase the motivation among the workers since they get the possibility to affect the outcome of the work that they are doing. They are also more likely to be more satisfied with their work, which can lead to a higher level of motivation.

### **5.3.2 Match the performance demands to the available resources to minimize stress**

Many interviewees, especially at the larger terminals, said they often have problems meeting the performance demands for the day. The performance demands are to sort and send away all the parcels that arrive at the terminal. The terminal workers expressed that when they cannot make it, they will feel stress, and they will also stress at the end to handle as many parcels as possible. This leads to that the high level of performance demands lead to stress for the workers, which can lead to slips, which can cause errors. It would, therefore, be desirable to match the performance demands better to the available resources. Suggestions for such an improvement could be to clearly define for the worker what the performance demands are, for example, to process X amount of parcel each hour. If there is a larger volume which will require the workers to process more than the goal each hour, it would be clear for the workers. This could lead to the fact that they don't feel as much stressed about it since they know it is over the normal. The manager could also clearly explain to the workers that there is an increased volume. It can be okay to leave parcels for the next day rather than stress through parcels so that they get more errors.

In the interviews it was also mentioned that late-arriving trucks and problems with the parcel sorting conveyor were factors that could increase the risk of not meeting the performance demands. It could, therefore, be a good idea to evaluate what it is that makes the trucks arrive late or what it is that causes stops on the parcel sorting conveyor. Such evaluations could maybe lead to it being fixed, which would minimize the stress for the terminal workers.

### **5.3.3 Improve the physical environment**

In the interviews, many mentioned that the climate in the terminal is very dependent on the climate outside the terminal. Meaning that if it is cold outside, will it be cold in the terminal, and if it is warm outside, will it be warm in the terminal. It was also mentioned that it is a lot of dust in the terminals. The heat in the terminal is tough to change since it is such big buildings and has already have installed the weather seals for the gates. However, since it is something that the terminal worker finds disturbing, could it be an idea to evaluate if any other alternatives could make it possible to improve the climate. Regarding the dust was it expressed in some interviews that they had installed air cleaners over the parcel sorting conveyors that had helped a lot according to the interviewees. It should, therefore, be preferable to install these air cleaners at all terminals that experience problems with dust in the air. A better work climate for the workers can lead to higher motivation and a higher desire to continue to work for DB Schenker.

### **5.3.4 Improve the learning process for new employees**

As mentioned in the current state analysis, is there no specific learning program for the new employees. The employees rather learn by going by the side of a more ex-

perienced worker by asking. To make the learning process faster and clearer for the worker, a learning process can be established. In the learning process, everything should be stated that the terminal worker needs to learn to handle the work and the order the terminal worker should be exposed to certain tasks. For example, when should the terminal worker learn the inline station and when should the worker learn the Ugly-parcel sorting. If a learning process is established, the terminal worker will know when he or she is expected to perform as the other workers and which task he or she can expect to be exposed to in the next step of the learning. This would also improve for the managers since they can more easily know which workers to master certain tasks and which tasks they should plan that the new employees should handle. This would most likely lead to more time-efficient learning for new terminal workers.

A further step would be to involve the new terminal worker in the learning and make it possible for the terminal workers themselves to decide if they are ready for the next step in the leaning. This would increase the control for the workers, which decreases the stress levels for the terminal worker.

# 6

## Discussion

From the calculations in the evaluation of the present state it could be seen that the Ugly-parcel handling caused large ergonomic effects, especially physical but also cognitive and organizational. In order to improve the ergonomics, several solution alternatives were tested. They will be discussed in the following sections. The ergonomics areas will first be covered one by one and then be discussed together in the last section.

### 6.1 Physical ergonomics

Two combination solutions to improve the physical ergonomics were established. One where it was assumed that the product terms couldn't be changed, and one where it would be required to change the product terms. The first alternative resulted in an improvement of the physical ergonomics. The risk rate in KIM I and III are decreased for all terminals, however it is only decreased to a three at the larger terminals which still is a high risk rate. The solution will also lead to that more resources need to be spent on the Ugly-parcel handling. The second solution involves changing the product terms for parcels so that the especially ungainly parcels should be handled as groupage instead. This solution led to that the risk rates in KIM I and III were decreased to two for most of the terminals, the only exception being terminal A where the risk rate still was a three.

This means that it will be hard to lower the physical ergonomic effect of handling the Ugly-parcels without removing the worst parcels. It is possible to reduce the poor ergonomics but the reduction is not that big and it will also lead to more resources being required to handle the Ugly-parcels. However it can be possible that DB Schenker don't want to change the product terms for parcels. It would in that case be a suggestion to consider whether it would be possible to handle the especially ungainly parcels as groupage anyway, and that either DB Schenker take that cost or ask that from the customer. It is clear that there will be positive physical ergonomic effects of not handling the especially ungainly parcels at the terminals.

During the analysis of the handling of Ugly-parcels, it was discovered that reducing the amount of parcels handled manually was the key to improving the physical ergonomics. Since all parcels handled on the parcel sorting conveyor are also handled manually, especially at the outlines it would be of interest to analyze how the physical ergonomics for a worker is when he or she works with that handling.

## 6.2 Cognitive ergonomics

There were several alternatives that could be implemented to improve the cognitive ergonomics for the workers. The two biggest areas for improvement were to reduce the sorting errors and to minimise the need to remember the sorting by heart. Since DB Schenker currently are developing a system that would display the sorting concept on the label, the effects of these problems would probably be decreased. However it is hard to say since the change hasn't been implemented yet and also that it would take some time before it can be. Therefore it could be more preferable to implement the smaller suggestions like putting the signs in an order so that it is easy to find the right cage.

Since the effects of the system change are unknown the cognitive ergonomics for the terminal workers would be interesting to study again after the implementation.

## 6.3 Organizational ergonomics

The largest organizational ergonomics effect that the terminal workers experienced was the stress level when they couldn't meet the performance demands. In order to reduce that problem it will be necessary to ensure that the trucks arrive in time and that the up-time of the parcel sorting conveyor is increased. However these solutions will require further investigation on the root cause to the problems, which makes it hard to directly improve for the terminal workers.

A short term solution would be to set goals for the terminal workers on how much they are expected to process during a shift so that if the volume is increased they would not feel so stressed about that. However that could lead to that customers get their parcels later, which probably is something that DB Schenker don't want to happen.

To summarise, the organizational ergonomics there is potential for improvement, but these improvements will need to be investigated further before they are implemented.

## 6.4 Total

In the long term eliminating the Ugly-parcels would have several positive effects and even though the suggested actions to improve the ergonomics were to be taken, they could not completely reduce the ergonomic effects of the Ugly-parcel. Not removing any Ugly-parcels would not decrease the physical ergonomic effect more than to risk rate of three in the KIM evaluation, which is still a high risk rate. The improvements needed to be taken will also most likely be very expensive and take a long time to implement. It could therefore be most beneficial for DB Schenker to either change the product terms for parcels, or handle the Ugly-parcels as groupage.

## 6.5 Further research

There are several areas that would still be of interest to study in order to find the optimal way of handling the Ugly-parcels for DB Schenker. A list of areas for future research is presented below.

- How would changing the product terms affect the sales?
- Could it be economically beneficial to handle the especially ungainly parcels as groupage?
- How is the physical ergonomics for the normal parcel handling?



# 7

## Conclusions

The purpose of this master thesis has been to answer two research questions:

1. Which physical, cognitive, and organizational ergonomics effects do the terminal workers at DB Schenker experience when they handle Ugly-parcels?
2. How could the effects discovered in the previous question be minimized or removed?

The answers to the research questions will be summarized below.

*"Which physical, cognitive and organizational ergonomics effects do the terminal workers at DB Schenker experience when they handle the Ugly-parcels?"*

In the current state analysis it was discovered that the physical effects of the Ugly-parcel handling were most prominent at terminal A, D and, E since they handled more Ugly-parcels at a straight conveyor belt. The analysis with KIM I showed a risk factor of four for women and three for men for all three terminals. The analysis with KIM III showed a result of four for all three terminals. The result, therefore, showed that it was a high risk that physical overload occurred for a terminal worker while he or she handled Ugly-parcels. At terminal B and C, fewer Ugly-parcels were handled and by the side of the parcel sorting conveyor. The analysis with KIM I showed a result of two for men and women for terminal B and a result of one for terminal C. The analysis with KIM III showed a result of two for both terminals. The results mean that there is a slightly increased risk for physical distress for some people, but in this master thesis a score of two has been considered an acceptable level.

Five areas for improvement for all terminals were discovered regarding the cognitive ergonomics based on the design principles listed by Bohgard (2009):

- The uncertainty to know what to do with a parcel if the conveyor stopped
- The noise level
- The need to memorize the sorting by heart
- The lack of standardized work and work instructions
- The risk for sorting errors

Four areas for improvement for all terminals were discovered regarding the organizational ergonomics based on the key factors listed by Kroemer and Grandjean (1997).

- Unclear process of how to give improvement suggestions and therefore affect

the work

- Unclear communication of how much work is expected of the terminal worker, which many terminal workers described as stressful
- Workers expressed discomfort regarding the work environment in terms of dust and heat
- Unclear learning process for the terminal worker

However, many of the cognitive and organizational effects are not exclusive for Ugly-parcel handling. These are most likely as true for the normal parcel handling. So it can be concluded that the largest effects of Ugly-parcel handling are the physical effects. There is, therefore, a risk that the terminal workers could get a musculoskeletal disorder from Ugly-parcel handling. It can also be concluded that the problems are most severe at the terminal that handles larger volumes.

***"How could the effects discovered in the question above be minimized or removed?"***

To minimize the physical effects of Ugly-parcel handling, three alternatives are suggested. The first, and most drastic alternative, would be to consider all Ugly-parcels as groupage and not handle them as parcels at the terminals. This however, could either have economic effects for the customer or DB Schenker depending on how it is handled. The second and third alternative consist of three common part solutions:

1. Ensure that all parcels that can be handled at the parcel sorting conveyor are handled there.
2. Use fixtures to enable the handling of thin and round parcels at the parcel sorting conveyor
3. Use a cage-lifter at the straight conveyor belt

What differs between alternatives two and three is that alternative two suggests that two operators lift the ungainly parcels, and alternative three suggests that the ungainly parcels are handled as groupage. Alternative two will not be as drastic change as alternative three, but it would lead to a productivity decrease since two operators instead of one are needed. Alternative three will instead improve productivity since fewer parcels are handled. Still, it will also lead to either extra costs from DB Schenker or the customer to transport the ungainly parcels as groupage. With alternative one all risk associated with the Ugly-parcel handling is removed. With solution two the risk rate at the larger terminals (A, D and E) is lowered to a three in KIM I and a three in KIM III, except for terminal A. With solution three the risk rate in KIM I is lowered to a two for the large terminals, except for terminal A which still is a three. In KIM III the risk rate is lowered to a two for all terminals except terminal A. It is therefore suggested from an ergonomic perspective to implement alternative three. However, worth nothing is that the ergonomic effects were mostly dependent on how many lifts the operator needed to do during a day. Since the operators at the normal parcel handling also do lifts, it will be necessary to evaluate the ergonomic situation for those as well.

It suggested that all five problem areas discovered in research question one are handled to support the cognitive ergonomics for the terminal workers. To clarify for the worker what to do if the parcel stops at the Cargo checker, a the computer program could be developed, displaying not only what's wrong, but also how to handle it. If it cannot be done, a work instruction could be placed by the computer. To decrease the noise level, the terminals can work with the culture and reduce the practice of dropping pallets. They can also enable the use of earplugs by making it clearer where forklifts should drive and where the worker needs to be aware of them. The terminals can minimize the need to memorize the sorting by heart by putting the signs with postcodes in numerical order, so it is easier to locate the right cage. DB Schenker is currently developing a system that enables the sorting code to be displayed on the label, so before they invest in a more advanced system like pick by light they could investigate the improvement with the new system. The same solutions also help to reduce the risk of sorting errors. To reduce errors KPI values of the number of wrongly sorted parcels can also be displayed for the workers. The terminal should also make the current work instructions available for the terminal workers and introduce them to a standardized way of working. These work instructions are today quite hard to read, so they also need to be developed by DB Schenker to be more user friendly for the terminal workers.

To improve the organizational ergonomics, it is suggested that all four problem areas discovered in research question one are handled. However, these problem areas are equally valid for the normal parcel handling and not exclusive to the Ugly-parcel handling. The process to leave improvement suggestions should be made more transparent for the terminal worker. The expected performance of the worker should be clarified. It could be, for example, how many parcels are expected to come in during the shift and how many that should be handled. There could also be a standard takt time. To improve the physical environment dust cleaners could be installed to reduce the dust in the air. To clarifying the learning process for new employees, a training program could be introduced. Lastly, it is recommended that the normal parcel handling should be evaluated from an ergonomic perspective since many of the ergonomic effects are as valid for normal handling as the Ugly-parcel handling.



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# A

## Appendix

Interview questions asked during the interviews at six terminals.

### A.1 Interview questions, Terminal worker

#### Background

- What is your current position at DB Schenker?
- How long time have you had this position?
  - Have you had any other position at DB Schenker before?
- How old are you?

#### The working day

- How are your working days structured, when do you have breaks and when are the sorting of packages done?
  - How often do you switch tasks within the group?
  - Which are the normal tasks that you do?
- Do you have any equipment that help you with the sorting, e.g. to lift the parcels or to tell you in which cage it should be placed?

#### Handling of ugly-parcels

- Which packages based on your experience cannot be sorted on the parcel line?
- How do you handled the ugly-parcels?
  - Why are you doing the sorting like that?
  - Which problems do you see with that handling?
  - How do you want to do the sorting differently?
  - How much of this handling would you say that you have mastered?
- How often do you as an individual need to handle ugly-parcels?
- How many are you that work with the ugly-parcel handling, or how much time do you estimate that you spend on the ugly-parcel handling?
- Does the ugly-parcel handling affect the normal sorting of parcels?

#### Physical ergonomics

- Have you experienced any physical overload from working here?
  - If yes, which kind?
- Is there any handling or task that you feel is especially risky?
  - Is there any part of the ugly-parcel handling?
  - Which risk do you see with the task or handling?

### **Cognitive ergonomics**

- Do you think that something with the package handling is mentally demanding?
- Do you experience any obstacles for reading the information at the terminal? (contrast, colour, glare etc.)
- Are there any noises in the terminal? (loud noises, rumbling etc.)
- Do you need to focus on many different things at the same time?
  - Something that interferes with your focus?
- Do you need to remember many things in order to do the sorting?
  - Do you need to know the sorting by heart?
- Where can you find information about how the sorting of ugly-parcels should be performed?
- How did you learn the handling of ugly-parcel?
  - How long time did it take?
- Is it easy to make errors?
  - Do you have any system that prevents errors?
- Are there any objects or sorting concepts that have similar names which makes it easy to commit errors?
- How do you know how you should sort the parcels?
- Can you in some way see how many packages that are coming in? (So you can prepare yourself for the work load)
- Do you follow any standardised working process?
- Do you have any work instructions?

### **Work environment**

- Do you experience any negative stress with your work?
  - Can you influence your work and the work routines?
  - Can you give improvement suggestions?
  - Do you feel support from your team leader?
  - Do you feel that you have a low, medium or a high workload?
  - Do you feel that you easily can achieve the performance requirements?
  - Do you feel job security?
- Do you think that the climate in the terminal is good for the work that you are doing? (e.g. cold, warm, good air etc.)
- What are your general thoughts about your work?
  - Do you feel motivated to go to work?
- How do you feel after a working day, are you mentally or physically tired?

### **Other**

- What are the main characteristics if it has been a good working day for you?
- Are there any parts of the work that you think should be performed differently?
- Are there any other concerns or thoughts that you think I should know?
- Do you have any questions for me regarding my master thesis or this subject?

## A.2 Interview questions, Team leader

### Background

- What is your current position at DB Schenker?
- How long time have you had this position?
  - Have you had any other position at DB Schenker before?
- How old are you?

### The working day

- How are your working days structured, when do you have breaks and when is the sorting of packages done?
  - How often do you switch tasks within the group?
  - Which are the normal tasks that you do?
  - How are the working days structured for the terminal workers (This questions was asked depending on if the team leader is part of the production or not)
- Do you have any equipment that helps you with the sorting, e.g. to lift the parcels or to tell you in which cage it should be placed?

### Handling of ugly-parcels

- Which packages based on your experienced can not be sorted on the parcel line?
- How do you handled the ugly-parcels?
  - Why are you doing the sorting like that?
  - Which problems do you see with that handling?
  - How would you want to do the sorting differently?
  - How much of this handling would you say that you have mastered?
- How often do you as an individual need to handle ugly-parcels?
- How many are you that work with the ugly-parcel handling, or how much time do you estimate that you spend on the ugly-parcel handling?
- Do the ugly-parcel handling affect the normal sorting of parcels?

### Physical ergonomics

- Have any terminal workers experienced any physical overload from working here?
  - If yes, which kind?
- Is there any handling or task that you feel is especially risky?
  - Is there any part of the ugly-parcel handling?
  - Which risk do you see with the task or handling?

### Cognitive ergonomics

- Do you think that something with the package handling is mentally demanding?
- Do you experience any obstacles for reading the information at the terminal? (contrast, colour, glare etc.)
- Are there any noises in the terminal? (loud noises, rumbling etc.)

- Do you need to focus on many different things at the same time?
  - Something that interferes with your focus?
- Do you need to remember many things in order to do the sorting?
  - Do you need to know the sorting by heart?
- Where can you find information about how the sorting of ugly-parcels should be performed?
- Is it easy to make errors?
  - Do you have any system that prevents errors?
- Are there any objects or sorting concepts that have similar names which makes it easy to commit errors?
- How do you know how you should sort the parcels?
- Can you or the terminal workers in some way see how many packages that are coming in? (So you can prepare yourself to the work load)
- Do you follow any standardised working process?
- Do you have any work instructions?

### **Work environment**

- Do you experience any negative stress with your work?
  - Can you influence your work and the work routines?
  - Can you give improvement suggestions?
  - Do you feel support form your boss?
  - Do you feel that you have a low, medium or a high workload?
  - Do you feel that you easily can achieve the performance requirements?
  - Do you feel job security?
- Do you think that the climate in the terminal is good for the work that you are doing? (e.g. cold, warm, good air etc.)
- What are your general thoughts about your work?
  - Do you feel motivated to go to work?
- How do you feel after a working day, are you mentally or physically tired?
- What are the main characteristics if it has been a good working day for you?

### **Other**

- What is the age and gender distribution at the terminal?
- What is your employee turnover rate?
- Are there any parts of the work that you think should be performed differently?
- Are there any other concerns or thoughts that you think I should know?
- Do you have any questions for me regarding my master thesis or this subject?

## **A.3 Interview questions, Terminal manager**

### **Background**

- What is your current position at DB Schenker?
- How long time have you had this position?
  - Have you had any other position at DB Schenker before?
- How old are you?

**The working day**

- How are the working days structured for the terminal workers, when do you have breaks and when is the sorting of packages done?
  - How often do they switch tasks within the group?
  - Which are the normal tasks that they do?
- Do you have any equipment that helps you with the sorting, e.g. to lift the parcels or to tell you in which cage it should be placed?

**Handling of ugly-parcels**

- Which packages based on your experience cannot be sorted on the parcel line?
- How do you handled the ugly-parcels?
  - Why are you doing the sorting like that?
  - Which problems do you see with that handling?
  - How do you want to do the sorting differently?
  - How much of this handling would you say that you have mastered?
- How often do you as an individual need to handle ugly-parcels?
- How many are you that work with the ugly-parcel handling, or how much time do you estimate that you spend on the ugly-parcel handling?
- Does the ugly-parcel handling affect the normal sorting of parcels?

**Physical ergonomics**

- Have any terminal workers experienced any physical overload from working here?
  - If yes, which kind?
- Is there any handling or task that you feel is especially risky?
  - Is there any part of the ugly-parcel handling?
  - Which risk do you see with the task or handling?

**Cognitive ergonomics**

- Do you think that something with the package handling is mentally demanding?
- Do you experience any obstacles for reading the information at the terminal? (contrast, colour, glare etc.)
- Are there any noises in the terminal? (loud noises, rumbling etc.)
- Do you need to focus on many different things at the same time?
  - Something that interferes with your focus?
- Do you need to remember many things in order to do the sorting?
  - Do you need to know the sorting by heart?
- Where can you find information about how the sorting of ugly-parcels should be performed?
- Is it easy to make errors?
  - Do you have any system that prevents errors?
- Are there any objects or sorting concepts that have similar names which makes it easy to do errors?
- How do the workers know how to sort the parcels?

- Can you or the terminal workers in some way see how many packages that are coming in? (So you can prepare yourself to the work load)
- Do you follow any standardised working process?
- Do you have any work instructions?

**Work environment**

- Do you experience that the workers have any negative stress with their work?
  - Can they influence their work and the work routines?
  - Can they give improvement suggestions?
  - Do you feel that they have a low, medium or a high workload?
  - Do you feel that they easily can achieve the performance requirements?
  - Do you feel that they feel job security?
- Do you think that the climate in the terminal is good for the work that you are doing? (e.g. cold, warm, good air etc.)
- What are your general thoughts about your work?
  - Do you feel motivated to go to work?
- How do you think that the workers feel after a working day, are they mentally or physically tired?
- What are the main characteristics if it has been a good working day for you?

**Other**

- What is the age and gender distribution at the terminal?
- What is your employee turnover rate?
- Are there any parts of the work that you think should be performed differently?
- Are there any other concerns or thoughts that you think I should know?
- Do you have any questions for me regarding my master thesis or this subject?

# B

## Appendix

The following appendix is containing summaries from interviews performed at 6 different terminals. The number in the beginning of the interview number indicates which functions the interviewed persons have: 1. Interviews with terminal workers 2. Interviews with group manager 3. Interviews with terminal manager or package manager. The following summaries are only containing the information from interviews which was relevant for this study. Since the questions asked were very open, the interviewed could determine themselves how much they want to answer, therefore not all interviewees answered all the questions.

### B.1 Interviews with terminal workers

In the following section are all interviews with terminal workers summarized.

#### B.1.1 Interview 1.1

Interview with terminal worker.

##### **Background**

The terminal worker has been an employee at DB Schenker since 1988 and is 52 years old.

##### **The working day**

The terminal worker start work at 9,11 or 14 and have a lunch break for one hour. The worker is usually one of two who works on the straight conveyor belt. They are shifting start time with each other every second week. The worker is mostly working with the Ugly-parcel handling on the straight conveyor belt since he/she thinks that task is the most varying. The workers can use forklift as a lifting aid at the straight line conveyor. They use it to lift up parcel cages to the same level as the conveyor belt so they don't need to bend down in order to grab parcels. They mostly use it for the heavy packages. The terminal worker said that sometimes they choose to not use the forklift since it takes longer time than to just lift up the parcels. However the terminal worker said that they feel it is okay that the forklift takes the time it takes, but at the same time, they want to perform as fast as possible. If they don't work fast, they will just need to handle the parcels later. The terminal worker said that they feel that they need more people at the straight line conveyor but at the same time they feel that it is okay that it takes the time it takes.

### **Ugly-parcel handling**

The interviewee felt that on the straight conveyor belt, they can handle all parcels that can't be handled with the ordinary flow. The terminal worker said that the ugly-parcels are sorted out either on the inline station or at the telescopic conveyors, also called Long-johns. Sometimes they get cages which only consist of Ugly-parcels, then they can transfer them directly to the straight conveyor belt. The terminal worker works with the ugly-parcels nearly every day. Sometimes they rotate more, but the terminal worker has now worked with the Ugly-parcels during all days. The terminal worker expressed that he/she likes to be there and that they can't put new personnel there since the sorting is too complicated, so the more experienced personnel needs to be there more often. Mostly they are two persons working with the handling, but some days they are three if they are delayed.

They have three work tasks on the straight conveyor belt. One handles all parcels without EDI, one puts the parcels on the line and one picks the parcels off the line. Since there is three tasks, they feel it should be three workers there. The terminal worker felt that the handling didn't affect the ordinary flow so much. They never put up the parcels on the line and therefore they don't affect. Ugly-parcels have some effect on the ordinary flow at the inline station and the telescopic conveyors. At the telescopic conveyor, they need to leave the parcels in the entrance of the gate at the terminal, so if they are behind their schedule, they might not be able to remove those parcels before a new truck needs to load of new parcels there.

### **Physical ergonomics**

The terminal worker has experienced some physical overload, since the terminal worker has been there so long time. He/she has some pain in the knee due to a bad meniscus. This creates sometimes a problem for the interviewee to bend down and lift in a good way.

The interviewee feels that one risk in the terminal is that you could drop the heavy parcels on your foot. Also heavy lifts are an increased risk. The worker said that they try to think more about how to lift when they know the parcels are heavy. They can get parcels which weigh 30-40 kilo in their import flow. Sometimes they try to lift two and two if the parcels are very heavy.

### **Cognitive ergonomics**

The terminal worker doesn't feel that there is any part that are especially challenging to do. The interviewee expresses that "when you have been here for so long time, you nearly feel that everything is boring and therefore you like to handle the Ugly-parcels since that is a more varying work". The terminal worker thinks that it is quite hard and challenging in the beginning with new sorting concepts. Like for Stockholm, which they recently split up into three instead of one sorting concept.

The interviewee expressed that it takes some time to learn the straight line sorting, new personnel need to be there a few weeks before they understand the handling.

About 75/

The terminal worker feels that the straight conveyor belt creates a lot of noise in terms of rattling. Therefore they try to shut it down in between so they don't need to hear it all the time, for example when they just sort out the parcels. They are offered to have earplugs out in the terminal, but it is up to each worker if they want to use them.

The interviewee said that some parts of the handling requires that you can have a lot of things in your head at the same time. They both need to look if they need to go to the telescopic conveyor, or if they need to pick parcel from the inline station, and at the same time sort the parcels. They have a folder where everyone can see how the sorting should be done (if you need to look how to do the handling), but this is not used so much. When the terminal worker learned the handling, he went parallel with a more experienced person. The interviewee said that the ordinary handling takes like 5 minutes to learn since you have only one or two sorting concepts on each outline. It is a big step to go to the straight conveyor belt where you have 28 sorting concepts. Therefore it takes a couple of weeks to learn the Ugly-parcel handling and that is the reason why they put the people with longer working experience on that handling.

The terminal worker said that it is easy to make mistakes in the sorting. Especially if the line is full and it starts to fall down parcels. If you don't look carefully on the parcel, it can be easy to put it in the wrong parcel cage. The Stockholm's three sorting concepts are very similar and therefore it is easy to put these parcels wrongly. It is even easier to put the parcel wrong on the straight conveyor belt. The interviewee said that you need to know the handling in order to do it right. They have a small book where you can find the sorting concepts and look up which city that should be put in a certain terminal, but it takes a lot of time to check in the book every time. You need to learn the sorting concepts in order to handle the parcels in the right speed. The terminal worker said that when you have been there for a long time you notice yourself if you put a parcel wrongly, since you unconsciously look at all parcels in the parcel cage when you put a parcel in the cage. So then you often notice if there is any misplaced parcel and you can correct the error.

The terminal worker can know how many import parcels coming in each day, but they can't know how many domestic parcels that will come in. They can sometimes get information when a certain customer contacts them and say that they will send more volumes than ordinary, but not all customers do so. The interviewee said that they have a standard process that they should follow when they do their work. They also have work instructions in the folder. There you can look them up if you want to.

### **Work environment**

The Interviewee said that they can affect the routines and how they should do the work up to a certain level. It depends on the situation. They can give suggestions for improvements and the interviewee said that it is up to the bosses to decide if it

is good. They hand in the suggestions to the team or group manager. The terminal worker feels that the worker has good support from his/hers boss and that the boss listens to him/her since they have worked a long time together. The interviewee feels that they have a high work load during the day. The worker said that you can take some small breaks to drink water and so during the shift, but they always have a lot to do. Further, the workload isn't the worst, it is the hard work with heavy lifts. The terminal worker think it is hard to meet the performance requirements. They have a goal to sort everything that comes in each day, but they can't meet this target every day. They feel it is okay to leave parcel cages to the other day if they need to do so. They feel that the bosses have faith in them and know that they do their best and therefore is it okay to leave cages some days.

The climate in the terminal is very warm at the summer and cold at the winter. Before, the truck drivers drove into the terminal while they worked in the terminal, which created a lot of exhaust in the air. Now the truck drivers are gone when terminal workers start to work, which the interviewee thinks is much better. The terminal worker feels that it can be hard to be motivated after so many years and that everything mostly is done based on routine. The worker still feels okay to go to work, but pretty neutral to it. The interviewee said that he/she can be physical or mentally tired some days but mostly not.

### **Other**

The characteristics for a good working day is when they have less import parcels and more ordinary parcels. The ugly-parcels are worst since they are long and heavy, so if they are less, it is also a better day. Some customers is also worse than others. The terminal worker said that it should be good with more information to the customers so they understand how they could make it easier for the workers at the terminal. The worker feels that customers don't know how the parcels are handled. There is more or less no consequences for customers sending the Ugly parcels. Sometimes they put a parcel to the side, if it is especially tricky, so it gets delayed one day. But that is the maximum consequence. The terminal worker said that it is a very heavy job.

### **B.1.2 Interview 1.2**

Interview with terminal worker.

#### **Background**

The interviewee has worked as a terminal worker since 2014/2015 and is 49 years old.

#### **The working day**

The interviewee feels that the days are a little stressful now. The terminal workers rotates between all tasks, but has the latest time been at the IVS station due to a work accident. The worker was handling long unpacked metal bars. The bars where put against a parcel cage and when she moved the cage the metal bar fell onto the workers shoulder. This accident happened at the ugly-parcels sorting and similar

parcels are arriving to the terminal every day. The interviewee explained he/she tries to be positive during the whole day.

### **Ugly-parcel handling**

The terminal worker often stands at the IVS station where the parcels which can't be scanned by the cargo-scanner directly are handled. These can be private parcels, bad label on the parcel, import parcels that need new labels, missing EDI etc. The terminal worker said that they rotate on all positions, but the worker is often placed on the harder stations since he/she has been there for a while and knows all parts of the handling.

### **Physical ergonomics**

The interviewee has only had the accident that was mentioned in the beginning. The interviewee said that he/she has never have been sick or away before. The terminal worker feel that if you don't think of what you are doing, accidents can easily happen. Like when the terminal worker was hurt.

### **Cognitive ergonomics**

The interviewee doesn't think that the work is mentally demanding. The worker feels for the job as "it is what it is" and have high work mentality and likes to work. However the interviewee feels that others may not be motivated by the work. The worker doesn't need to read any information since she knows everything by heart. Therefore the worker doesn't have any knowledge about how readable the information is. The interviewee said that it is some noise at the straight conveyor belt, but otherwise the worker thinks that the noise level is quite low. The terminal worker also said that you can use earplugs if you need them, but the worker chooses not to use them. The interviewee said that sometimes you need to focus on more than one thing at the time, but it depends on who you are working with. The worker said that the late shift is harder since then they have more difficult parcels to handle which requires you to keep more information in your head. The terminal worker expressed that a lot of the other workers forget to think about other tasks, which creates more jobs for those who have been working there for a long time.

The terminal worker thinks it is easy to know what to do. The worker said he/she has learned fast. The interviewee said that every day, the same type of parcels are coming in, so if you remember the parcels from one day, they will come tomorrow as well and you will know what to do with them. Further, said the worker, you often don't need to scan them in order to know what is wrong if you remember the parcels. The same customers send parcels every day so you recognize them. The terminal worker said that how fast you learn is very different from person to person. For those who don't want to learn, it will take longer time. Often it takes like a week or so for the workers to learn the normal sorting. The interviewee said that it is easy to make errors. If you don't concentrate while doing the sorting or at the IVF station, errors will occur. You need to keep the focus on what you are doing the whole time, otherwise it will be problems. The terminal worker has some knowledge on how much work they are going to have since it is pretty much the same every

day. The worker said that they don't have any standardized process they should follow, but instead you learn what everyone else is doing.

### **Work environment**

The terminal worker thinks that it is stressful with colleagues who don't do their best, since this means that somebody else needs to compensate for them and focus on them so they don't do errors. The worker said that when he/she worked in Germany before, the bosses were good at going to the employees and collect suggestions, which they evaluated and selected some for implementation. The interviewee said this is not the same at DB Schenker and she thinks it is bad since she likes how it was in Germany. The terminal worker expressed that she likes to give suggestions. The terminal worker expressed the desire to be included in the process to develop the processes and decrease the costs.

The worker feels support from the bosses and said that it is no problem with them. The interviewee thinks the work load is on a medium level. The worker can go and drink water and so when he/she wants. The terminal worker said that sometimes they need to leave parcels to the other day which is quite stressful. The terminal worker feels they have a good job security. The worker doesn't think it gets cold during the winter in the terminal since they do a lot of physical work that keeps them warm. So the worker thinks the climate in the terminal is good. The worker tries to be positive to the work every day to make others positive as well to their work. The interviewee said that he/she is tired in both the body and the head after a working day. The terminal worker often gets bruises on the body, since they often need to support the long and heavy parcels against their body to be able to lift them.

### **Other**

The characteristics for a good working day according to the terminal worker is when everyone helps each other and tries to do something all the time. When you don't need to tell someone what to do and also you don't need to nag on the others to do their job. The interviewee feels that one can't make any changes as a terminal worker. It is the bosses that decide and what you as a worker thinks doesn't matter. The worker thinks that the big parcel isn't the biggest problem, the main problem is that the terminal workers don't help each other.

## **B.1.3 Interview 1.3**

Interview with terminal worker.

### **Background**

The terminal worker works with the parcels handling and has done so since the worker was seventeen. He/she worked at DB Schenker for about 5-6 years, then he/she needed to leave the company when they lost a big customer. The worker is now back at the same position and has been working for 3-4 years ago. The interviewee is 29 years old.

**The working day**

The terminal worker starts every day at 14 and starts with arranging around the parcel sorting conveyors. He needs to put cage-flags on the cages etc. They start the line at 14:20 to 14:30 dependent on which parcels they have. They sort until 18:30-19, then the terminal worker is left alone and prepare the parcel line for the night shift and clean around the work place. The terminal worker said that they use a forklift to lift up the pallets if they can't use they cage-lift. When a parcel is hanging out from the pallet, they can't the cage-lift. They had a vacuum-lifter at the old parcel sorting conveyor and it was said it should be used for heavy parcels, but they experienced that it lost its power over time and was hard to clean so it was worn out and not used.

**Ugly-parcel handling**

The parcels that can't be handled on the parcel sorting conveyor, are the long parcels over about 1.8m. Before, on the old parcel sorting conveyor, they could handle all parcels up to 2m but now at the new parcel line they get stuck at the first turn. If they get round parcels, they often need to slice up the bar-code in order to be able to scan it. The terminal worker wish that the parcels would be broader so it easier could be scanned. They also have some very heavy parcels that can't be handled on the parcel sorting conveyor. They have some special customers that creates problems even though the parcels can be sorted on the parcel sorting conveyor. They have very heavy parcels and if those parcels are late it can be hard to pack the cages good since you want those parcels in the bottom. Sometimes, they even need to start on a new cage which can lead to a lower utility of the parcel cage.

The terminal worker thinks that the parcel sorting conveyor should be broader so more parcels could be sorted on it. The worker thinks that the width is the main problem on the conveyor. In the turns the parcels are rotating and then they can get stuck in the next turn since they don't come in to the turn straight. If you then loosen up the parcel, the sorting conveyor "forgets which parcel is which" and therefor also how to sort it, so it returns on another outline and needs to be sorted manually. When they get a parcel that can't be handled in the normal flow , they pick them out and scan them with the HDT and then they put it on a pallet by the outlines. Everyone handles the Ugly-parcels during the day. Sometimes they also put the Ugly-parcel on the no-read arm and the workers at the outlines scans and picks them. The interviewee thinks that sometimes the Ugly-parcels affect the normal sorting much, but at the moment they don't have so high volume of parcels, so right now it works good as it is. They have about 1300 parcels now and had 1700 before. But they expect it to increase again to Black-Friday and Christmas.

**Physical ergonomics**

The terminal worker hasn't experienced any physical distress from the work. The worker doesn't know which part of the sorting that could be especially risky. The interviewee thinks it is important to think about how you are lift the parcels. The worker thinks the inline station is the most demanding station, since then you need to lift all the parcels. It can be many heavy parcels at the same time and then it

is very demanding for your body, for example it can be only 20-25 kilogram parcels on three pallets in a row.

### **Cognitive ergonomics**

The interviewee thinks it is easy to read all the information in the terminal. The worker doesn't think it is a lot of noise in the terminal. The terminal worker feels now, when they have a new parcel sorting conveyor, is it a better noise level than before. Partly due to the new conveyors and partly due to that they have moved to another part of the terminal where the forklift traffic is more limited. On the old place where the parcel sorting conveyor was located, it was more noises. So the terminal worker likes the new environment better. The interviewee especially likes the temperature and the light better. The terminal worker doesn't think that the work is especially mentally demanding. The worker doesn't think that one needs to focus on more than one thing at the same time since the workers in the team try to work much together and support each other. The interviewee doesn't think that one needs to keep a lot of information in your head. In the beginning when you start to learn the sorting, it is very hard to learn how it should be done. It requires some learning. It took about 2 month for the worker before he/she felt that he/she had fully control of the work. The terminal worker has also learned the groupage handling. There you need to learn the sorting in detail and by heart. If you don't know how to do it, you can always ask.

The terminal worker doesn't think it is easy to do errors. Some of the names on places are alike, like Alvesta and Avesta. They also get a lot of wrongly sorted parcels that should have been at Nybro, Oskarshamn and Linköping, so maybe they have some places that have similar names to our places. The worker thinks that it can be quite easy to place the parcel in the wrong parcel-cage if there is one that has a similar name. The worker can't see in any way how much parcels that should come in during the day. The worker knows, based on experience ,that on Wednesday's and Fridays there are less parcels. The terminal worker said that they have a folder with some standardized tasks which should be done. It tells you what to do in the preparation etc. But often they experience that the new personal are just thrown into the production directly and that they are not properly learning the standards.

### **Work environment**

The terminal worker said that you in some ways can affect your work. They can determine how they should have the layout of the sorting depending on what is best for them. The worker however feels that you can't give suggestions for improvements, they don't discuss improvements in the group. The worker feels that he/she has good communication and support from the boss. The terminal worker said they has a medium work load, it feels like a reasonable amount of work. The worker thinks that you can meet the performance demands. The worker feels that you have a good job security at DB Schenker.

The worker thinks it can be very cold at the winter in the terminal and then you

need to have gloves and a cap, especially if you drive the forklift. When the gates to the terminal are open, it gets very chilly. But at the new part of the terminal where they are today, the worker feels it is better. But they haven't been there over the winter yet. But it is also very warm during the summer period. The interviewees general thoughts about the work, is that you sometimes feel a bit unmotivated to go to work, but generally you feel good about it. The worker thinks it is more motivating now since they switch with the groupage handling also. So this is something that motivates the worker. The terminal worker expresses that it is a good relationship between the workers and the bosses. The interviewee thinks that he/she is a bit physical tired after work and that he/she needs to calm down a bit when the worker comes home.

### **Other**

The interviewee thinks it has been a good work day if everything flows in a good way and you have been able to take about five minutes before you leave the shift and just calmed down a bit. The worker thinks that those five minutes is very good for you and has a positive effect on how you feel when you arrives home. If the interviewee got to choose , he/she would like to broaden the parcels sorting conveyer so that the parcel don't get stuck in the turns. This is the biggest disturbance for them. But the worker likes the new parcel sorting conveyor more than the old one since it is less noisy and gives them a better work environment.

The Work Environment Authority has been visiting the terminal and complained about the sorting into the parcel-cages, and that they sometimes need to repack the cage. They try to avoid the repacking, but if you get a heavy parcel late, you need to try to repack in order to get good utility of the cage and also protect the other parcels so they don't get smashed. But if the parcel-cage already is half full, they sometimes need to take a new parcel-cage. They don't know how to solve it in another way. They would like to rotate more with the groupage department. They think that the groupage personnel don't want to be at the parcel sorting, but at the same time it would be better for all. It is one of the suggestions that they should discuss all together later. In those meetings where they discuss similar things, they try to have representatives from the terminal handling's both night and day shift and the managers. The worker said that it is the managers responsibility to solve the problem but that the worker personally thinks that rotation would be very good.

## **B.1.4 Interview 1.4**

Interview with terminal worker

### **Background**

The interviewee works as a terminal worker and handles most parcels and has been at DB Schenker for 16 years. The interviewee has always been at the parcel sorting and is 41 years old.

### **The working day**

The shift starts at 15 and ends 20:30, they don't have any breaks. The worker starts the shift with inspecting the parcel sorting conveyor so it looks okay (if conveyor belts or wheels are broken or if something else is wrong). At Fridays, the worker starts 14:30 and before production, they clean the conveyor belt. The sorting is done from 15 to 19, then they clean and put everything in order the night shift. They rotate the work tasks every hour. They should not stay on the inline station for more than one hour during the shift. The terminal worker said they can use the HDT as an aid to see to which terminal the parcel should be sent. But this aid doesn't work with the new sorting concepts for Stockholm.

### **Ugly-parcel handling**

The parcels which can't be handled on the parcel sorting line (based on the terminal workers' experience) are round parcels, flat parcels, long parcels and strange shaped parcels. If they can't handle a parcel on the sorting conveyor, they either leave them in a parcel-cage by the inline station and drive the cage to the outlines, or they go directly with the parcel to the outline. These are also scanned with the HDT. According to the terminal worker, this is the best solution that they think works. The interviewee thinks that the handling of Ugly-parcels takes a lot more time and that these parcels often also are heavy. This handling can also be a bit stressful since it is easy to miss or down priorities the handling so you need to rush with it at the end. The Ugly-parcels can also be hard to fit in the parcel-cage so you might need to repack the cage. This is especially the case when new employees are packing the cages since they often don't have time to think about how they should pack. The terminal worker said that all should take common responsibility to sort the Ugly-parcels, but it is often the more experienced personnel who do it. The interviewee said that if there is a lot of Ugly-parcels, it will have a significant effect on the other production, If it is just one cage, that works fine but sometimes there is like three cages.

### **Physical ergonomics**

The terminal worker expressed that he/she has pain in the back and also pain in the feet from walking on the concrete floor. The worker said that they have rubber mats on some places which they think helps a lot. The terminal worker said that you needed to nag in order to get the mats. The terminal worker doesn't think that any of the tasks are especially physical demanding, but the inline station is the worst station for the back.

### **Cognitive ergonomics**

The interviewee doesn't think that the handling is mentally demanding, but it can be stressful. This is due to that when you handle the Ugly-parcels you see all parcel that bulk up at the conveyor belt and then it becomes very stressful. The terminal worker explained that many of the new workers forgets that part, and the hourly employed personnel don't care so much. The interviewee thinks it is easy to read the signs in the terminal in order to find information about the sorting. It can be a little harder with Stockholm since it is so many locations on the sign, so the text becomes very small and can be hard to read. The terminal worker feels it is a lot of

noise from the forklifts, both the floor and forklifts are old.

The interviewee doesn't think it is so many things to keep in the head or to focus on, since he/she has done it for so long time so he/she does everything on routine. The terminal worker said that you can't manage to read all the signs within the right time, so you need to learn the sorting concept by heart. It takes different amount of times for all new personnel to learn the sorting, it can be weeks or it can be months. When beginners learn, they should walk beside someone experienced, but often they are short with manning so beginners get thrown into the production directly. The worker said it is easy to sort the parcel wrong and put it in the wrong parcel-cage. The terminal worker expressed that when you have been working for such a long time as he/she, your mind automatically read on the already placed parcels in the cage when you put in a new parcel. Then you can see the errors quite fast and correct them which is more difficult for new employees. The worker said that this mindset takes some time to develop. There are some sorting concepts which are quite alike. Stockholm and Västerås have some that are very similar. Also Avesta and Alvesta, Kristinehamn and Kristianstad etc. The interviewee can't know how much they have to do each day.

The terminal worker said that they have a standard way of working which they always learn new personnel, but it is not written down. The worker tries to learn beginners by going with them on the outline and then help them with the postcodes and try to guard them so they can start to pack the cages right directly. A tip is to keep it flat and build your way up. When you have more parcel-cages you can also put the small parcels on the top and start with a new cage when you get big parcels. But it is hard when you only have one cage. The worker means that a common error beginners do is that they don't think ahead on how to fit parcels in the parcel-cage.

### **Work environment**

The interviewee said that they can't affect the routines and the work so much. They can leave suggestions for improvement to the group manager or the terminal manager if they want. The worker said that they has good contact with many of the managers. The workers said that they often listen to what you say at least partly, and some things gets tested. The worker think that the workload is quite high during most parts of the year under the summer is it a bit lower. Normally do you exactly manage to do what you need, you often need to stress a bit in the end to manage to do the work. The terminal worker feel that they has a good job security.

The interviewee thinks the air in the terminal is bad and it gets warm in the summer and cold in the winter. The gates are often open and that of course effects the heat. They have now received some air cleaners which has helped a bit with the air quality, since it reduces the dust in the air which comes from the parcels. The terminal worker said that they have had a big cleaning week which has also helped with the air quality. The worker generally feels motivated to go to work and feels that he/she contributes to something. The interviewee is both mentally and physical tired after

the work, worst is the last quarter of the year which is very stressful.

### **Other**

A good working day for the worker is when they are finished with the sorting with a big time margin and they have had a good team work at the parcel sorting conveyor. It is also good if the parcels come in a bit now and then and not all at the same time, because then it becomes very crowded. The worker said that they don't want to receive cages or pallets with only two parcels on each, this disturbs a lot in their flow. It also disturbs if the driver often put the parcels in the wrong place.

### **B.1.5 Interview 1.5**

Interview with terminal worker

#### **Background**

The interviewees current position is terminal worker and the worker has been working with this for 3 years now. The terminal worker is 27 years old.

#### **The working day**

The shift is 11:15-20:00 with a lunch between 14:15-15:00 Lunch is often the only break they have. Sometimes they have a break at 16:00 but then it needs to be very calm if they should get it, so that rarely happens. They rotate different amount of times depending on which position they have. If you are at the inline station, you rotate with the computer and the forklift one time each 15 minutes, and do so during the whole shift. One the other positions, you usually are positioned during the whole shift. The terminal worker said that they usually have the more experienced workers at the inline station and the more inexperienced at the outlines. At the inline station you need to know what you should do when you scan the bar-code in order to figure out what is wrong with the parcel. At Cargo 5, which is their straight conveyor belt, they have a vacuum lifter. They also have signs hanging from the roof which tells them how they should sort the parcels. The terminal worker said that they don't use the vacuum lifter so much. The worker said that many are unused to it, one person who has been working at the terminal for a long time uses it, but nearly no one else does. It is usually very hard to use the lifter since the parcels either can miss a flat surface where you can put the vacuum on or the packaging is too weak.

#### **Ugly-parcel handling**

The parcels they can't handle in the normal flow is usually the long parcels, too thin or light parcels and parcels with deviating shapes. The deviating shapes can be that it is round or have other strange shapes or things sticking out. The worker sees a problem with the handling since they are usually just one person working at that station. This lead to that you need to put up the parcels and take them off yourself, so you need to run a lot back and forward. The conveyor is also very long so according to the worker, the ergonomics is not good. The interviewee said it is very rare that they are at the straight conveyor belt since they also often handle the

Finland sorting, which is a similar handling, and you shouldn't be on both these stations in a week. So since the worker has been a lot at the Finland sorting, he/she hasn't needed to be on the Ugly-parcel since both these stations are worse for your body compared to the normal handling.

The terminal worker said that you can only be one whole day at the Ugly-parcel handling each week. Before, they rotated one time during the shift, then it was maximum two half days working with Ugly-parcel handling. Now they don't rotate, which they like since they feel that otherwise the work gets disturbed, and you need to remember who you should rotate with. The interviewee likes to focus on his/her own tasks. The terminal worker thinks the straight conveyor belt handling affects the normal handling a lot. If you are at the inline station, you need to put all Ugly-parcels to the side. Before they put them on the ground, but now they have a rolling parcel-cage where they can put them in directly, but it takes time to put them away. You often also need to send people from the normal handling to the straight conveyor belt in order to finish that handling on time.

### **Physical ergonomics**

The terminal worker has had some stretch injury in the back, from lifting a parcel wrongly. There is also much more dust by the straight conveyor belt than by the parcel sorting conveyor. The worker experiences that they have been getting colds from the dust. The terminal worker thinks that the injury risk also increases when you are stressed. It is also risky when you need to lift a big parcel which you can't lift in the right way. The worker also thinks it is a risk with the cages which are bad packed and when you open them, parcels can fall out over you. The inline station can also be a risk, long Ugly-parcels can fall from the parcel-cage and some have gotten those in their head.

### **Cognitive ergonomics**

The terminal worker said it can be mentally demanding when you drive the forklift. You need to know how you should drive and where to place the parcel-cages. The worker experiences this as challenging since he/she is not experienced with that part of the handling. The interviewee also thinks it is challenging to sort the parcels at the straight conveyor belt since he/she often needs to look on the signs in order to know where to put the parcel. When you are responsible for the forklift driving, you put the cages on the right cage-lifter. It can be hard to know which one is the right lifter since certain parcels need to be prioritized to some of the inline stations.

The terminal worker thinks the signs is pretty easy to read. You stand right under them so they are quite easy to read. The interviewee thinks it is a lot of noise in the terminal. There is rumbling from the conveyors, which is noticed when you shut the conveyers down (it gets very quiet). It is also a lot of noise from the forklifts. It can also be high sudden sounds if one of the workers drops a parcel that is heavy or containing hard items. The terminal worker said that many of the noise problems is due to metal hitting metal. The terminal worker said that they can use earplugs, but you don't want to use it since then you miss the sound from the forklifts which

can be dangerous. The forklifts drive everywhere so you really need to use your hearing much.

The interviewee said that you need to focus on many things if you stand on some of the stations. On the inline station you need to see if it is transit or departing parcel. You need to put the bar-codes right. When you drive forklift, you need to keep your eyes open. By the computer you have to know what to do when it stops. The worker feels that at the straight conveyor belt you can manage to read the signs and still keep the right speed for the handling. Some days is calmer and you have enough time. But usually you have a lot to do, and sometimes you don't manage to ready the signs, so you need to know the basic places. For example you need to know like if it is number eight, it should be in the north. When you learn the straight conveyor belt handling, you go parallel with someone else and then you learn yourself by doing the work. It variates a lot on how long time it takes to learn, but after about 5-6 times there you should you be pretty good at it.

The terminal worker said it "should not be easy" to put the parcels in the wrong cage if you read the signs and labels carefully. You need to be very sure that you sort correctly. There are some concepts, like Arboga and Arvika, Alvesta and Avesta, Mariestad and Mariefred, Kristinehamn and Kristanstad, which are very easy to confuse with each other. Then it can be easy to make mistakes since you might think "was it Mariestad or Mariehamn in Västerås" so then you should look carefully. The interviewee said that they can't know how many parcels coming in each day, but they know based on historical data that it should be about 300-400 parcel at the straight conveyor belt (since that is what it usually is). According to the terminal worker they don't have any standardize work or work instructions. The worker said that you have your own routines. Some persons empty one cage and then they empty the conveyor belt, and some empty more cages before they empty the conveyer belt etc. You have your own way.

### **Work environment**

The worker said that since you can decide your own routine, you can affect the work in some way. The terminal worker said that you can give suggestions for improvements to your group manager. The worker said that at least they think about the suggestions, but the worker didn't know if they have used them. The worker feels he/she trusts their group manager. The terminal worker said there is a medium work load, you get sweaty but not extremely tired. The worker said some days they can't manage the volume that you should do, for example if the parcel sorting conveyor stops you will have trouble to manage. The worker feels that they have a good job security. The worker said he/she has had a work related injury recently, but then the problem were fixed directly afterwards.

The worker feels that the air in the terminal is bad due to the dust in the air. In the summer it is very warm, like an oven. In the winter it is cold, but you can always put on more clothes. Last summer, when they had a warm summer, the fire alarm went off since it detected a high heat close to the roof. The interviewee feels

mostly motivated. The worker has had some troubles with depression, so of course there is some bad days. After a work day, the worker is sometimes mentally tired, but not so often due to the work. He/she is sometimes physically tired, it depends on how much stress it has been. If you are stressed you feel more tired even though the work load is the same and if you are at a new position you also get quite tired.

### **Other**

A good working day for the production, according to the terminal worker, is if they don't need to leave anything behind and when they finish the day, they can clean and still have some time margin left for the day. For the terminal worker personally, a good day is if one feels that he/she has performed his/her best and hasn't had any bad thoughts even though it has been a stressful day. For the worker, the worse is if there comes a lot of parcels in the end of the day, it is better if they come more even during the shift.

## **B.1.6 Interview 1.6**

Interview with terminal worker

### **Background**

The interviewee is a terminal worker and has been working since May 2017. The worker started as a temporary worker, and since 1 November 2018, the worker has been a full time worker. The terminal worker is 21 years old.

### **The working day**

The interviewee starts at 12:00 Monday to Thursday and at 11:00 on Fridays, so they can go home earlier on Fridays. They have a break 17:40-18:00 and lunch between 14:00-15:00. On Fridays, they have lunch between 13.00-14.00. They try to switch tasks one time each shift. The terminal worker thinks this is good. Before they didn't rotate on the straight conveyor belt but now they have started with rotation here as well which they like. The worker said it is hard to be at the straight conveyor belt because everything is heavy or big and the bags are so many so it takes long time to sort them. The worker said that one need to keep so many numbers in your head so when you throw on the parcels, you get tired in your body, and when you sort parcels, you get tired in your head.

The terminal worker said that they know how they should lift but they don't do it correctly since they don't think they have enough time for it. They are always stressed so they lift it as fast as possible and don't think so much of how they do it. They stress since they feel the pressure to be ready with the sorting as fast as possible. It is not a pressure from DB Schenker, more from the others in the group, the work colleagues. The terminal worker feels that DB Schenker don't really need him/her, they can manage without the worker, but the colleagues need him/her. The interviewee wants to be nice to the colleagues and therefore be done with the sorting as fast as possible. The goal for them is always to go home a little bit earlier on Fridays, but it is also good to be ready early the other days, since then the

loading person have time to drive out the cages when it is calm and count them in a good way. According to the terminal worker, they like to have a calm last hour. The worker said that they don't have any equipment to help with the sorting. The computer helps them some with what is wrong with a parcel that stops. When you are the loader, you need to keep much in your head and at the same time look so the driver do what they should and take the parcels they should have. They have lifting equipment at the straight conveyor belt, a vacuum lifter, but they don't use it and also a lifting table. On the parcel sorting conveyor they also have a cage-lifter.

### **Ugly-parcel handling**

The terminal worker said that they started with a straight line last year. Before they went out with the parcels manually. They are handling more parcels on the side now, mostly round and big parcels. The interviewee said that the worker personally is standing very often at the straight line since it requires experienced personnel. The terminal worker thinks that a problem for DB Schenker is that they don't have any training for the new employees. They have few full-time workers and for the hard tasks, they pick those all the time so these workers need to take a big responsibility. The interviewee said that it is fun with the responsibility but the worker thinks that he/she should be able to relax a bit and also sometimes be placed on the easier stations. The terminal worker said there is a rotation nearly every day on the straight conveyor belt. It is the same with the loading rotation. The terminal worker knows that the worker personally will get either one of those hard tasks. The interviewee thinks that more people should know how to do everything. They try now to variate a bit more. The worker says that some persons have been at the terminal for three years and still haven't been on the straight conveyor belt any time. This is frustrating for the worker. It feels like DB Schenker doesn't want to invest in all employees. The interviewee thinks they need to give them the opportunity to learn, you can never perform good in the beginning. They are usually two or three persons at the straight conveyor belt, mostly two, but sometimes they need extra personnel and then they can be four persons there. A problem is that not everyone can be at the straight conveyor line. The terminal worker thinks that the Ugly-parcels are affecting the normal production a lot. It is demanding both psychological and physical. Sometimes, you need for example to lift a whole cage with parcels which weigh nearly 30 kilos and they need to do so in a high speed.

### **Physical ergonomics**

The terminal worker has experienced some physical strain himself, not so much so the worker has been on a sick leave, but the worker has many days experienced back pain. The worker had a pain in the shoulders this summer, so he/she needed to switch to other positions since the worker couldn't lift the parcels high. The interviewee said that the worker personally has always trained a lot which he/she thinks has been good. The terminal worker thinks that if you should work at DB Schenker, you should need to have a bit basic training so you know how you should lift and have some basic strength. The interviewee thinks that training ones per week would be good for everyone. The terminal worker said that standing at the straight conveyor belt is the most demanding work. It is also hard mentally. There are always

problems with the computer and then you need to go to it and scan manually which creates irritation. Often you also stress so much so you forget how you should lift. They have tried to improve it by installing a table-lift and a vacuum-lifter, but it was only a few weeks ago when they knew the Work Environment Authority should come. The terminal worker said it feels like the company only prioritize the work environment when someone external comes. The worker thinks that the company doesn't think so much on the workers and their body's. The terminal worker would like DB Schenker to focus more on maintaining the workers' health in a better way. The terminal worker thinks that they only make emergency solutions and don't want to invest in the workers' health.

### **Cognitive ergonomics**

When they teach a new employee a task, that person receives a guide who shows all stations and how you should do them. The terminal worker thinks a main problem is the teaching of new employees. The company invests much in few workers which mean that those need to take big responsibility for the more demanding tasks. If someone is sick, you don't have the time to teach someone new. The straight conveyor belt is mentally very demanding. Nearly every other parcel stops so you need to go to the computer and correct. You get irritated and that creates anger. The loading station is also hard since you need to have contact with many persons. The lack of training for the personnel results in less knowledge on how you should load and then they need to correct which takes a lot of time. The terminal worker thinks that many employees don't care since they only work extra at the terminal.

The interviewee thinks that the signs are easy to read, but the worker knows the concepts by heart so he/she doesn't think about them so much. The terminal worker says it is a lot of noise in terms of rumbling in the terminal. The workers are offered earplugs but they don't want to use them since you need to hear good while you are in the terminal for safety reasons. You can use them at the straight conveyor belt but it can still be quite unpleasant since you want to hear the trucks, not just see them. The terminal worker said that you need to know the sorting by heart, you can't manage to read the signs because then you don't manage to do the work in right time. He/she feels it is irritating when it takes too long time for the new personnel to learn. They need to have a good speed also since the bosses have demands on them as well.

The terminal worker said it is easy to sort wrongly since it is so many parcels you should read and after some hours you lose the focus. The worker said it is especially hard for those that haven't been in Sweden for so long time, since they don't recognize the places. It is quite hard for them. Some of the places have similar names, which can easily be sorted wrongly. Some places also share the postcode in some way, which makes it hard to know how you should sort the parcels. For example Karlshamn and Karlskrona both have 37 in their postcode. The interviewee can't see how much parcels that should come in. Nobody knows the incoming quantity. They know if a customer has a sale but otherwise they don't know anything. They have a standard way of how they should work in their position but they are just try-

ing to do their best. You know which responsibilities are included in your position. After the production they have a list of things they should do in order to prepare the terminal for the night shift.

### **Work environment**

The terminal worker said that they can in some way leave improvement suggestions. They can talk to the boss but they don't really have time to sit down and go through the improvements. They have monthly meetings which the worker thinks is very good, because then you can get the chance to talk to the work leader. They have had one improvement work meeting, but then it was cancelled since the company said that they didn't have time for it. The worker thinks this is "bullshit". The company could just call them in a bit earlier one day or they could stop the production for a while. The worker said that you need to think about what is the most important to do. Today, most of the improvements which are executed, come from the bosses. But the worker thinks it would be better if the bosses just say they have an idea and check with the workers. It is a problem that the bosses don't know the processes as good as the workers do.

Some time ago they had a team visiting the terminal which should help out with the work ergonomics, but the worker said that the team didn't even talk to the workers. They only talked to the highest boss. The worker said this was very strange since how should the boss know how it is to work at the straight conveyor belt, he is never there. Therefore the worker thinks it would have been much better if the team had talked to the workers instead. The worker said that maybe he/she should engage in the union so something happens. The terminal worker said that many persons don't like the higher bosses. The workers understand that the bosses have an important work, but since the workers are doing "all the shit" they should themselves decide how they should lift or not. But the worker thinks that the closest bosses is very good and listens to them. He/she shows respect and help them and has a good working experience. This is very good, you can benefit a lot if you have good bosses. The worker said that they know that their boss will back them up if there is a problem and he/she support them.

The terminal worker thinks that they can meet the demands that are put on them, but how it will affect them in the long term he/she doesn't know. The terminal worker said that he/she is good on what he/she is doing, but it is a high workload. The interviewee feels that they have a good job security. The terminal worker said it is a lot of dust in the terminal. They have a air cleaners, which they had for about half a year, but they help mostly for the parcel sorting conveyor and the parcels, not for the workers since they are placed over the conveyors. The worker said it would be better if the air cleaners where placed over the workers instead. The terminal worker thinks the noise is the worst problem. They have earplugs, but many noises is very unnecessary as well. For example is someone drops a pallet. The worker feels motivated to go to work, since "you get your paycheck" and the worker is satisfied with that. But the worker said it can sometimes be hard to go to work since you don't know how the day will be, all you know is that it will be heavy. The worker

said you need to learn how to handle it and find small things which motivates you. You can for example be satisfied if you clean and then it looks good or if you move things so you get a good order and similar things. The worker is both physical and mentally tired after a day at work, but at the same time, the worker is now used to it. It is like you have done a hard gym pass, but at the same time having pain in the back, the worker said.

### **Other**

The interviewee said that a good day at work is if you don't have any pain in your back, if you are done in right time and if the worker personally have done the job correctly. Then the worker feels proud. The worker said that of course it might be stupid to be proud of those small things but at least you feel it. The worker further said that sometimes you need to take a step back to distance you from the work. The worker also tries to motivate him-/herself by having nice food for lunch and a good social contact with the other workers.

If the interviewee could change something, it would be that the company had time to give more learning to all personnel so all employees are treated in the same way. Everyone should be taught in the same way. The worker said that also hourly workers should be involved in meetings so the whole team are there. If they have monthly meetings, also the hourly workers can be there since many of them are in the terminal nearly every day. The worker would also like to have more meetings like the monthly meeting. The worker also said that the company are a bit sloppy with the meeting and sometimes forgets to tell everyone about when it is. The bosses should generally be better to gather everyone. The terminal worker also wishes that the bosses would be clearer with the information to the workers.

The terminal worker added that he appreciated that I was there to interview them and listened to them. The worker thinks it is good that the problems are discussed and that you don't just assume that the lifters will solve everything since you still need to do the movements. The interviewee said it would be good if they rotated even more, maybe even to accept a decrease in the productivity to have a more sustainable work environment. The workers feels that they often get the responsibility to always solve "that little extra thing", like the ugly parcels. The worker thinks this should be done on a planning department (or similar) rather than by them. The terminal worker also said the headquarter always ad small work tasks which they need to solve, but they are just made so the headquarter can have better control of the workers. The worker thinks the headquarter doesn't know how it is for the workers. He/she said that the workers rarely get to know the purpose of these tasks and who it is done for or why.

## **B.1.7 Interview 1.7**

Interview with terminal worker

### **Background**

The interviewee is a terminal worker and has been working for 2 years. The terminal worker is 27 years old.

### **The working day**

The terminal worker normally starts at 11:30 and work until 20:00, but every sixth week they are working longer. A normal day, they start with handling of a customers who has a special customer solution. This handling means that they sort up the groupage and also sort their parcels. Then the interviewee explained that they clean up. They have a break 14:45. The terminal worker said that after the break they look at the schedule if they should be at the groupage handling or the parcel handling. The parcel sorting is done until 18:30. The worker said that they don't have any special helping equipment, they use the forklift on the inline station but they haven't used it now since the forklift which is dedicated for this handling is broken.

### **Ugly-parcel handling**

The terminal worker said there is no parcels which the parcel sorting conveyor can't handle, so the parcels they sort out, are the one which are outside the product parcel terms. The parcels they need to pick of are therefore too long and too heavy. They write on these parcels, what is wrong with them, and then another operator the next morning rewrite them as groupage. The terminal worker said that they usually are four or five on the parcel sorting conveyor. Usually one or two of these are temporary personnel. The often choose to place the temporary personnel on the parcel sorting conveyor. They do so since they don't have so much signs for the groupage sorting. For the groupage handling, they have a book where they can check where the groupage should go. The terminal worker said that as a beginner, you start at the parcel sorting conveyor. The terminal worker said the Ugly-parcel doesn't affect the normal production so much. The worker however said that it can of course be annoying and disturbing when you need to walk over there all the time.

### **Physical ergonomics**

The terminal worker hasn't experienced any physical distress from the work. The interviewee thinks it is no risky parts with the sorting. The terminal worker thinks that if you are long and strong, you don't have so much problems.

### **Cognitive ergonomics**

The terminal worker says it can be hard with some trucks that are mixing parcels and groupage in the same parcel-cage, that can be quite annoying. It can also be hard if some customer has forgotten to send in EDI on the whole pallet. The terminal worker said you need to be a bit aware of this when you work on the inline station. The terminal worker thinks the signs are easy to read. The interviewee thinks that the noise level in the terminal is good, of course there are some peaks when you slide the pallet onto the truck or when you drop a pallet. The terminal worker doesn't think there is anything disturbing their focus. The workers also said you need to look carefully on the parcels on the inline station since some customers try to send dangerous items or other things you can't send as parcels. So you need

to keep your eyes open.

The terminal worker said you need to know mostly of the signs in order to sort the parcels in the right speed. Further, the terminal worker said it is okay if someone doesn't know them since then the more experienced personnel can help them. The terminal workers learned the work by going beside somebody else. However, the worker wanted to learn him-/herself so when he/she didn't know how to do the work, he/she checked in the book or manual how to sort out the parcels. The terminal worker said it took about three to four months to learn the handling. The terminal worker said that if you don't know how to sort a parcel you can also use HDT to see where a parcel should go.

The interviewee said it is easy to do errors, especially for the new sorting concepts for Stockholm. It is hard since some of the postcodes numbers are very alike, but should go to either the A-house, B-house or Uppsala. The terminal worker also thinks the parcels which are sorted to the red lines, also are hard since they are different compared to their groupage handling. On the groupage you send everything through Sundsvall so sometimes you can put the parcels wrongly since you are used to that everything should go to Sundsvall. Some of the concepts also share the two first digits which can be confusing. The terminal worker can't see how many parcels they should receive during a shift. They can know for example that for certain periods, they have an increased volume, but that's all. The terminal worker said that you have your own way of doing the work. Some wants to build high back of the cage and some wants to keep it flat. So you have your own way. They also try to start with all hard parcels if they have them in the beginning. So it helps if you think about on how you should pack the parcels in the parcel-cages.

### **Work environment**

The interviewee can to some extent affect the work and the routines. The terminal worker feels you can leave suggestions if you want. The worker feels they have support from the group manager. The terminal worker thinks they have a medium to high work load. It is a lot of physical work. The terminal worker said they usually finished what they should in time. The interviewee feels that they has a good job security. The terminal worker feels he/she is safe at work and also are able to keep the job if he/she wants to. The terminal worker thinks he/she is doing a good job and therefore the worker is not worried about losing the job. The terminal worker thinks the climate is cold at the winter in the terminal, especially at the parcel sorting. The terminal worker also said it is quite warm in the summer. The worker said it is better at the groupage handling. The terminal worker feels motivated to do the job and go to work in the morning. The terminal worker likes to work at the terminal, but of course he/she doesn't like all persons he/she is working with, but "that's the way it is". After a working day the worker can be physical tired. The worker said he/she could have pain in the legs and feet after working at the parcel sorting conveyor. The terminal worker said they had a rubber mats before and it was better then. The terminal worker has told this to the leaders but hasn't got any response.

### **Other**

The terminal worker said that a good working day is when you get away everything in time, which mean that everything has left the terminal.

## **B.2 Interviews with group managers**

In the following section are all interviews with group managers summarized.

### **B.2.1 Interview 2.1**

Interview with group manager .

#### **Background**

The interviewee is a working as group manager and has done so for about 10 years. The interviewee started as foreman year 2000, but stopped working for the company after some time and came back at 2009 as group manager. The group manager is 42 years old.

#### **The working day**

The group manager's working days are hectic, it starts directly from when he arrives at work and continue in full speed until the leader goes home. The interviewee starts to work different times depending on which day it is. When the interviewee starts early, he/she mostly prepare for the production start. If the leader works late, he/she mostly look how things are going. The group manager said they rotate the personnel as much as possible, about one time each day. Some personnel want to do the same thing the whole day, so they are at the same position the whole day. The personnel starts at different times and also have different times for their break so they shift after they have had their break. The group manager said they don't have any lifting equipment or likely for the parcels. They have a high- lifting forklift which they can use at the straight conveyor belt to help to get the parcels in a better position. They have tried to use vacuum lifters but they haven't worked. They take too much time to use. The production will suffer to much if they use them.

#### **Ugly-parcel handling**

The group manager said they have signs at the inline stations telling which parcels can't be handled on the parcel sorting conveyor. Those parcels are the one which can't lay flat down (like rolls) or all parcels above 140 cm (and a bit shorter since they need to have some margin if the parcels are turning while they are on the conveyor). The banded parcels with loose bands or tape are also a problem for the parcel sorting conveyor since the sensor sometimes notice that something hangs out of the conveyor or the plate. This result in a stop on the whole parcel sorting conveyor. The main problem, according to the group manager, are the import parcels since the terminal have many of these parcels. They sort out the Ugly-parcels from either the parcel-cages at the inline station or on the telescopic conveyors. They take these parcels and put them aside and the personnel from the straight conveyor belt

picks them up and sorts them first into either business parcels or private parcels. The reason is that import parcels for private persons need to be relabeled and also since they have different max weight and measurements for private- and business parcels.

It is often the same persons (two guys) handling the ugly-parcels. The interviewee said they have tried to rotate the personnel at the straight conveyor belt with others, but they want to be there. The group manager said they are mostly two as minimum at the station, sometimes they are more if they see it comes a lot of parcels at the same time which need to be handled there. There are also more people at the station if there are many parcels left from the day before. The group manager thinks the Ugly-parcel handling had some effect on the normal handling. The group manager would like to have three persons at the straight conveyor belt all the time since they sometime don't have time to take the parcels from the telescopic sorting conveyor and that can affect the handling. This is especially true if there are new personnel who don't have the routine for which parcels they should put away and how they should place them in order to make it easier for the personnel who comes to collect the parcels.

### **Physical ergonomics**

The interviewee said that some personnel has experienced some physical distress from the work, both in knees and shoulders from the lifting. The group manager thinks that the lifts from the floor is especially risky, these are performed by the telescopic conveyors. The group manager thinks the heavy parcels are not as big problem as the ungainly parcels which can have the weight in one part of the parcel and be harder to grasp. The interviewee said that if the customers think much about how to pack their items, the terminal can get more of the parcels sorted on the parcel sorting conveyor. For example if the mats are folded, they can put them on the parcel sorting conveyor and if not, they need to be handled on the straight conveyor belt. The group manager also said they have a customer who sends iron bars which are very heavy and are badly packed, this creates problems. The group manager don't think these should be parcels. Some of the employees have also been hurt on the bars, they have cut themselves or been hit by them falling out of the parcel-cage.

### **Cognitive ergonomics**

The interviewee said there is some parts in the work which are mentally more demanding. Since the terminal have some new personnel, the old personnel needs to stand on these hard stations. Here you have about ten programs to look into to figure about what is wrong with the parcel. There is signs along the straight conveyor belt with information about how the parcels should be sorted into the cage, but if you should work there, you need to know all the places and sorting concepts by heart. The personnel working there have worked at the terminal for about 20-30 years and they know all the places. The interviewee said that at the normal sorting, the sorting conveyor sorts everything. Some outlines have two concepts on each line so then you need to sort them to the right one, but otherwise it is only one sorting concept for each outline.

The group manager said there is some rumbling noise from the parcel sorting conveyor all the time. Before there was also a problem with people dropping the pallets, but they have worked with this so it is not such a big problem anymore. They have figured out that the parcel sorting conveyor sounds more if it is a lot of dust in the conveyors, so when they installed more brushes to clean them the noise level went down. The straight conveyor belt has more rumbling. The group manager thinks it would be good if the personnel could focus on more things because now they are very focused on a specific part. When you work by the straight conveyor belt you need to focus more if it is full with parcels on the inline stations or the telescopic conveyors. However they have developed a working procedure that works quite well for them. First they run all parcels they have and while one person places the parcels on the conveyor the other person relabel the parcels that needs to be relabeled. Then both persons start to sort out the parcels and when they are nearly ready, one of them goes to the inline station to get more parcels. Often they can work according to this procedure without needing to look at how much parcels there are at the inline stations.

The group manager don't think it is so easy to make mistakes. The workers can see the places on the signs so the parcels should end up in the right cage. The import parcels even have a marking like "MMA" . They can't trust the marking to 100% but they at least know where to start checking first. This is at least some help for new employees. The interviewee said that the parcel-cages are placed the same as before (when they only had a straight conveyor belt). The group manager thinks this is the best order for them to stand. The group manager can't see how many domestic parcels which will come in, but they can, based on experience, know how the volumes differs between the week days. For the import parcels they get from the Danish office how many trucks which are planned to come. The interviewee said they don't have any standardized process or work instructions for the Ugly-parcel handling or the other handling. If there are any changes, they tell the personnel at the sorting conveyor and then it is spread to others. So personnel are learning the work by people telling them how it has been done before.

### **Work environment**

The group manager said it is always stress involved the work but "that's the way it always has been". The group manager thinks you can affect the work to some extent. The group manager said that the administrative work often takes most time and the manager doesn't have so much time to support the production as they wish to. According to the interviewee, everyone can leave suggestions for improvements to the boss and he/she feels they have good support from their boss. The group manager feels they have a high workload. The group manager says that mostly the production can meet their demands but it is often done in expense of the groups manager's work and they needs to leave their work for tomorrow.

The group manager feels that they have good job security. The interviewee says that the climate in the terminal follows the outside climate. If it is 30 degrees out-

side, it can be 35 degrees inside so during summertime, it can be very hot. It is easier during wintertime since then you just put on more clothes. The group manager feels motivated to do the job, but of course some days are harder than others. The interviewee thinks that many of the ordinary personnel, who do the little extra in their work, are both physical and mentally tired when they come home since they sometimes need to cover for more inexperienced personnel who can't perform in the right speed or sometimes are missing the right working moral.

### **Other**

The group manager said it has been a good working day when the notifications have worked well and the group manager knows how much they need to plan for and everything flows well. The ugly-parcels affects also. If there are a lot of those parcels they can need to leave them to the next day since these take longer time to process. They close the handling of Ugly-parcels at 18.00 independent of how much they have left. Then they drive these parcel-cages to the outlines so they can put more parcels in them if they are not full. The age of the personnel are between 20 to 64 years old. The interviewee said they had more females employed before, but now some of them have stopped working at the terminal so the company tries get in new ones. Right now there are more men working in the terminal than females. It can be harder for the elderly personnel to do the tasks which are very physically demanding. Therefore they try to give them more of the mentally demanding tasks like forklift driving.

The group manager said that the personnel turnover rate is very low for the full-time and part-time employees. The personal turnover rate for the temporary employees is much higher. They have about 16-17 full-time employees, 3-5 part-time employees and 2-5 temporary employees, in total about 27-29 people. The group manager thinks that even if the parcels are according to the product terms, you can't say that the Ugly-parcels are parcels when you look at them. They have some customers who always send especially "hard to handle" parcels and the manager can't understand how these can be sent as parcels.

## **B.2.2 Interview 2.2**

Interview with group manager.

### **Background**

The interviewee currently work as a group manager and has been working at DB Schenker since October 1991. The interviewee has been a manager for about 10-12 years. He/she started as a terminal worker with the parcel handing and has also done groupage sorting. The group manager has worked both day and night shift. The interviewee is soon 48 years old.

### **The working day**

The interviewee starts to work at 6 o'clock in the morning. First task is to talk to the night personnel to check how everything has been. It takes just a couple of minutes. Then the group manager check if it is something special that should

be delivered that day, the manager gets emails about it. When this is done, the manager helps with the departure for all the trucks. The interviewee looks at the statistics and spend some time to plan for the employees. Some customers have special agreements which takes time to handle and also reporting of left items etc needs to be done. The group manager change working times from one week to another, one week they work early and one week late.

The group manager said they don't have any plan for rotation, but they switch between some tasks. One day you are at the long/heavy groupage department and the other day in the terminal. The personnel at the parcel sorting conveyor are doing their own rotation. The group manager said they rotate more at the night shift when all are doing the groupage handling and sort all parcels. The interviewee said that they get in the parcels late at the night shift so when they start to work with them, they need all the personnel to help in order to manage the sorting. The lift equipment they have for the parcel sorting, is the cage-lifter. They also have the forklift which can lift the pallets up if there is a small amount of parcels on the pallet.

The group manager said they tried to use a vacuum-lifter, but the problem was that the personnel didn't want to learn how to use it. The interviewee thinks that when they had it, they would have needed to determine to use it as much as possible to get the habit. According to the manager, this handling can be a little bit slower, but at the same time you could have a more even work phase and since the outlines didn't need to wait, the speed should be enough. The manager also thinks the workers would get less pain in their backs if they use the vacuum-lifter. The lifter requires a certain technique, so before you get used to it, it can be hard and easy that the workers do the work the lifter should do. The group manager also felt that the lifter didn't work each time and it became worn out after some time, then it wasn't used. The group manager said the vacuum-lifter could be used to lift everything that had one flat surface to lift in.

### **Ugly-parcel handling**

The group manager said that parcels which are long and wide in combination can't be run on the parcel sorting conveyor. They also can't run the too long parcels. The reason is that the first turn on the conveyor rotates the parcels and then they get stuck. The manager said this wasn't a problem on the old parcel sorting conveyor since that conveyer didn't have any turns. Uneven parcels are also a problem, if for example you have lumps on the parcel or something is sticking out in the middle, that won't work at parcel sorting conveyor. The interviewee said that everyone working at the parcel handling needs to handle the Ugly-parcels. The group manager don't know how much Ugly-parcels there are. The manager thinks that the Ugly-parcel handling affect the normal production, but not so much. The small parcels don't affect so much either since workers just put a lid under them to get these parcels into the normal flow. Some of the parcels are worse, like rolls or parcels where the bar-code is hard to scan.

### **Physical ergonomics**

The group manager has no experience from that workers have received any serve damage from working with the parcels. But the manager said that the workers at the night shift have become worn out since they have worked in a bad way for so many years. Before, they put up the parcel-cages and carried the parcels they scanned manually to the right cage. They worked like this since they felt they didn't have enough time to use the straight conveyor belt they then had. The workers are now using the cage-lifter instead which is better for them. The risky part with the parcel handling is to lift the parcel below the knee level or above the shoulder into the cages. Sometimes they also need to go into the cage to put the parcel there and you can't turn inside the cage. The group manager personally doesn't feel that that physical strain is the worst handling because you often just drop the parcel without going inside the cage. He/she thinks that the worst handling is the lifting when you reach for the parcel placed in the back of the cage. The manager also thinks the repacking they sometime need to do is bad.

### **Cognitive ergonomics**

The group manager doesn't think the handling is mentally demanding. However, if you are new at work, it can of course be very demanding and create a lot of stress. The group manager said that you often therefore start at the inline station if you are new. The group manager said it differs a lot between different persons regarding how long time it takes to learn the job, but it takes from a couple of weeks up to a month. The group manager said they have sometimes rented personnel to work in the terminal, especially for holidays or if someone is sick. Now they have some hourly employees who wants to work extra and the manager prefer to bring these in instead since then the same personnel comes back.

The group manager thinks it is easy to read the information in the terminal. The manager thinks the noise level in the terminal is pretty good, especially with the new sorting conveyor. The group manager doesn't feel that you need to keep a lot of things in your head. At the nightshift it is worse, then you need to sort out some special customers and remember more things. They don't have any signs for this now at the parcel sorting conveyor since all workers at the night shift knows the handling by heart. The group manager said it is very easy to put the parcels in the wrong parcel-cage, but he/she doesn't know how much they are sorting wrongly.

The group manager thinks it is easier if you accomplish to divide the sorting concepts with similar postcodes on different outlines. The group manager imagine that the terminals with only a straight conveyor belt will have more problems since they need to check the postcode numbers and at the same time the work is building up behind them. The manager thinks that if you need to check the numbers it will be especially hard. The group manager says that some places are alike which makes them easy to mix with each other. The group manager thinks the biggest problem is if postcode numbers shares the first digits. The interviewee said that they can during the nightshift see how many parcel-cages that are coming in. The group manager said they don't have any big customers so the workload is not shifting so much from day to day. The group manager said they have detailed instructions in

Polaris which they try to work from and teach to the new personnel but they don't show them directly. The group manager thinks they don't need to since the parcel handling is easy to handle.

### **Work environment**

The group manager said the workers can in some way affect the sorting, like how you put up the cages, but the working times are very strict since they need to deliver on a specific time. The manager also said the workers can rotate in the group as they wish. The group manager says the personnel can give suggestions if they want to. The interviewee feels he/she has support from the boss. The group manager thinks he/she has a medium to high work load, but he/she can manage the work that he/she should do. The group manager thinks it is quite easy to manage the tasks but sometimes it is too little time for doing them.

The group manager feels good job security at the company. The manager thinks that the climate in the terminal is quite good especially if compared to when the manager began to work there. The interviewee said it was even colder during the winter, now the manager thinks it works. The group manager feels mostly quite motivated to work, but says that it sometimes is quite monotonous. The only thing the manager feels is bad, are the working hours, he/she says it would be better to work between 7.00 to 16.00. The group manager isn't mentally or physically tired after a working day, only if there has been a very stressful day. The night shift is the worst demanding and special days it can be up to 30% more volume, like black Friday.

### **Other**

The group manager said that a good working day is when everything is done in right time with a good margin so when you leave to the other group manager, everything is done. The group manager said there are only men at the terminal but the ages are pretty mixed from 20 to about 65 years old. The personnel turnover rate is very low at the terminal and many have worked there for a long time. The part-time personnel change sometimes but otherwise people stay for a long time. The problem with the working hours is that there is peaks in the workload and they can't have split shifts. The manager would like DB Schenker to close more days around the holidays as many other companies do. But at the same time they understand that clothes companies need to be open and that medicine needs to be delivered in the right time, so transports are needed to be done. The group manager thinks that DB Schenker generally work pretty good trying make things easier. Sometimes they have had problem with the HDT but now they are getting new ones which they think will be good.

## **B.2.3 Interview 2.3**

Interview with group manager.

### **Background**

The interviewee is currently a group manager and has been so since this summer. The group manager worked before team leader and before that as a terminal worker, at the night for about 10 years. The group manager is 36 years old.

### **The working day**

The group manager works with a lot of administrative tasks and follow up before and after lunch out in the production with the personnel how it goes. The group manager checks if the cleaning has worked and so on and that the routines are followed. The group manager said they have lost some personnel recently so they have a lot of new personnel that hasn't got the forklift license yet and therefore can't work on all places.

The terminal workers starts to work with the parcel sorting at 15:00. They try to process about 200-300 parcels which come in before lunch and before the ordinary parcel personnel comes in. So they try to help them. This is not done every day but as often as possible. The normal production is then done from 15:00 to about 18:30-19:00. During the day the group manager tries to move people around to the right place.

The group manager said the rotation for the parcel sorting is done based on that you should never be more than one hour in total at the inline station. They also have a plan to start to rotate with the VoV machines at the groupage department. They did so before when the workforce was more collected so the plan is to do that again. The group manager explained that this requires that the personnel have the right forklift license and so on. They will try to operate more as one unit in the future and not so splitted between parcels and groupage. The lifting help the terminal workers have is the cage-lifter. They had a vacuum-lifter as well but it was bad placed and a bit hard to use and it was only used for the most heavy boxes, so it was removed. The group manager said they now use a cage-lift instead. They also work a lot with how they are lifting and try to point that out to each other. The group manager also said that when you are new employee ,everyone gets a paper with information regarding how the ergonomics is and what you should think about.

### **Ugly-parcel handling**

The group manager said that the parcels which are longer than 1,2 m will create some problems. The manager said it is also problems with customers that put the bar-code in the opening of the box and then they need to scan it by hand. Round parcels and parcels which are badly packed will of course also be a problem. The group manager thinks that the Ugly-parcels don't affect how you position personnel but it is a boring side task that needs to be done. It is not production critical for them. The group manager said the personnel at the parcel handling is very impressive and they try to empty the cages with Ugly-parcels continuously.

### **Physical ergonomics**

The group manager thinks that sometimes some of the personnel gets a stretch injury in the back from the parcel handling but it doesn't happen a lot. The group manager also said that you can experience some pain in the back but it is not a clear

link to the parcel handling. The group manager said that if someone say they feel bad, they try to rotate so that person can do other less demanding tasks instead. The manager said he/she wants the personnel to have an open and honest communication. The group manager experience the inline station and the twisting that occurs there as the worst task. The group manager thinks it is better at the outlines since you can lift the parcels from a better height. The interviewee said they also have rubber mats which limits the strain on the knees. The group manager said the ungainly parcels are the worst. The manager also said it will be more twisting the more the parcel weigh.

### **Cognitive ergonomics**

The group manager said it is not especially mentally demanding but you need to keep your focus since they have a lot of forklift traffic. They also sometimes put the parcels on the side of the cage-lift, especially parcels form Norway which they need to scan with the HDT. The group manager thinks it is quite high rumbling levels in the terminal. It is many forklifts driving around. The worst thing is when people throw pallets to the ground, these are often according to the group manager the elderly that already have lost the hearing. The manager also said that sometimes the workers play music very high and the manager thinks this is quite disturbing sometimes.

The group manager thinks it should be easy to put the parcels in the right cage since you have both the location and the postcode on the sign above the cage. The interviewee thinks that you have the time to read the signs and this works good with new employees. When they hire a new employee, he/she will walk beside someone else as an extra person for 2 weeks. The manager said that after this time, the person usually knows enough of the places in order to be part of the ordinary personnel in the production. The group manager can use the cage app to detect how many parcel-cages which will arrive for the night shift. The manager can't see how many parcels they will have for the day shift so they need to estimate the volume based on experience. The group manager said it is not necessary for them to know this either since they don't have so many parcels on the departing shift. The group manager said they have a schedule they should follow for rotation on the inline station but otherwise they don't have any specific routines or work instructions. The interviewee said they try to communicate good and help each other as much as they can.

### **Work environment**

The group manager said the workers can't affect the routines they should follow so much. The group manager said they need to look a lot on how much the workers have to do in order to distribute the personnel well between groupage and parcel handling. They are trying to make the personnel more flexible. The group manager experience that the personnel often comes after or during the shift and say what is wrong, for example if it was lot to do or something like that. Often they go to the group manager and then they need to transport this information further. The group manager thinks it is quite easy for them to meet the demands and the manager feels that the/she do that and know what is expected from him/her. The interviewee

thinks the climate in the terminal is very warm and in the winter it is very cold. There is also bad air with a lot of dust. So they are in the project to install new air cleansers in the terminal. The group manager said it can be as low as 12 degrees during the winter. At summertime it is very warm, but they can't have the gates open due the safety requirements.

### **Other**

This part of the interview was not covered since the interview needed to be shortened due to lack of time.

## **B.2.4 Interview 2.4**

Interview with group manager.

### **Background**

The interviewee is a group manager at the parcel department and has been so for one year. The group manager was before a terminal worker since September 2013. The interviewee has therefore been a part of the departing shift for six years. The group manager is 25 years old.

### **The working day**

The group manager starts the day with going to the gym and then he/she starts the work day a while before the shift start to be ready before the personnel start. The manager tries to answer all the emails which the people who starts at eight has written. The group manager said he/she has a lot to do at the computer and tries during the day to communicate with the group leaders. The group manager also tries to keep in contact with the workers, "so you don't forget where you come from" said the manager. The group manager said he/she is going on some of the group meetings but the manager wants the group leaders to take those meetings. The group manager is only at the start meetings to inform about decisions they have received. Sometimes they get fixed guidelines but sometimes they get a bit free space so they can decide how to do it. Then they can discuss in the group how they want to do it.

Some of the terminal workers start at 11:15, mostly of them is full-time employees and some are part-time employees. The rest of the part-time employees and the temporary employees start at 14:30. They start the shift with preparing for the production, and then at 15:00 production starts. They also have some smaller parcel agent parcels which they are processing in the morning. The sorting of the parcels are done until 18:45. The group manager said they then need to finish everything and prepare for the night and clean up.

The workers have a vacuum-lifter at the straight conveyor belt available which they can use for lifting. The group manager however said that it is not optimal for those parcels which are processed there. It is used for the flat parcel but the uneven parcels can't be lifted with the vacuum-lifter. The group manager said they also

have a high lifting forklift they can have to help the workers. The group manager said that the update of Manet, which will come, also will help them with the sorting there since it will show on the label which cage the parcels should be placed in.

### **Ugly-parcel handling**

The parcels they can't run on the parcel sorting conveyor are pipes, long parcels, metal items which are badly packed, metal pigs that sticks out, round parcels and cable-drums. The cable-drums are very heavy and they would like them to have a hard packing on them so they can run them on the parcel sorting conveyor. The problem with the cable-drums is that they can roll off the conveyor or they get down to the outline with a high speed which is a safety risk.

The interviewee said that the workers maximum can be at the straight conveyor belt once per week. The manager said that the sorting tasks demands you to have a some knowledge about the sorting concept, so they can only place a limited amount of people there. The group manager said that during summer, they are usually one person at the straight conveyor belt, but normally there are two persons placed there. It is a demanding position so they want it to be two persons there all the time. The group manager said the sorting is quite inefficient but they need to ignore this and instead focus on the personnel there and to be two at that sorting. The group manager said the Ugly-parcel handling disturbs the ordinary handling. They have a certain amount of parcels they should process each day and all the Ugly-parcels needs to be put away at the inline station. The group manager said it might not take so much time for one parcel-cage, but for a whole shift it will be a lot of time.

### **Physical ergonomics**

The group manager said that some of the personnel have gotten some physical distress from the work. The manager said that if you work fast the risk increases for problems. Therefore they are trying to do something about it and try new things which could make it easier for the workers. The group manager thinks the personnel stress since he/she thinks the mental mindset is that you want to do your best. They also have goals for how many parcels they should process each hour which they need to meet. They also have fixed departing times which they need to adjust the production after so that all parcels can get on the trucks.

The group manager said that he/she as a leader, needs to help the personnel as much as possible. The group manager said that errors and injuries can occur when you just should do a little thing to make it easier for somebody else and if you don't think carefully about what you are doing. The manager says that maybe you don't want others to be affected by you and therefore you try to work fast. The group manager thinks that when you lift parcels over the shoulder level into the parcel-cages is especially hard for the body. They have demands on how much they should fill a cage which makes that they need to fill up the cages and do the high lifts. The group manager said that not everyone is 2 m high, so this will be a problem for them. The group manager said he/she can't see how you should avoid this which the manager thinks is very hard. The group manager thinks it is hard when you

can't find a solution to do things better.

### **Cognitive ergonomics**

The group manager said the handling which could be mentally demanding, is when you should be the one that drives away the parcel-cages from the outlines and switch to new cages. That task requires a lot of thinking, then you need to know which outline you need to prioritize and which can wait etc. The group manager said there is quite much noise from the conveyor belts which you hear all the time, but after many years you forget that sound. The manager also said the forklifts sounds a lot, some of them have hard rubber on the wheels and when the rubber is worn out it sounds a lot. It is also a problem with people who throws pallets on the floor. The manager said they work on that problem but it can happen anyway if someone forgets it.

The group manager said it is easier to do the sorting if you learn the places for the sorting, you also learn them automatically when you have worked there for a while. The manager said they have tried to put the signs in an order so it should be easier to find the right parcel-cage. The interviewee said that when you are new, you should be with someone else at the straight conveyor belt for about ten times. They also try to put new personnel there on Thursdays or Fridays when the volume is a bit lower. The manager said that then will the more experienced person help them and support them as much as possible with the work procedures and also with the sorting.

The group manager said it shouldn't be easy to put a parcel in the wrong cage on the manual sorting. However some errors will occur on the parcel sorting conveyor since when you put the parcel in the cage ,they can't look on every parcel so they have now decided that they should look on every third parcel. The interviewee doesn't think the sorting concepts are alike. You need to look on each parcel when you sort them so the parcel should end up in the right cage. The group manager said you should first look on the postcode and then you look at the place and when you find it on the sign, you know that the parcel is placed in the right cage. The group manager said that everyone does that.

The group manager can't see how many parcels or cages that is expected to come in. They can do some estimations based on experience and forecasts from the bigger customers. The smaller customers are impossible to get forecasts from and they also don't affect the volume so much, so it is not needed. The manager said that the big customers which comes after 18 is the most critically to know the volume from. The interviewee said the personnel don't have any information regarding the volume, only if there is very special things that stands out. They don't give any specific number but instead say that "now it should begin to increase a bit" or something like that. The group manager said they inform about the deviations from normal.

### **Work environment**

The group manager said the workers in some way can determine over the routines and the work. They can for example decide which tasks should rotate with which.

The ones from the forklift wanted to rotate with the inline station. Some thought this was good, but some didn't like it since they needed to do it after someone else. So then they compromised, so those that didn't want to rotate got to stay. They try to be flexible. The interviewee says the workers can leave suggestions for improvements. They don't have a suggestion box or something like that, but they try to be as open as possible so that the personnel can come to them with improvements. The group manager also experience that they do so. The group leaders have a competence matrix for all so they now how much they are developing.

The group manager thinks that the workers have a medium workload. The manager thinks that they have a physical workload but if someone needs to leave for a while to drink water, the group leader jump in for them. The group manager said it is often on the limit that they manage to deliver in time. They have departing times and the customers want to have later and later pick up times. The group manager said they always stops the parcel sorting conveyor at the same time independent if they have parcel left. Then they have the routines they need to follow to finish the shift.

The interviewee thinks it is very hot during summer in the terminal due to the metal sheet roof. The interviewee also said it is cold during the winter, but then they can get clothes. The group manager experience it is easier to put on clothes than to take them off since you need to wear clothes for safety reasons. The group manager thinks the personnel is at the terminal because they want to and tries to be motivated to deliver the service to the customers. The manager thinks this is important and therefore tries to say this during the interviews. The interviewee said it is harder to motivate temporary employees since they sometimes go to school or have other things on the side which are their main priority. The group manager hopes that the workers aren't mentally or physically tired when they come home, but the manager doesn't know that. The group managers' own experience was that the manager thought it was fun to work at the terminal and therefore he/she wasn't tired, of course sometimes physical tired due to physical tasks.

### **Other**

The group manager likes the days when the manager personally feels that he/she has done something to create a purpose for someone else. The production will in the most cases function without any problems. What makes a good day for the group manager is the little extra, when you feel that you or your personnel have been able to help another department or if they have had a hard case which they have been able to solve together.

### **B.2.5 Interview 2.5**

Interview with group manager.

#### **Background**

The interviewee works as a group manager for departing parcel handling and has

been doing so for four years. Before, the interviewee was a collective worker so in total, the interviewee has worked for DB Schenker since 2012. The group manager is 35 years old.

### **The working day**

The group manager starts to work at 12 and starts with preparing the starting meeting which takes place at 15:00. The manager makes these preparation until 14:00. The manager has lunch from 14:00 to 15:00. The other part of the working day, the manager are working with administrative tasks. The terminal workers starts at the same time. The workers will prepare the sorting until 14:00 and from 15:00 until they are finished, the main production is running. The workers have some lifting equipment they can use. They have cage-lifters on all inline stations and on the straight conveyor belt they have a lifting table. They also have a vacuum-lifter at the straight conveyor belt and on the big transmissions outline. It is not used so much. It is only used for some specific parcels if the parcels on a pallet have the same shape and are heavy.

### **Ugly-parcel handling**

The parcels which they, according to the group manager, can't run on the parcel sorting conveyor are the parcels which can hurt the line or itself, parcels that rolls of or parcels that can get stucked. It is also problems with the parcels that are too thin or light, then the scanner is the problem. The group manager also said they have troubles with bags in the scanner and the sorting conveyor lose track of the bags. The bags get stuck between the rolls on the conveyors and when it moves again, the parcel goes to the wrong outline. Not all parcels can be handled on the parcel sorting conveyor, they are instead sorted on the straight conveyor belt.

They either pick out the Ugly-parcels into a new cage at the inline station or parcel-cages with a lot of Ugly-parcels are transported directly to the straight conveyor belt according to the group manager. When the Ugly-parcels are sorted, the parcel-cages will either be transported directly to the right gate or to the outlines so they can fill in more parcels in the cage. The interviewee said that the personnel is at the straight conveyor belt max one rotation each shift. The group manager also tries to not place the personnel on the same position two days in a row. The group manager said they are usually two or three people working with the Ugly-parcels. They are often three in the beginning of the week and two in the end of the week when the volume is lower.

The group manager thinks the handling on the straight conveyor belt affects the normal handling positive. They can have a higher capacity with that sorting as an addition to the normal sorting. The manager also said that now when they have a straight conveyor belt the can also prioritize to sort the good parcels on the parcel sorting conveyor. The interviewee said that before they had the straight conveyor belt they had a totally manual handling of the Ugly-parcels. They scanned them manually and then placed them in a cage, similar to what the night shift are doing. The group manager said that they know sort out more parcels then they did before since they have a better flow for the sorting. For example, the group manager said,

if there are cages that has mostly Ugly-parcels they take the whole parcel-cage to the straight conveyor belt.

### **Physical ergonomics**

The interviewee doesn't think that any of the workers have gotten any physical distress from the normal work. Then it has been accidents. The group manager said that the handling which is the most risky, is the straight conveyor belt, especially the inline station there. It gets even worse if you don't use the lifting equipment. The manager also said it can be hard to lift the Ugly-parcels in the right way.

### **Cognitive ergonomics**

The task which can be mentally demanding according to the group manager is the loading function they have. That person loads all the cages to the trucks and writes documents to the drivers. This person can have a very high workload in the end and that can be very hard mentally. The group manager doesn't think that the other parts of the handling is so demanding so it can be a big difference to go to the harder tasks. The interviewee said that of course it is sounds from the forklifts and the conveyor belts, but the manager doesn't think it is so high. The interviewee said they have earplugs which they can use and the manager thinks many uses them.

The group manager said you can manage to read the signs within the time you have to sort so you don't need to know the sorting by heart. The interviewee said you can find how to do the sorting on the signs, and you can also ask others. The interviewee said they don't have any standardized work but rather you as a beginner are learned from the experienced workers so you learn their way of how they do the sorting. The manager said they have standards that they should follow but they are not written down. The group manager said they workers have some written instruction on what they should clean at the end of the shift but that are all instructions they have.

The interviewee said it is easy to do errors. The human factor determines how many errors they have. The manager thinks they get errors because some ones don't focus and some ones do the sorting a bit too fast. The group manager doesn't think the sorting concepts are alike. The interviewee can't see how many parcels that should come in. The manager can see forecasts from some of the customer but that's all. The group manager makes prognosis based on historically data and the manager thinks this is usually working quite well. The manager shows the personnel these numbers before each shift.

### **Work environment**

The group manager said the workers can affect the routines and the work themselves. The manager says the workers can leave improvements suggestions. The group manager checks for ideas from the personnel on the monthly meetings. The interviewee experiences that on the monthly meetings they get a lot of input from the personnel. The group manager experiences that it is less input in the daily work from the terminal workers. The group manager feels that he/she has support from

his/her boss.

The group manager thinks the terminal workers have a high work load, especially high between some hours during the day, from 15:00-20:00. The manager said that it differs if they can meet the demands, it depends on if the cages are arriving late. Some days when they can't manage everything the manager has noticed that some of the workers gets very stressed by it. The interviewee thinks that the workers and the managers have a good job security at DB Schenker. The manager thinks the climate in the terminal is good. Of course a bit cold in the winter but the manager thinks it is okay. The group manager has experienced that the workers general thoughts to the work differs a lot from person to person, some of them are motivated and some not. The group manager personally feels motivated to do the work. The interviewee said the workers probably are physically tired after the work. The manager doesn't think they are mentally tired. The group manager personally is sometimes mentally tired.

### **Other**

The group manager said it has been a good day if they are finished with a margin and it is cleaned in the terminal when they leave. The manager said the age is pretty low at the shift, nearly everyone is under 30 in the departing shift. The interviewee thinks this is mostly due to the working hours and since they use many temporary employees. The manager said there is always mostly men that work in the terminal, but for some periods they have had more women working there but it has mostly been temporary employees. The group manager said it is hard to attract women to apply for the jobs.

The group manager said the personnel distribution is about 80% of permanent employees and 20% temporary employees. The manager wish to get more of the workers to be full-time employees. The interviewee thinks they have a high personnel turnover rate, mostly for the temporary personnel, but also for the full-time employees. The group manager said that many takes the job as something to do before they know what to study. If the group manager could change something, it would be to increase the capacity of the parcel sorting conveyor, the workers always think they are on the limit. The manager added that they do their best with the work environment and the ergonomics, but it is a hard job. The time windows make it very hard to do something good out of the day.

## **B.2.6 Interview 2.6**

Interview with group manager.

### **Background**

The interviewee is currently a group manager during the day shift. The interviewee has been so for about two years. The interviewee has in total been at DB Schenker for six years on different functions. The interviewee started at the production support, then worked as a terminal worker, and after that the booking and then as a

group manager. The group manager is 29 years old.

### **The working day**

The group manager can start to work on three different times, they rotate weekly. The shifts are 06:00-14:30, 07:00- 15:30 and 11:30 to 20:00. They rotate also on a shift where they work until 22:00, they have that every 15 week. The group manager works mostly with customers specific sorting and also with stins accession. The manager also looks over so that everyone has something to do and knows what to do. Some of the terminal workers starts at 10:00 but some starts at 11:30 and one that goes to 21:00 to the night and one rotating to 22:00. Some are switching tasks and rotate during the day.

The group manager also said you should keep track of where you can help if you don't have so much to do. Some are more comfortable with sorting and some with the inline station so they determine themselves how to rotate. The temporary personnel are often placed at the inline station since they don't know the sorting. They have the signs on the cages as help for the sorting. Some places are not included on the signs so to find where those parcels should go, the workers scan the parcel with the HDT to see where it should go. They also have apps they can use to see where it should go. The HDT is unfortunately not so good but a new is coming soon so they don't want to order a new one yet.

### **Ugly-parcel handling**

The parcels they can't handle on the parcel sorting conveyor is according to the group manager the heavy parcels, parcels where the customer have done errors. Unpacked parcels should also not be placed on the parcel sorting conveyor. The manager said that if you know that it is over 30 kilo you don't need to lift it up on the conveyor, otherwise the parcel will be stopped by the computer. The terminal has only a straight conveyor belt as parcel sorting conveyor, so they only have one inline and one outline. Even though they could handle the parcels which are miss packed, the manager said they should put them aside and rewrite them as groupage to make it easier for the arriving terminal to handle them. The personnel work with the parcel sorting about two or three days each week. The group manager said they usually are four that works on the parcel sorting conveyor. This is usually one to two temporary employees and one to two full-time employees. They try to get in experienced temporary personnel, but it is hard. The group manager thinks the parcels which needs to be lifted of the conveyor affects the flow a lot, since you need to go to the computer all the time.

### **Physical ergonomics**

The group manager thinks that some of the workers have experienced pain in the back from the parcel sorting. The manager personally has had pain in the back. The interviewee said that you often need to lift the parcels which go beside the normal flow a lot of times. The group manager thinks that if you put heavy parcels on the top in cages, this can be a risk factor. It is also a risk when you haven't closed the cage since you can have parcels sticking out and can fall out. Also long parcels which

you put in the cage risk to tilt over the persons who are packing the parcel-cages. It is also a risk that you get parcels over you when you pick the parcels from the parcel-cages. The group managers said that if you get pain it is mostly that you get tired in the back. The manager said that if you lift right you can minimize the risk for that.

### **Cognitive ergonomics**

The group manager said you should think about some things which are good to keep in mind the whole time. The interviewee said that on the inline station you should keep track of many things. You should also always keep track of the forklifts and other people who are moving around the terminal. The group manager thinks the signs is easy to read. The manager said there always is noises in the terminal, both from the forklifts and the conveyor belt. The interviewee said you can manage to read the signs within the time you should sort out the parcels, but it helps a lot if you know at least some of the concepts. Minimum is that you know some of where you should go with the parcel, for example if a place is in the north or south.

The group manager said it is very easy to do errors. All cages look the same and some sorting concepts sound the same but should go to different terminals. It is also important with the right sign on the right cage. The manager said it is both sorting concepts and postcode number which are similar for many terminals. So it is easy to make errors. The group manager also said it is hard when the sorting concepts are changed. The interviewee said they can't see how many parcels that should come in during the shift. They can know based on experience how many it should be and if any customer have some sale they get that information as well. The group manager said that if they would get information from all customers, it would be chaos, but it will also be chaos if they don't get information if a customer has a sale. The group manager said they also give this information to the terminal workers. The instructions they have are a sign at the computer which helps you how to do if the conveyor stops. They also have some standards they follow, for example that you always should pack the heavy parcels in the bottom and so on.

### **Work environment**

The group manager said that of course do the terminal workers experience some stress, especially if they start the day with stress because then they can't prepare so much for the parcel production. The manager said you can leave suggestions for improvements on the lean meetings they have. These meetings sometimes gets down prioritized but they try to have them. They get some suggestions from the personnel at these meetings, but not so many so they seem to be quite happy with how they have it now. The group manager thinks the terminal workers have quite high work load, right now it is more medium so you finish without stressing but usually it is high. The manager said they usually finish the production in time but they get an increase of errors if they need to stress.

The group manager feels they have a good job security at DB schenker. The interviewee thinks the climate in the terminal is a bit better now than it was before.

They have recently switched the light so it is better. There is noise which can be a problem, but he/she doesn't know how you could solve it. The group manager generally feels motivated towards the work and thinks it is fun. After a working day, the group manager is both mentally and physically tired.

### **Other**

The group manager said that a good day is when everything is done and you have a few minutes break before you need to go home. It is good if you don't leave anything behind. The manager said if it is stressful, you can't check everything, you should like check for damages and also count everything and so on. The interviewee said that the age spread at the distribution is very good and they have some elder and also some young and new employees. They have some women at the terminal but there is more men than women. At the night shift they have only men unfortunately. The group manager said it is hard for girls if they are shorter to do the work. The manager said the turnover rate is very low for the personnel, many stay very long. The manager said he/she experiences that either the personnel stay very long or very short. The group manager said that if something could be improved, it would be the communication at their terminal so that everyone knows what is happening and nothing falls between the chairs.

## **B.3 Interviews with terminal managers**

In the following section are all interviews with terminal managers summarized.

### **B.3.1 Interview 3.1**

Interview with parcel manager.

#### **Background**

The interviewee works as the parcels manager. The interviewee has done so for about three years. The interviewee has worked at DB Schenker for 33 year. The terminal manager has before also worked with booking and the GU function. The interviewee is 53 years old.

#### **The working day**

The parcel manager said that the terminal workers shift position one time each day and have one hour with lunch. They don't have any other breaks but they can whenever they want go and get water or bring a bottle of water, some also needs to have a break to eat something since they have diabetes and so they try to meet those demands. They also try to include the straight conveyor belt in the rotation but the personnel there don't always want to do rotate. They had a problem a half year ago when they missed knowledge on how the sorting should be done, since it is done manually and all who knew how to do it was on vacation. The parcel manager said that now they have learned five to six people to cover up for sickness and vacations. The manager however said that not everyone work these since you need to remember all the sorting concepts in order to do the sorting. The manager

said it doesn't work to look at the signs every time. The parcel manager said they don't want to have the Ugly-parcel handling at all. The interviewee said it affects the normal handling much and take a lot of time to do the handling.

The terminal manager said they have a high-lifting forklift which they can use to lift up the parcels at the straight conveyor belt but the workers often forget to use it. The manager said they have driven a project in their old plant where they only had one inline and two outlines. The parcel manager installed a vacuum-lifter but the personnel didn't use it. The interviewee didn't think it went slower but the personnel wasn't used to handle it. The parcel manager thinks it is pity since a vacuum-lifter would help the workers and decrease the load on them. The terminal manager said they have ordered a new telescopic conveyor which will have a vacuum lifter to make the lifts from the ground easier. The manager however said it requires some technique to use the lifters. When the manager visited another terminal he/she experienced they liked the vacuum-lifter.

### **Ugly-parcel handling**

The parcel manager said that the parcels which they can't handle on the parcel sorting conveyer, are the rolls, parcels over 140cm, unpacked parcels which can damage the conveyor, fluids, tires and wood boxes since they can damage other parcels and they risk to fly off due to bad friction. It is also very steep down on the outlines so hard parcels can damage other parcels. They also have problems with uneven parcels and iron bars which they can't handle. They pick out Ugly-parcels from the parcels-cages on the inline station or at the telescopic conveyors. They handed all these parcels at the straight conveyor belt. The small parcels are however handled on another station. All personnel handles the Ugly-parcels at least every second day, since you handle them either if you are at the inline stations or at the straight conveyor belt. The parcel manager thinks the Ugly-parcels disturbs the normal production. You need to move them away which takes time.

### **Physical ergonomics**

The parcel manager said they have had some problems with back problems but when they increased the rotation it helped that problem. They recently had an incident when a parcel fell down on a personnel on the shoulder. The interviewee thinks the outlines is the biggest problem since you don't have any lift help there. The inline with the telescopic conveyors is also a big problem since there are lifts from the ground.

### **Cognitive ergonomics**

The IVS (international work stations) stations are the hardest mental tasks they have according to the manager. The interviewee said they has received feedback that the personnel get fast tired since they often need to change program and find the errors when they stand there. It is always new challenges and you also need to know all parcels, it is only the import part of the flow which is affected. The terminal manager said they have good lighting which should simulate the day light. The manager said there is very much dust, parcel dust in the terminal. The par-

cel manager also said that it can blow cold air, and be extremely hot at the summer.

The parcel sorting conveyor is very quiet according to the parcel manager. Sometimes people forget so they drop the pallet from a high level which creates a high sound but that's not so common. They also have some distribution trucks which park inside the terminal which affects the environment in the terminal. The straight conveyor belt has a high noise, but they will invest in new parts so that it will be better. The parcel manager said they don't need to have any splitted focus, but according to the manager, they should have it more. At the IVS station they need to have more splitted focus and some have expressed that after a while you get mentally tired so you lose your thoughts and that increases the chance for errors. The terminal manager said they have tried to put up signs on how you should do so you don't need to remember everything.

The interviewee said that some of the workers have easier to learn and then these know most parts of the handling by heart. At the straights conveyor belt you need to remember the places to be able to do the sorting well. It will be hard to check every sign. The parcel manager said that if you don't know something you should ask. The interviewee said that some sorting concepts share outline but others have a separate outline so it should be easy to put the parcel in the right cage. At the night shift they have more parcels on each outline and then it is easier to put the parcel in the wrong place. At the straight conveyor belt you also have many names to keep in your mind so it is quite easy to do errors. At the IVS station it is easy to do errors but the workers don't do it so much, so they are good on it according to the parcel manager. The interviewee said that some sorting concepts have equal names and sounds the same so then you need to be more aware of where you should place the parcel.

The parcel manager said they forecast the volume by looking at the historical figures. The manager has kept statistics since 2001 which they can look at. They can also use a program wich shows the productivity but the manager wants to have it for each product type like import, export etc. The parcel manager shows which volume they have had and if it has been something special for example as a record. The interviewee said that they have put up the forecasts before but they experienced that the personnel wasn't interested in it. The manager explained that sometimes the personnel come and ask about the forecast and then the manager can give them an answer. The terminal manager said he/she would like to develop a real time data on how much they are doing to motivate the personnel, they are in the development phase of a project that will updated the data each fifth minute. They have a standardized process,s but it is just for the overall production, not for specific tasks. The parcel manager said they can't have more specific instructions since they have so many special cases which they should deliver. They have instructions for their local customers but not for other districts' customer. They have the instructions on the intranet and the terminal workers can look in the computer in the terminal if they need to look something up.

**Work environment**

The parcel manager said that the terminal workers in some way can affect the way they work, but they need to follow the routines which are central otherwise the job will be worse performed. The terminal workers have a fixed lunch break but they can go and take water and small breaks when they need to, said the parcel manager. The terminal manager said that the workers can leave suggestions for improvements. They can give suggestions in a box by the lunchroom. The manager however said that he/she hasn't received any suggestions. They have received suggestions from the goods central regarding some things which has led to improvement for the workers, said the manager.

The parcel manager tries to support the personnel by always being out in the production, he/she doesn't like to stay at the office. The interviewee tries to be at work early so he/she can meet the night personnel as well. The parcel manager said he/she tries to support the personnel if it occurs big incidents and tries to be present and general support them. The terminal manager always tries to praise the workers if they have done a good work. The manager thinks it helps if the manager is present in the production. The parcel manager said he/she has had many work leaders during his/her years at DB Schenker and has experienced that the managers often is not so present. Therefore, the parcel manager tries to be so.

The terminal manager thinks the personnel have a high work load, and they also use the body a lot. Often it is a lot of pressure in the production. The manager therefore experience that it is a stressful environment. The manager also said that it comes in things all the time, so it is never any calm periods. The parcel manager said there are some peaks in the workload, like black Friday and Christmas. The interviewee said that before the volume was lower during summer period but now it doesn't go down. The parcel manager said that the workers often needs to leave some import parcels behind after the shift. The manager said that this can the personnel feel frustrated about since they know they need to do take it tomorrow and also that they never get to finish the task. The parcel manager thinks the workers have a good job security. Many of them also stay a long time, but the manager feels that the younger personnel don't stay so long since they often wants to try different jobs. The parcel manager said that the climate in the terminal during summer is very warm, it is dust in the air, and cars which drives in the terminal creates exhaust in the air. The interviewee thinks it variates a lot if the workers are motivated to work. Some is always positive and some is always complaining. The parcel manager said that they have a good team spirit and always say if someone not performs as expected.

**Other**

The parcel manager said that a good working day is when everything works without stops. Unfortunately those days are rare since it is an advanced machine. The parcel manager said they try to mix the age at the terminal and also men and women in order to have a more balanced workplace. The manager also tries to recruit more older people who can calm down the youth. At the night it is only men working but

a mix between the ages. Unfortunately have the women they have had for the night shift not stayed for long. The personnel turnover rate is very low for permanent workers but for the hourly personnel it is higher. The parcel manager said they try to have about 80% permanent personnel and about 20% other. It is often the permanent personnel who handles the harder stations, as the Ugly-parcels. The parcel manager wishes that they could include the straight parcel belt more in the rotations but the personnel there don't want to. The interviewee said that in the best case they would not need to handle any Ugly-parcels, but he/she thinks they work as good as they can with the prerequisites they have.

### **B.3.2 Interview 3.2**

Interview with terminal manager

#### **Background**

The interviewee is currently the terminal manager and Codi manager, and has been a terminal manager since 2006. The interviewee started directly as the terminal managers at DB Schenker. The terminal manager is 59 years old.

#### **The working day**

The terminal manager starts the morning by checking how the night shift has been going. The manager tries to have contact with the night shift through email and deviation reports. The manager also checks with the group managers since they start at 6 and therefore meets the night personnel. The terminal manager then checks if something needs to be reported further and starts to check emails etc. The manager also continuously helps the truck drivers and follow up so routines are followed. The manager also has a lot of meetings with different departments during the day. The interviewee said that he/she as a manager needs to check different statistics to see how much has been produced, and also check the prognoses in different programs. The terminal manager said the terminal workers start at 14:00 with cleaning and preparing for production, and then when the others arrive, they start to sort out the parcels. There is always three workers at the parcels handling. The interviewee said that when the sorting is done the worker closes the cage and drives it to the right place. Then the terminal workers pick everything together so it is prepared for the night.

The terminal managers said that the workers have the forklift as help advice so they can lift up the pallets if they can't use the cage-lift. The manager also said the worker can use the HDT to scan the barcodes which the cargo scanner can't handle. On the old parcel sorting conveyor they had a vacuum-lifter. It was not used so much since they have too big differences in the parcels according to the terminal manager. The lifter needed a flat surface in order to lift the parcels which not all parcels have.

#### **Ugly-parcel handling**

The terminal manager said that the parcels that can't be sorted at the conveyor are

the parcels which don't have a flat surface, so the parcels that are uneven. They also can't handle if the parcels have strange shapes or if one part of the parcels sticks out from the rest. They can handle parcels up to 150 cm at the sorting conveyor. Parcels longer than this needs to be handled on the side. The parcels which also have a very big area will be a problem since they get stuck in the curves. They can't put them on the edge to run them if they are thin. The terminal manager said they conveyors are 80cm broad so if the parcel is broader than 50cm it will create problems.

The Ugly-parcels are scanned manually and then placed on a pallet. The personnel at the outlines pick them and put the parcels in the right cage. The terminal manager said that since they are a small terminal and have a short distance between the outline and inline, it is easy if they have time help another. The terminal manager thinks that the Ugly-parcels affects the production. Often they try to put parcels on the conveyor and then when they don't work, you either need to take it off the conveyor or put it out again. The manager also said that you can need to do this even a second time before it works. Then you handle it two extra times. The Ugly-parcels also needs to be put away which also takes time of course and you also lose the rhythm that you have according to the interviewee. For the small parcels which will create problems at the cargo-scanner, the personnel put on a lid under so they can be sorted on the parcel sorting conveyor. These parcel also affect of course but it works pretty well said the terminal manager. At the outline they take away the lid and place it in a box which they carry back to the inline station. Here they need to communicate good to get it to work well.

### **Physical ergonomics**

The terminal manager said they have some problems with elbows. Otherwise there are no big problems. The manager said that many have worked with them for a long time and are used to the work. But of course after a working day, you are tired and worn, but you don't have any sick leave from it or something like that. The interviewee said that the handling at the night shift is more risky than the other handling. Especially when you open the cage at the departing shift. It may be so that the district have loaded the cage from one side and leaned it on one cage gate and if you then open the cage, the parcels will fall out on the person who opens the cage. The terminal manager said that there are specific customers who send iron which is badly packed and they are heavy. These parcels is also a risk for the operators to handle. The manager said that the Work Environment Authority had remarked on the part when you go into a cage and that you need to do so in order to place parcels in the bottom of the cage. The manager agrees with the authority that it is a problem when you can't have the parcel close to the body and when you need to reach it. You can't bend in a proper way when you are inside the cage. But they also talked about lifts over the shoulders. The manager doesn't think this is such a big problem since you try to have the heavy parcels in the bottom, so the parcel on the top is smaller and lighter.

### **Cognitive ergonomics**

The terminal manager said that the time pressure is quite demanding. It is okay on the departing shift since the parcels are in time, but at night shift the trucks often get late and when they need to be finished about 5:30 and much comes in, it will be very stressful. It can be very calm and then everything comes in at the same time and also the driver comes and requires help. The manager said that there can be many things which disturb your focus and you can't finish what you are doing. The interviewee said that it would be better if it could be an even flow, now it is like zero and zero and then it is fifty. The terminal manager doesn't think there are any specific obstacles to read the signs. But they also have a lot of signs which the manager thinks that not everyone has read. They are a quite small terminal so the manager thinks that it works. The signs at the departing shift are big and good but at the night shift, they have just smaller signs which they lay out on the ground if they have new personnel.

The terminal manager thinks there are some noise at the terminal especially when they drive in and out with the trucks. Also if the trucks are old, they rattle more. They are quite used to the sound so it doesn't disturb so much. They have earplugs which they can use if they want to. The terminal manager said that on the night shift you need to focus more on different things since you have to keep in mind when you should go to the parcel sorting conveyor. The manager said that the groupage sorting requires more focus, since you get disturbed from drivers and others who ask questions or need help.

The interviewee said that you need to know most of the sorting by heart. If you have any unexperienced personnel it takes a lot more time. You need to learn, and the ones that have been working here for a long time almost get a bit geeky about it and also put a pride in knowing the places. There are clear signs on where the parcels should be sorted especially at the departing shift. If you need to read the signs it takes a lot of time. If you don't know where a parcel should be, it can be easier to put it wrongly and you get stressed so you put a parcel wrong. Some of the sorting concepts are the same but the manager said that they don't know so much about that. Some of the districts have the same first digits in the post code which makes the sorting difficult. We can't see how much parcels that are coming in. The interviewee said that they can see the volume for the arriving shift at the night shift but not for the departing shift. The volume is mostly the same so they know in a way how it should be. The interviewee said they don't have any standardized work or work instructions.

### **Work environment**

The interviewee thinks that the personnel have a good possibility to affect the routines and the work themselves and often he/she experiences that they do so. They can develop their own strategies to solve problems. It is fixed which registration and how it should be sorted, but how they do it, is up to them. For example now with the Work Environment Authority all know which points they need to solve and now everyone tried to think about how they can solve the problems together. The interviewee said they can give suggestions, and they have lean meetings two

times a week, mostly the meetings are information but then the workers can give suggestions if they want. Sometimes there are small suggestions, like can we move that sorting to there etc. The big changes they can do is like for parcels, “can we move that cage to there (etc) so we can even out the work load”.

The terminal manager tries to be present to support the personnel and he/she has terminal meetings where the workers can bring up problems. They try to use lean. The manager thinks the terminal workers have quite a high workload. The manager thinks they often meet the demand on the sorting, they nearly never leave parcels on the departing shift. The interviewee thinks the workers have a good job security, they have a lot to do. The climate in the terminal can be very cold if it is cold outside. If it is normal temperatures, it is at least 6-7 degrees in the terminal. But in the morning if it is -20 degrees and all gates are open, it gets cold in the terminal. During summer it can be 25-27 degrees when they open up the gates in the afternoon. The terminal manager thinks the terminal workers are both motivated and not. Many persons have been here many years which indicates that they like it. Especially for those who works with the groupage handling. The one at groupage who has been there shortest time, has been there for at least five years. The manager thinks the workers are physical tired when they come home and some days when there is a lot to do, they can be mentally tired, especially the group leaders. The problem is that there is always a new task which should only take 10 minutes each day and then another and then this builds up to quite a lot of time.

### **Other**

The terminal manager said that a good working day is if the groupage and parcels come in even through the shift, then it will work best since it will never be crowded. The manager said that the days when they have a lot of volume, but it comes in even, they experience as less to do than the days with less volume, but this come in uneven. The right papers and EDI's should be sent in as well.

The terminal manager said there are only men at the terminal. Unfortunately they have not had many women. When search personnel for a new position, there is always only men who applies. The interviewee said that the age is mixed at the terminal, there is quite a lot of elder but also some younger. The whole branch has a big challenge since the E-shopping is increasing, which increases the pressure on the personnel at the terminals. They now think about if they could distribute the work more. He/she thinks the technical solution will be too hard, for them you need to put higher demands on the customer so more lift equipment could be used. The manager said they think much about rotation, both between the groupage and the parcel department. The terminal manager also said that if you think big, you can also think about if the cages could be opened at the long side instead to give more room for loading, but then they need a bigger area to put them up at by the line. They have thought about smaller cages as well, but then you need to switch more often. It is a quite complicated problem.

### **B.3.3 Interview 3.3**

Interview with terminal manager.

#### **Background**

The interviewee is currently a terminal manager and Codi since 2010. Before he/she was a work leader since 21 years. The manager is 48 years old.

#### **The working day**

The terminal manager has a lot of meetings during the day. He/she also has a lot of reporting and discussions with the work leaders. The interviewee said that they get more and more central things to do, so they need more personnel who can help with those tasks. The manager mostly gather the information and the workers and work leaders need to do the actual work to implement. The terminal manager also have quality meetings and meetings with the board etc.

The terminal manager said that they try to give the terminal workers as much hours as possible so they have 4-5 hours, unfortunately the few hours they can offer results in that they often switch personnel. It is hard when they can't be full time workers. They are usually 3-4 persons at the parcel sorting conveyor. They rotate one time each hour. They only switch with the inline and outline station, but they want in the future also to rotate with the VoV machine at the groupage sorting as well. The terminal manager often experiences that the head quarter only have visited the big districts and often in order to make it work, the smaller terminal have the same people on several work tasks making it more difficult. They don't want to have the "we and them" feeling, so they are trying to do that transition. The manager said that they don't have any equipment to help out with the sorting. They are waiting for an update from the project , but the manager is afraid that it will be a sensitive system. They want a robust phone that they can scan with and see where it should be placed.

#### **Ugly-parcel handling**

The terminal manager said that all parcel over 1.4 m is a problem, sometime they can handle 1.6m. There are very sharp curves on the parcel sorting conveyor which creates problems. They also try to stop parcels which can damage other parcels, and also round parcels which can roll off. The terminal manager said they put these parcels in a cage beside the inline station. Sometimes they get a whole cages or pallet with Ugly-parcels, then they put it directly by the outlines so the operators can sort out the parcels. The interviewee thinks the big problem is the products which are allowed. At night shift where they are using more outlines, they divide the parcels into two different cages which they then drive out to the outlines. If the operator is unsure of where the parcel should go they will try to ask the more experienced personnel. The terminal manager thinks this handling affects the ordinary handling in some way. The production would go faster without this handling, but they have tried to live with these parcels. These production conditions are the problem. They drive the line 15:30-18:30 at the afternoon shift and at night shift 22:00- 05:30. They are about 6-7 operators on the parcel line at night shift and

sometimes even more.

### **Physical ergonomics**

The terminal manager don't experience that someone has got any specific work related injuries, specially not at the departing shift, it is harder during the arrival shift. They have had very high efficiency so they have now put in more people instead to lower the efficiency a bit but make it easier for the personnel. About ten years ago did they only have the vacuum-lifter as help but that wasn't used by the operators. The terminal manager thinks that the greatest risk is when the first person take the parcel, since then you don't know so much about which parcel it is and how much it weighs. It is also a risk when you should pack the parcel in the cage above shoulder level. You also can get very much clamping injuries when you should close the cages.

### **Cognitive ergonomics**

The terminal manager doesn't think it is mentally demanding to do the parcel handling. However the manager said it is crowded at the inline station and a pillar which is in the way, so you need to be focused when you are driving with the forklifts. The manager thinks the information is easy to see and that you easy can find it. The interviewee said there is noise in the terminal in terms of rumbling from the forklifts. They also sometimes play very high music which the manager thinks is very high and disturbing. The terminal manager said there is quite a lot you need to focus on and you need to keep many things in your head, like with bill of loading's etc. The terminal manager said that they don't have any written instructions. The terminal manager thinks you have time to read the signs if you need to do so. The manager said they only have the signs as an help for sorting correctly. There are some sorting concepts which have the same postcode numbers in the beginning. They have tried to separate these on different outlines. The manager said that if they have had more outlines, it would be optimal. The interviewee said that they can't see how much will come in at the departing shift, on the night shift they can see how many cages that should come in. They don't have any bigger customers so therefore they don't know anything about the volumes from the customers. The manager said that they don't have any written instruction or standardization. You learn the job by going next to one of the more experienced workers.

### **Work environment**

The terminal manager said that there is a tight time frame when you should deliver which creates a lot of stress for the workers. You often think that you can't make it, but they often make it anyway since they stress in order to make it. The interviewee said that the workers can affect some routines but some things are central guidelines so they can't affect those. The terminal manager said the worker can come with suggestions but it is mostly the work leaders who come with suggestions. The terminal manager tries to support the workers if the work condition doesn't work. The work leader is the main responsible manager for the coaching towards the terminal workers. The terminal manager thinks the workers have a medium work load and sometimes a high work load. Sometimes it is stressful and then they have calm period etc. The interviewee thinks they nearly never leave any parcel so

they can often meet the performance requirements. The terminal manager thinks that many feels they have a good job security. The manager generally feels that the personnel is motivated to work and if they aren't, they should switch job according to the manager. The terminal manager thinks that the personal is more mentally tired if you drive the forklifts at the terminal and more physical tired if they work with the parcel handling.

### **Other**

The terminal manager said that it has been a good working day if everybody are safe when they come home, they are finished in time and feel that they have done a good job. The problem they have is the small delivery window. The age of the workers at the terminal is mostly young people, many have recently retired and there is also people that are on the way to retirement. Many have worked at the terminal for a very long time. The turnover rate for personnel is a bit higher with the hourly personnel. They are eleven persons in total on the whole terminal. Often many stays a very long time at the terminal. He/she would like to have some more knowledge in the ergonomics to improve the workers work environment. He/she thinks that it is something that they should have. The working environmental authority also wanted them to have more information for the personnel. The terminal manager himself or herself went 1988 so it would be good to have some repetition.

### **B.3.4 3.4**

Interview with parcel manager.

#### **Background**

The interviewee is currently the parcel manager and has been so for two years. First the manager worked for 16 years at DB Schenker on the shop floor, customer services, reception, traffic and booking. Then the manager was away from DB Schenker for some years and came back to DB Schenker. The manager was then first a transport leader in two years and after this, the manager became the parcel manager. The interviewee came back to DB Schenker since he/she missed the social contact you have at DB Schenker. The interviewee is 44 years old.

#### **The working day**

The interviewee said that no day is like the other day. There are a lot of meetings. The distances are also very long between the places he/she is expected to be at, so he/she walks a lot. But the manager wants to be at the parcel line and have their office there so the manager is closer to the parcel production. The parcel manager tries to support the workers as much as he/she can. The interviewee wants to ask the workers much about the current state so he/she can represent them well in the meetings which he/she goes to and speak on their behalf. There is also continuously changing things so the manager needs to keep updated. The parcel manager said they have four different shifts. At the arrival shift, they are using an extra straight conveyor belt in another house to manage the production volume. So they have two shift at the arrival shift. When they introduced this, it was very hard for the

workers, but now it is better after some while.

They have the dispatch personnel who starts at 05:00 in the morning. Some at the departing shift starts at 11:00 but the majority start at 15:00 and go to 20:00, they only have a lunch break. At the inline station, they are rotating each quarter with the forklift or the computer, so you don't need to stand there for so long time. The parcel manager said that at the outlines the operators are standing for the whole shift. They have a vacuum lifter at cargo five where they handle the Ugly-parcels, but it is not used. The manager doesn't know why, but he/she thinks the operators may think it is difficult to get it, grab it and so on.

### **Ugly-parcel handling**

The parcel manager said that on the night shift they put up the cages in a group and sort out the parcel in different areas, but they don't use the straight conveyor belt. The parcels which the parcel sorting conveyor can't handle are the flat parcels, small bags, round, wood boxes and missing packing. They have a sign on the inline with reminders on what they can't handle. They sort out everything which risk to fall off, to get stuck between the plates or which risk to damage other parcels. They don't want to have any drift disturbances. They old parcel conveyor belt they had, could handle more different parcels, but that conveyor was very bad from an ergonomic perspective. Then you looked on the parcels manually and pushed them to the right outline based on the experience. The manager said that maybe they could handle more, but it was much worse for the personnel and their bodies.

The parcel manager said they leave the rotation planning on the parcel handling to the work leaders. They don't have any signs for the sorting on the night shift for the Ugly-parcels, they have their own system that works for them. The manager thinks the workers can affect the normal sorting. They have tried to do a big work to estimate the ugly-parcels. They have had some customers who only had Ugly-parcels, and for those customers they haven't earned any money. They also try to get the customers to understand their production so now customers know how they need to package the parcels in the right way so they can be handled on the parcel sorting conveyor. For example, they put cardboard's on the rolls so these can be handed on the parcel sorting conveyor.

### **Physical ergonomics**

The manager thinks that absolutely the workers have gotten some physical distresses from the work. You need to work in the right way all the time since the work is very demanding, and when you get stressed you don't do that. They therefore have a problem with the limited time window, the time they have when they get in the parcels and when they need to be finished. It is always a high pressure at the end. This creates stress which often might lead to that you don't work ergonomically correct. It is the same at the night shift. The parcel manager thinks that one of risky parts, is the work with the Ugly-parcels and also the work at the inline stations when you put the parcel on the conveyor. Much are depending on how the parcels are packed in the cages. Sometimes you open the parcel-cage and all parcels fall out.

The manager also thinks that they often use the cages too long after they should have been moved out from production which increases the risk for injuries.

### **Cognitive ergonomics**

The parcel manager doesn't think it is so mentally demanding on the shop floor at the terminal but for the leader it might be harder. There is a lot of noise in the terminal. The conveyor belt creates a very high sound. There is forklifts and often someone drops a pallet. They can have earplugs if they want, but there is only a few that wants to use it. In the A house, you don't need to know how to sort but at the B house you need to know all the streets. When you are new, you need to start and work your way. They try to communicate a lot with the truck drivers so they get a good layout for the sorting to make it easier for the workers. They also get the feedback on how they have performed.

They try to have the layout flexible to adapt after the demands. It is easier to sort right in the automatic sorting since the parcel sorting conveyor always should do the sorting correct. But since it should do it right, you don't check, so if something goes wrong you might miss it. They get a list of how much they have sorted in the wrong way. The manager shows this for the personnel each day. On the B house, where they do the manual sorting, they are more dependent on the personnel which might create some more errors. The manager can't see how much parcels that are coming in especially, not on the departing shift. They try to communicate with the sales and production coordinators that the customers should notify them about how many they will deliver. They especially want to have this information from the biggest customers. They have some standards which should be followed in the terminal. They get first get an education first about what's included in the work tasks. You also get a mentor from the personnel who supports you the whole way of your learning.

### **Work environment**

The parcel manager thinks a stress right now is the lower volumes which gives that the operators need to be on more than one position. When the volume is higher they can focus more on only one position. So they like when it is higher volumes. They also think it is stressful with late trucks. The manager said it is very warm in the summer and very cold in the night. It is bad lightning in the house since they got their demand denied from the board. A new terminal is planned in Södertälje so then they mean that you shouldn't focus on the old terminal now. The last summer, 2018 the fire alarm went off since it was over 60 degree closest to the roof. So they needed to adjust the alarm to be able to sort and you can't take of the clothes due to safety reasons. The gates which are open are a big problem. It can be very cold in the winter so you need to have a jacket on.

### **Other**

The parcel manager thinks that a good working day is when it is clean when you go home and you have had time to clean after and put away everything after the production. There is a quite young crew at the parcel line now. They have some

few old persons but few can manage to work for a long time. They have some who have been here for a long time, but at the departing shift they have a high turnover of the personnel since it can be bad working hours when you get a family. Unfortunately they don't have an equal share of girls and boys. Now they have some more women than before, so they have 4-5 on each shift, but they need to get a more heterogeneous groups. They have tried to not make the work so physic anymore. The hard thing for them is the area, they need to walk a lot. The big area they need to cover is a real big problem.

### **B.3.5 Interview 3.5**

Interview with terminal manager. This interview was done in addition to another, so it will not cover all parts. The terminal have had an visit from the working environment authority so the conversation was more open and focused more on the challenges the terminal noticed themselves.

#### **Background**

The interviewee has worked as a terminal manager for almost two years and started at the company directly as a terminal manager. The manager is 48 years old.

#### **The working day**

The interviewee said that one day is never like the other. But a big part is to sit in meetings about work environment, quality etc. The terminal manager tries to be at the parcel line sometimes, he/she mostly go through the parcel manager. The terminal manager wants to sometimes be on the start up meeting so the workers know who the terminal manager is and can ask questions. The terminal manager said it is hard with the business 24/7 approach since the night is hard to visit. But they try to have extra meetings with the night personnel. It is not so easy for the night shift personnel to communicate with the daytime manager and to just come by the at their office, so the manager tries to have three extra meetings with them every year. On this meetings the manager are telling what they in the board are working on right now, which decisions that is affecting them etc. Both on high and low levels. The working environment authority has been there to do an inspection. They need to be better on information for beginners so the individuals get the information and follows the standards to improve ergonomics. They have some signs which say how you should lift but they have had them there before as well and the employees don't look at them. It is also hard to know what the authority are judging since some terminals have got remarks and some haven't got any. The terminal will move on by taking in an external ergonomic expert who can help them. They mostly want to focus on the new employees. They also want to have something more systematic so that someone go through the work with the new workers.

#### **Ugly-parcel handling**

The terminal manager felt that he/she was not so familiar with how the Ugly-parcels were handled so the discussion was more general for all parcel handling.

### **Physical ergonomics**

The terminal manager said that the Ugly-parcels is not always the worst if you lift them good. If you lift the good parcels bad they can be worse. The worst is the ungainly parcels since you can't lift them right independent on the weight they have. So those parcel you should need to lift two and two, but they don't do that. They have some help equipment but you can't use it and you also don't experience that the parcels are so heavy so you need it. The manager thinks this is very bad productivity so it is bad for everyone. They don't want to have these parcels since they don't think it really are parcels. But the sales department say it is good profitability on them. They want the sellers to focus on this to evaluate if their customers is a problem so they understand how the production is done at DB Schenker. They have reviewed so that customer pays what they should do. So they want the customer to pay if two people is necessary in order to lift the parcels. At the inline is very important to rotate one time each quarter. They have a collaboration with the chiropractor to get feedback if there are any injuries on the employees which are common. For the parcel personnel it is now the shoulders which seems to have the highest effects from the work.

### **Cognitive ergonomics**

The terminal manager thinks the parcel-cages are very bad, it is very easy to squeeze your fingers. The manager said that everyone squeeze their fingers and a problem is that nobody report on that. They need to report everything so that they get the pressure to improve it. It is not that culture in the terminal. They don't want to put time on it. The manager said that at the managers previous job, they had a goal to do three reports per person each year since they estimated that everyone should be exposed to at least three risks. It needs to be easier and faster ways to do the incident reports. The terminal manager doesn't think there is any focus on the safety, he/she has never heard it from the head quarter. If not the highest board think it is important nobody will think it is important.

The interviewee thinks that the noise level in the terminal is very good. The manager doesn't react anything on the noise when he/she steps into the terminal. The manager doesn't know if it is that he/she doesn't notice it, but he/she doesn't think it is a problem. The terminal manager said it is easy to do errors. It happens each day that you sort parcels wrongly. It is also quite intense especially some hours and then errors occur. The manager or the personnel can't see how many parcels that is coming in. The manager can only estimate based on historical data. The interviewee thinks they have a big challenge with this in the future, to predict how many parcels that should come in. They don't get any forecasts from sales. They would like to know if there is a new customer, then it for example will be three more cages at the terminal. They can sometimes get information about delayed trucks; but it is not organized by Schenker, it is more that they have created a relationship with the drivers. They have started a SMS group for all work leaders and drivers to which the driver can write if they are late. They do this to decrease the stress for the employees. They would like to have a board like on the airports where they can see directly who is late and so on. Often the same customer are sending parcels each

day so they know approximately how many parcels they will get in on the departing shift but not always.

### **Work environment**

The terminal manager said they have negative stress in periods. They have had problems in relation to Black-Friday last years. So then they needed to sit down and evaluate how to handle this the next years. They try to eliminate the negative stress since they can't rely on that workers will work like crazy. They try to do some proactive activities. They needed to work super-fast, but they couldn't manage to do everything in time anyhow. They even didn't have room in the terminal for everything so they needed to move parcels into another building. On an ordinary day, it is easy to meet the production demands on them. The work load for the workers is high and the manager thinks it should be even and high, they don't want it to be too low since that will also create concerns for the work leaders and the workers and they will get bored. They try to even out the high and low workload.

The climate is a problem since the building is so big, so when it is cold it is really cold and during summer it is warm. On the winter they need to wear a jacket. On the summer when it is warm they can't remove clothes. The manager thinks that the workers mostly are motivated to go to work each day and they have chosen to work there. So the manager tries to help others who aren't so motivated to find their motivation. They try to have a communication to find out if they can help them in any way, by switching work task or shift and so on. The manager thinks that the workers are both physical and mentally tired after a day at the parcel sorting conveyor. It is hard to work at the parcel sorting conveyor, it is high work load and you have heavy lifts.

### **Other**

According to the terminal manager a good working day is when it has been a high and even workload because then they think the workers feel the best. You should be able to take breaks but also go home and feel good. The manager said that they miss girls to have a good gender distribution, the manager thinks it is hard to get girls. The manager thinks it is due to that the lifts are heavy. Also when it is many men, you nearly need to hire girls in a lump so they get a good social sustainability. They try to work with the culture it should not be a hard boys' culture. They want to have a mix with age, ethnicity, gender and so on. The employee turnover rate is not so high, the manager was a bit surprised when he/she started, it is about 17-20% in the production which is good. The manager also said that many persons who quit, come back a few years later. The terminal manager thinks it can be hard to get the employees involved. The manager thinks that maybe we need to change the view that you can't have the same work until you are 70. Maybe you need to switch jobs during your life. It is a big challenge. The manager thinks it is hard to get the right personnel so you need to take care of the elder and accept that they can't work as fast as a 20 year old. They really want to have a mix.

### **B.3.6 Interview 3.6**

Interview with terminal manager

#### **Background**

The interviewee is a terminal and Codi manager. The manager has been so for eight years. The interviewee started as the terminal manager directly. Before he/she worked at the port and also 16 years at Volvo. So his/her working time is quite short time compared to others at DB Schenker. The manager said that it can be good but of course also a risk to be at a company for so long time. The interviewee is 50 years old. What the manager likes with DB Schenker is that it is high competition within the sector, so you need to all the time think about the customer which make you focused and you need to think new all the time.

#### **The working day**

The terminal manager said that the working days are very varied. It is a lot of production to follow up so the manager looks at all production reports. The manager looks at different specific customer flows. Then the manager has meetings and if he/she has time, the manager goes out in the production. The interviewee thinks it is easier and more structured for the workers. They follow their times. There is some rotation between the shifts but mostly you are on one shift. The manager would like them to rotate more on the morning as well. They rotate within the shift so one time on departing and two times at the arrival shift.

The lifting help they have are the cage-lifters, on the big parcel shipments they have a vacuum-lifter. On the straight conveyor belt they have a lifting table and a vacuum lifter. They started with a lift table since they thought it was good, they didn't ask the personnel about it. They knew that the workers needed to have some lifting help. The manager thinks that the personnel wants to have some help to improve the ergonomics. They have first now found a good lifting table.

#### **Ugly-parcel handling**

The parcel they can't handle, are those longer than 140 cm. The weight should be under 30 kilograms. Before the sorting was done with a HDT and they sorted out the parcels manually as they do at night shift now. The manager thinks the night should start to use the straight conveyor belt as well. A problem is that on the departing shift it is easier to transfer whole cages to the straight conveyor belt, but at the arriving shift, the Ugly-parcels are usually mixed in the parcel-cages. You sort out about 8-10%. They have nearly the same amount on the departing and the arrival shift. They have problems with the bags as well since they weigh less than one kilogram so the turning table which should put the parcels down on the right outline can't take them, so they just continues. On the departing shift you are usually in the Ugly-parcel handling one time each shift. Most of the personnel can handle to stand on the ugly-parcel handling. The manager thinks that the straight conveyor belt affects the ordinary flow positive since they directly can sort them out from the flow.

#### **Physical ergonomics**

The terminal manager doesn't think they have any work related injuries which they can relate to the parcel line. But of course they have had some incidents but not many. The manager doesn't think the workers complain much about pain. They have done KIM I analysis on the whole sorting and the manager thinks they are red on the outlines so they try to rotate more on those. The inline station and the forklift driving is green and the straight conveyor belt is yellow. The manager thinks that the high lifts on the outlines are bad. They have looked on the medium weight on the parcels so they haven't analysed the highest load.

### **Cognitive ergonomics**

The manager doesn't think the parcel handling is mentally demanding. You need to think a bit more on the no-read, but it is not much you need to think. The terminal manager doesn't think it is a lot of noise in the terminal. The manager thinks you can manage to read the signs if you need to. On the arrival shift it is more to sort, so you need to remember more there. It is easy to do errors, you need to trust the people. The manager thinks they don't have so much errors though. The interviewee thinks they have it as clear as they can. But at the departing shift, the manager thinks it is easy to put the parcel right. The terminal manager thinks there are few errors which comes to the customer, they notice the errors at the arrival shift. They can see how many parcel-cages that should come at the arrival shift. They can't see anything about the volume on the departing shift, only if a customer has a campaign or a sale. They don't have any standardized work or work instructions but they get some help from the computer that tells you what is wrong with the parcel when you scan it.

### **Work environment**

The terminal workers can on the daily meetings affect the work and the routines. Also on the monthly meetings they can affect it. On these meetings they go through improvement suggestions. During the ordinary production they should follow the schedule that is done so it is very controlled for them. The terminal manager experience that they get many suggestions. The workload for the terminal workers is high in peaks 17:00-20:00 but before and after is it lower. If the trucks arrive in time and the parcel sorting conveyor are working, they manage to do the work, but if something goes wrong they can't manage in time. They don't have any room for disturbances. The terminal manager thinks the climate is good in the terminal. They have heating and they have good isolation which helps in the winter. It should not be over 25 or under 12 degrees so that is measured. They also have new air cleaners at the terminal which helps with the dust. The interviewee thinks that the workers are physical tired but they are moderate tired so it is fine. The manager said it is a physical job so of course you are bit tired but it should be moderate. They are careful with pauses and breaks. They have a break during the afternoon which many others don't have and this helps them a lot.

### **Other**

For the terminal manager, is a good working day when the trucks have arrived in time and everything have gone out in time. Also if they have an even flow with the

parcels that comes in and the volume is according to prognosis. If everything flows, they perform well, but they have more problems if they have disturbances. The age distribution is good if you look on the whole terminal, people from 20-65 years old, but it is quite unbalanced between the departments, too high on the long/heavy groupage department and too low on the departing shift for parcels. The ethical background is also mixed. The manager is not happy with the gender distribution, it is 90-10 in distribution and in the personnel pool it is 60-40. They try to prioritize to get in more women. The manager wants to have mixed groups since they are performing better. It is a longer start time but the result is usually better in the end. They try to work with the culture and that everyone should be able to handle their work. The personnel turnover rate is low.

Another thing that the terminal manager wanted to say was that the manager doesn't think the parcel sorting conveyors are adapted after the parcel agent parcels explosion which they have had the recent years. So they are a bit behind on this part. If they should grow in parcels, they should think about a another setup for the parcel sorting conveyors. The volume has increased so much. The business customers are more careful when they pack their parcels, but the direct private customer can send more strange parcels which are worse to handle. The parcel sorting conveyor is very sensitive.

### **B.3.7 Interview 3.7**

Interview with terminal manager. This interview was done over the phone since the terminal manager didn't have time to sit down during the terminal visit.

#### **Background**

The interviewee is the terminal manager and Codi manager and has been so since May 2019. The interviewee has been at DB Schenker for two years in total and before worked with operational excellence. The interviewee is 30 years old.

#### **The working day**

The terminal manager has meetings and follow up static planning. The manager also answers many emails and take care of the personnel. The personnel starts at 11:30 with a customer specific sorting. They start with the parcel sorting at 13:30 and continues with it until 19:30 as latest. At the night shift, they start 22:00, some 23:30 and some 00:30. They start the parcel sorting at about 00:00 and sort until latest 06:00. On the departing shift they have good rotation, but at the night shift they don't have as much rotation. They are trying to take the parcel personnel to the groupage handling as well. Unfortunately, at the night shift, some are always at the parcel sorting. The workers don't have any lifting aids. Before they had an ergonomic education, but they don't have that now.

#### **Ugly-parcel handling**

The terminal doesn't have any parcels within the product terms which they can't handle on the parcel sorting conveyor.

**Physical ergonomics**

The terminal manager doesn't think there is any workers that have physical damages from their work. The manager thinks that the risky tasks are when you don't use the forklift to lift up the parcel-cages at the inline station. The manager thinks it is not used since it will go faster to do the work if you don't use it. The manager said that they didn't have room for any cage-lifter so they need to use the forklift as lifting help instead. A problem is that sometimes you don't even have room to use the forklift.

**Cognitive ergonomics**

The terminal manager said that the sorting is mentally demanding and you need to focus on putting the parcels in the right cage. On the inline station you also need to know what to do if the computer stops. They have recently put up a sign there which tells the personnel what to do when the computer alarms, so that all personnel can stand there. The interviewee thinks it is easy to read the information in the terminal. There would be good with the signs on digital screens but that is expensive. It would be more flexible for them when signs are changed. When you should switch the signs, you need to be two to do that and it takes some time.

The terminal manager said that the trucks in the terminal is pretty noisy, it is an environment where it is never is quite. The manager thinks it is okay. The manager doesn't know how to get it better. The manager said that you should be able to read the sign on the departing shift within the right time, but on the arrival shift it is more complex and many more sorting concepts. On the night shift they have about 50-60 sorting concepts, so that is more complex. Then you need to know more of them by heart. The manager said they have signs about how to sort. They have A3 signs which they put up. The manager thinks it is easy to do errors since the sorting is done manually so errors can occur. On the departing shift they can't see anything about which volume that is expected. On the arrival they can see how many cages they should get, but it doesn't say much about how many parcel there are. But they know the historical data. They have routines to follow but they don't have any fixed standards.

**Work environment**

The terminal manager said that the personnel can't affect the sorting much, but they like to take in improvement suggestions regarding other things if they have any. But they are not getting many suggestions. They don't think so much about how they should improve. They have lean meetings where you either can write or say the suggestions. The manager tries to be present to support the personnel. The manager is mostly there under the day but tries to be there some nights as well, at least once each month. Many of the night workers quit at eight in the morning so the manager can meet them in the morning as well. The manager said that they have some high peaks in the workload where they have harder to meet the performance requirements, but normal they finish all the sorting in time. They are much depending on whether the trucks arrive in time. If they are late, that will affect the

production. The manager thinks it is a medium to high work load. It varies a lot.

The manager thinks that the personnel feel a good job security, at least the manager hopes so. The manager tries to be open with the results and how the company are performing. The climate in the terminal is a bit cold in the winter but they have better work clothes now than before. They can miss the daylight. They have some dust in the terminal, but they now have much more cleaning which helps them. They are buying the cleaning service now instead and the manager thinks the cleaning works better since then. The parcel sorting conveyor is a bit more dusty than the groupage handling. The terminal manager thinks it is easy to prioritise away the cleaning, so it is better that someone else is doing it. The personnel should focus on being a terminal worker. But of course, they have an own responsibility to keep it decent. The manager thinks that the general thoughts about the work is very mixed between the worker. The interviewee thinks that it also is mixed if they are mentally or physical tired. The terminal manager thinks you need to know many parts of the handling in the terminal since they are so few workers.

### **Other**

According to the terminal manager it is hard to say what a good working day is since the manager doesn't work so close to the parcel handling. But for the manager a good day is if the team leaders feel satisfied and they feel calm and not stress and you manage all you need in time. The terminal manager thinks that the gender distribution could have been better in the terminal, there are a lot of men, 4 ladies in the day. At the night there are only men. The age distribution is better, they have some young and some elder. They have about 10-15% temporary workers on day shift and 30% on night shift. They have some turnover rate for the night shift, but otherwise it is pretty stable. They have had more in the office, they have had three terminal managers in two years. The terminal manager would like to have a new parcel sorting conveyor with more outlines, they are trying to do a demand for this. Their current parcel sorting conveyor is adapted for about 5000 parcels each day and they have today about 6000 at night shift, and the parcel agent parcels are increasing. They want to have the security and work environment high when they take in new personnel.

# C

## Appendix

### ASSESSMENT OF MANUAL HANDLING TASKS BASED ON KEY INDICATORS Version 2001

Where there are a number of individual activities with considerable physical strains, they must be estimated separately.

Workplace/Activity:





#### 1<sup>st</sup> step: Determination of time rating points (Select only one column !)

Lifting or displacement operations (< 5 s)		Holding (> 5 s)		Carrying (> 5 m)	
Number on working day	Time rating points	Total duration on working day	Time rating points	Overall length on working day	Time rating points
< 10	1	< 5 min	1	< 300 m	1
10 to < 40	2	5 to 15 min	2	300 m to < 1 km	2
40 to < 200	4	15 min to < 1 hr	4	1 km to < 4 km	4
200 to < 500	6	1 hrs to < 2 hrs	6	4 to < 8 km	6
500 to < 1000	8	2 hrs to < 4 hrs	8	8 to < 16 km	8
≥ 1000	10	≥ 4 hrs	10	≥ 16 km	10
<i>Examples:</i> • laying bricks, • placing workpieces into a machine • taking boxes out of a container and putting them onto a conveyor belt		<i>Examples:</i> • holding and guiding a cast iron slug while working on a wheel stand, • operating a hand grinding machine, • operating a weed-eater		<i>Examples:</i> • furniture removal, • delivering scaffolding parts to a building site	

#### 2<sup>nd</sup> step: Determination of rating points of load, posture and working conditions

Effective load <sup>1)</sup> for men	Load rating point	Effective load <sup>1)</sup> for women	Load rating point
< 10 kg	1	< 5 kg	1
10 to < 20 kg	2	5 to < 10 kg	2
20 to < 30 kg	4	10 to < 15 kg	4
30 to < 40 kg	7	15 to < 25 kg	7
≥ 40 kg	25	≥ 25 kg	25

1) „Effective load“ means in this context the real action force which is necessary for moving load. This action force does not correspond to the load mass in each case. When tilting a carton, only 50 % of the load mass will have an effect on worker and when using a cart only 10 %.

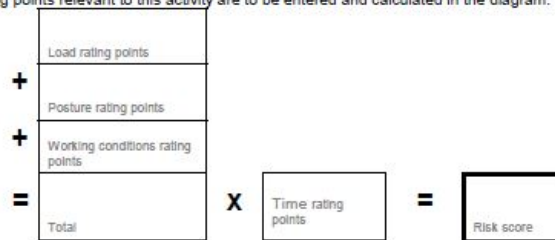
Typical posture, position of load <sup>2)</sup>	Posture, position of load	Posture rating point
	<ul style="list-style-type: none"> <li>• Upper body upright, not twisted</li> <li>• When lifting, holding, carrying und lowering the load is close to body</li> </ul>	1
	<ul style="list-style-type: none"> <li>• Slightly bending forward or twisting the trunk</li> <li>• When lifting, holding, carrying und lowering load is near to medium to body</li> </ul>	2
	<ul style="list-style-type: none"> <li>• Low bending or far bending forward</li> <li>• Slightly bending forward with simultaneous twisting of trunk</li> <li>• Load far from the body or above shoulder height</li> </ul>	4
	<ul style="list-style-type: none"> <li>• Bending far forward with simultaneous twisting of trunk</li> <li>• Load far from body</li> <li>• Restricted stability of posture when standing</li> <li>• Crouching or kneeling</li> </ul>	8

2) To determine the posture rating points the typical posture during manual handling must be used. For example when there are different postures with load a mean value must be used – not occasional extreme values.

Working conditions	Working conditions rating point
Good ergonomic conditions, e.g. sufficient space, no physical obstacles within the workspace, even level and solid flooring, sufficient lighting, good gripping conditions	0
Space for movement restricted and unfavourable ergonomic conditions (e.g. 1: space for movement restricted by too low high or working area less than 1,5 m <sup>2</sup> or 2: posture stability impaired by uneven floor or soft ground)	1
Strongly restricted space of movement and/or instability of centre of gravity of load (e.g. transfer of patients)	2

**3<sup>rd</sup> step: Evaluation**

The rating points relevant to this activity are to be entered and calculated in the diagram.



On the basis of the rating calculated and the table below it is possible to make a rough evaluation. <sup>3)</sup> Regardless of this provisions of the Maternity Leave Act apply.

Risk range	Risk score	Description
1	< 10	Low load situation, physical overload unlikely to appear.
2	10 bis < 25	Increased load situation, physical overload is possible for less resilient persons <sup>4)</sup> . For that group redesign of workplace is helpful.
3	25 bis < 50	Highly increased load situation, physical overload also possible for normal persons. Redesign of the workplace is recommended.
4	≥ 50	High load situation, physical overload is likely to appear. Workplace redesign is necessary <sup>5)</sup> .

<sup>3)</sup> Basically it must be assumed that as the number of point rating rises, so the risk of overloading the muscular-skeletal system increases. The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an orientation aid. More exact analyses require specialist ergonomic knowledge.

<sup>4)</sup> Less resilient persons in this context are persons older than 40 or younger than 21 years, newcomers in the job or people suffering from illness.

<sup>5)</sup> Design requirements can be determined with reference to the number of point in the table. By reducing the weight, improving the execution conditions or shortening the strain time, elevated stress can be avoided.

Check of the workplace necessary for other reasons:

Reasons: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Date of assessment: \_\_\_\_\_ Assessed by: \_\_\_\_\_

**Key indicator method for assessing physical workload during manual handling operations**

If a number of different tasks are performed within one one working day, they must be recorded separately.


task

Version 2012




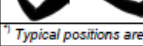
**1st step: Determination of time rating points**

<b>Total duration of this activity per shift [up to ... hours]</b>	1	2	3	4	5	6	7	8	9	10
<b>Time rating points</b>	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5

**2nd step: Determination of the rating points for the type of force exertion, gripping conditions, work organisation, working conditions, posture and hand/arm position and movement**

Type of force exertion(s) in the finger-hand area		Holding				Moving					
		average holding time [secs per minute]				average movement frequencies [number per minute]					
		60-31	30-16	15-4	<4	<1	1-4	5-15	16-30	31-60	>60
<b>Level</b>	<b>Description, typical examples</b>	<b>Rating points</b>									
 low Very low forces e.g. button actuation / shifting / ordering Low forces e.g. material guidance / insertion Moderate forces e.g. gripping / joining small work pieces by hand or with small tools High forces e.g. turning / winding / packaging / grasping / holding or joining parts / pressing in / cutting/ Working with small powered hand tools Very high forces e.g. cutting involving major element of force / working with small staple guns / moving or holding parts or tools Peak forces e.g. tightening, loosening bolts / separating / pressing in Hitting with ball of the thumb, palm of the hand or fist high		2	1	0.5	0	0	0.5	1	2	3	
		3	1.5	1	0	0	1	1.5	3	5	
		5	2	1	0	0.5	1	2	5	8	
		8	4	2	0.5	1	2	4	8	13	
		12	6	3	1	1	3	6	12	21	
		19	9	4	1	2	4	9	19	33	
	-	-	-	1	1	3	6	12	21		
The work cycle must be observed and the rating points for the force categories marked. Added together (left and right hands separately) these produce the force rating point. To calculate the total point rating values the higher figure must be used.		<b>Rating points of force exertion:</b>						<b>Left hand:</b>	<b>Right hand:</b>		

Force transfer / Gripping conditions	Rating points
<b>Optimum force transfer/application</b> / working objects are easy to grip (e.g. bar-shaped, gripping grooves) / good ergonomic gripping design (grips, buttons, tools)	0
<b>Restricted force transfer/application</b> / greater holding forces required / no shaped grips	2
<b>Force transfer/application considerably hindered</b> / working objects hardly possible to grip (slippery, soft, sharp edges) / no grips or only unsuitable ones	4





Hand/arm position and movement <sup>1)</sup>	Rating points
 <b>Good:</b> position or movements of joints in the medium (relaxed) range / only rare deviations	0
 <b>Restricted:</b> occasional positions or movements of the joints at the limit of the movement ranges	1
 <b>Unfavourable:</b> frequent positions or movements of the joints at the limit of the movement ranges	2
 <b>Poor:</b> constant positions or movements of the joints at the limit of the movement ranges / enduring static holding of the arms without hand-arm support	3

<sup>1)</sup> Typical positions are to be considered. Rare deviations can be ignored.

Work organisation	Rating points
<b>Frequent variation of load situation</b> due to other activities / a number of work operations / adequate opportunity for recuperation	0
<b>Rare variation of load situation</b> due to other activities / few work operations / recuperation times adequate	1
<b>No/hardly any variation of load situation</b> due to other activities / few single movements per operation / high working rate due to high line balancing and/or high piece-work output / uneven work sequence with concurrent high load peaks / too little or too short recuperation times	2

Features not mentioned in the table are to be taken into account accordingly.

## C. Appendix

Working conditions		Rating points
Good: reliable recognition of detail / no dazzle / good climatic conditions		0
Restricted: impaired detail recognition due to dazzle or excessively small details / draughts / cold / wet / disturbed concentration due to noise		1
<i>Features not mentioned in the table are to be taken into account accordingly. Under highly unfavourable conditions rating point 2 can be assigned.</i>		
Posture <sup>*)</sup>		Rating points
	Good: alternation of sitting and standing is possible / alternation of standing and walking / dynamic sitting is possible / hand-arm rest possible as required / no twisting / head posture variable / no gripping above shoulder height	0
	Restricted: trunk with slight inclination of the body towards the area of action / predominant sitting with occasional standing or walking / occasional gripping above shoulder height	1
	Unfavourable: trunk clearly inclined forward and/or twisted / head posture for detail recognition specified / restricted freedom of movement / exclusive standing without walking / frequent gripping above shoulder height / frequent gripping at a distance from the body	3
	Poor: trunk severely twisted and inclined forward / body posture strictly fixed / visual check of action through magnifying glasses or microscopes / severe inclination or twisting of the head / frequent bending / constant gripping above shoulder height / constant gripping at a distance from the body	5
<sup>*)</sup> Typical postures are to be taken into account. Rare deviations can be ignored.		

### 3rd step: Evaluation

Enter the rating points applicable for the activities and calculate the risk score in the diagram.

	Type of force exertion(s) in the finger-hand range				
+	Force transfer/gripping conditions				
+	Hand/arm position and movement				
+	Work organisation				
+	Working conditions				
+	Posture				
=	<b>Total</b>			X	Time rating points
				=	<b>Risk score</b>

On the basis of the risk score calculated and the table below it is possible to make a rough evaluation.

Risk range <sup>***)</sup>	Risk score	Description
1	<10	Low load situation, health risk from physical overload is unlikely to appear.
2	10 to <25	Moderate load situation, physical overload is possible for less resilient persons. For this group redesign of workplace is helpful.
3	25 to <50	Increased load situation, physical overload also possible for normally resilient persons. Redesign of workplace should be reviewed.
4	≥50	High load situation, physical overload is likely to appear. Workplace redesign is necessary.

<sup>\*)</sup> The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an orientation aid. Basically it must be assumed that as the number of risk scores rises, so the risk of overloading the muscular-skeletal system increases.

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# D

## Appendix

### Key indicator method for assessing physical workload during manual handling operations

If a number of different tasks are performed within one working day, they must be recorded separately.

task

TERMINAL A

Version 2012





#### 1st step: Determination of time rating points

Total duration of this activity per shift (up to ... hours)	1	2	3	4	5	6	7	8	9	10
Time rating points	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5

#### 2nd step: Determination of the rating points for the type of force exertion, gripping conditions, work organisation, working conditions, posture and hand/arm position and movement

Type of force exertion(s) in the finger-hand area		Holding				Moving					
		average holding time [secs per minute]				average movement frequencies [number per minute]					
		60-31	30-16	15-4	<4	<1	1-4	5-15	16-30	31-60	>60
		Rating points									
low	Very low forces e.g. button actuation / shifting / ordering	2	1	0.5	0	0	0.5	1	2	3	
	Low forces e.g. material guidance / insertion	3	1.5	1	0	0	1	1.5	3	5	
	Moderate forces e.g. gripping / joining small work pieces by hand or with small tools	5	2	1	0	0.5	1	2	5	8	
	High forces e.g. turning / winding / packaging / grasping / holding or joining parts / pressing in / cutting / Working with small powered hand tools	8	4	2	0.5	1	2	4	8	13	
	Very high forces e.g. cutting involving major element of force / working with small staple guns / moving or holding parts or tools	12	6	3	1	1	3	6	12	21	
	Peak forces e.g. tightening, loosening bolts / separating / pressing in	19	9	4	1	2	4	9	19	33	
high	Hitting with ball of the thumb, palm of the hand or fist	-	-	-	1	1	3	6	12	21	
The work cycle must be observed and the rating points for the force categories marked. Added together (left and right hands separately) these produce the force rating point. To calculate the total point rating values the higher figure must be used.		Rating points of force exertion:					Left hand: 6		Right hand: 6		

Force transfer / Gripping conditions	Rating points
Optimum force transfer/application / working objects are easy to grip (e.g. bar-shaped, gripping grooves) / good ergonomic gripping design (grips, buttons, tools)	0
Restricted force transfer/application / greater holding forces required / no shaped grips	2
Force transfer/application considerably hindered / working objects hardly possible to grip (slippery, soft, sharp edges) / no grips or only unsuitable ones	4





Hand/arm position and movement <sup>*)</sup>	Rating points
 Good: position or movements of joints in the medium (relaxed) range / only rare deviations	0
 Restricted: occasional positions or movements of the joints at the limit of the movement ranges	1
 Unfavourable: frequent positions or movements of the joints at the limit of the movement ranges	2
 Poor: constant positions or movements of the joints at the limit of the movement ranges / enduring static holding of the arms without hand-arm support	3

<sup>\*)</sup> Typical positions are to be considered. Rare deviations can be ignored.

Work organisation	Rating points
Frequent variation of load situation due to other activities / a number of work operations / adequate opportunity for recuperation	0
Rare variation of load situation due to other activities / few work operations / recuperation times adequate	1
No/hardly any variation of load situation due to other activities / few single movements per operation / high working rate due to high line balancing and/or high piece-work output / uneven work sequence with concurrent high load peaks / too little or too short recuperation times	2

Features not mentioned in the table are to be taken into account accordingly.

## D. Appendix

Working conditions		Rating points
<b>Good:</b> reliable recognition of detail / no dazzle / good climatic conditions		0
<b>Restricted:</b> impaired detail recognition due to dazzle or excessively small details / draughts / cold / wet / disturbed concentration due to noise		1
<i>Features not mentioned in the table are to be taken into account accordingly. Under highly unfavourable conditions rating point 2 can be assigned.</i>		
Posture <sup>*)</sup>		Rating points
	<b>Good:</b> alternation of sitting and standing is possible / alternation of standing and walking / dynamic sitting is possible / hand-arm rest possible as required / no twisting / head posture variable / no gripping above shoulder height	0
	<b>Restricted:</b> trunk with slight inclination of the body towards the area of action / predominant sitting with occasional standing or walking / occasional gripping above shoulder height	1
	<b>Unfavourable:</b> trunk clearly inclined forward and/or twisted / head posture for detail recognition specified / restricted freedom of movement / exclusive standing without walking / frequent gripping above shoulder height / frequent gripping at a distance from the body	3
	<b>Poor:</b> trunk severely twisted and inclined forward / body posture strictly fixed / visual check of action through magnifying glasses or microscopes / severe inclination or twisting of the head / frequent bending / constant gripping above shoulder height / constant gripping at a distance from the body	5
<sup>*)</sup> Typical postures are to be taken into account. Rare deviations can be ignored.		

### 3rd step: Evaluation

Enter the rating points applicable for the activities and calculate the risk score in the diagram.

	Type of force exertion(s) in the finger-hand range	6			
+	Force transfer/gripping conditions	2			
+	Hand/arm position and movement	1			
+	Work organisation	1			
+	Working conditions	1			
+	Posture	3			
=	<b>Total</b>	<b>14</b>	x	Time rating points <b>4</b>	= <b>56</b> Risk score

On the basis of the risk score calculated and the table below it is possible to make a rough evaluation.

Risk range <sup>***)</sup>	Risk score	Description
1	<10	Low load situation, health risk from physical overload is unlikely to appear.
2	10 to <25	Moderate load situation, physical overload is possible for less resilient persons. For this group redesign of workplace is helpful.
3	25 to <50	Increased load situation, physical overload also possible for normally resilient persons. Redesign of workplace should be reviewed.
4	≥50	High load situation, physical overload is likely to appear. Workplace redesign is necessary.

<sup>\*)</sup>The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an **orientation aid**. Basically it must be assumed that as the number of risk scores rises, so the risk of overloading the muscular-skeletal system increases.

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**Key indicator method for assessing physical workload during manual handling operations**

If a number of different tasks are performed within one one working day, they must be recorded separately.

task

**TERMINAL B**

Version 2012

**1st step: Determination of time rating points**





Total duration of this activity per shift (up to ... hours)	1	2	3	4	5	6	7	8	9	10
Time rating points	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5

**2nd step: Determination of the rating points for the type of force exertion, gripping conditions, work organisation, working conditions, posture and hand/arm position and movement**

Type of force exertion(s) in the finger-hand area		Holding				Moving						
		average holding time [secs per minute]				average movement frequencies [number per minute]						
Level	Description, typical examples	60-31	30-16	15-4	<4	<1	1-4	5-15	16-30	31-60	>60	
low	Very low forces e.g. button actuation / shifting / ordering	2	1	0.5	0	0	0.5	1	2	3		
	Low forces e.g. material guidance / insertion	3	1.5	1	0	0	1	1.5	3	5		
	Moderate forces e.g. gripping / joining small work pieces by hand or with small tools	5	2	1	0	0.5	1	2	5	8		
	High forces e.g. turning / winding / packaging / grasping / holding or joining parts / pressing in / cutting / Working with small powered hand tools	8	4	2	0.5	1	2	4	8	13		
	Very high forces e.g. cutting involving major element of force / working with small staple guns / moving or holding parts or tools	12	6	3	1	1	3	6	12	21		
high	Peak forces e.g. tightening, loosening bolts / separating / pressing in Hitting with ball of the thumb, palm of the hand or fist	19	9	4	1	2	4	9	19	33		
		-	-	-	1	1	3	6	12	21		
		Rating points of force exertion:						Left hand: 6	Right hand: 6			

The work cycle must be observed and the rating points for the force categories marked. Added together (left and right hands separately) these produce the force rating point. To calculate the total point rating values the higher figure must be used.





Force transfer / Gripping conditions	Rating points
Optimum force transfer/application / working objects are easy to grip (e.g. bar-shaped, gripping grooves) / good ergonomic gripping design (grips, buttons, tools)	0
Restricted force transfer/application / greater holding forces required / no shaped grips	2
Force transfer/application considerably hindered / working objects hardly possible to grip (slippery, soft, sharp edges) / no grips or only unsuitable ones	4

Hand/arm position and movement <sup>1)</sup>	Rating points
 Good: position or movements of joints in the medium (relaxed) range / only rare deviations	0
 Restricted: occasional positions or movements of the joints at the limit of the movement ranges	1
 Unfavourable: frequent positions or movements of the joints at the limit of the movement ranges	2
 Poor: constant positions or movements of the joints at the limit of the movement ranges / enduring static holding of the arms without hand-arm support	3

<sup>1)</sup> Typical positions are to be considered. Rare deviations can be ignored.

Work organisation	Rating points
Frequent variation of load situation due to other activities / a number of work operations / adequate opportunity for recuperation	0
Rare variation of load situation due to other activities / few work operations / recuperation times adequate	1
No/hardly any variation of load situation due to other activities / few single movements per operation / high working rate due to high line balancing and/or high piece-work output / uneven work sequence with concurrent high load peaks / too little or too short recuperation times	2

Features not mentioned in the table are to be taken into account accordingly.

Working conditions		Rating points
<b>Good:</b> reliable recognition of detail / no dazzle / good climatic conditions		0
<b>Restricted:</b> impaired detail recognition due to dazzle or excessively small details / draughts / cold / wet / disturbed concentration due to noise		1
<i>Features not mentioned in the table are to be taken into account accordingly. Under highly unfavourable conditions rating point 2 can be assigned.</i>		
Posture <sup>**) </sup>		Rating points
	<b>Good:</b> alternation of sitting and standing is possible / alternation of standing and walking / dynamic sitting is possible / hand-arm rest possible as required / no twisting / head posture variable / no gripping above shoulder height	0
	<b>Restricted:</b> trunk with slight inclination of the body towards the area of action / predominant sitting with occasional standing or walking / occasional gripping above shoulder height	1
	<b>Unfavourable:</b> trunk clearly inclined forward and/or twisted / head posture for detail recognition specified / restricted freedom of movement / exclusive standing without walking / frequent gripping above shoulder height / frequent gripping at a distance from the body	3
	<b>Poor:</b> trunk severely twisted and inclined forward / body posture strictly fixed / visual check of action through magnifying glasses or microscopes / severe inclination or twisting of the head / frequent bending / constant gripping above shoulder height / constant gripping at a distance from the body	5
<sup>**) Typical postures are to be taken into account. Rare deviations can be ignored.</sup>		

**3rd step: Evaluation**

Enter the rating points applicable for the activities and calculate the risk score in the diagram.

	Type of force exertion(s) in the finger-hand range	6			
+	Force transfer/gripping conditions	2			
+	Hand/arm position and movement	1			
+	Work organisation	1			
+	Working conditions	1			
+	Posture	3			
=	<b>Total</b>	<b>14</b>	x	Time rating points	1
			=	<b>14</b>	<b>Risk score</b>

On the basis of the risk score calculated and the table below it is possible to make a rough evaluation.

Risk range <sup>***)</sup>	Risk score	Description
1	<10	Low load situation, health risk from physical overload is unlikely to appear.
2	10 to <25	Moderate load situation, physical overload is possible for less resilient persons. For this group redesign of workplace is helpful.
3	25 to <50	Increased load situation, physical overload also possible for normally resilient persons. Redesign of workplace should be reviewed.
4	≥50	High load situation, physical overload is likely to appear. Workplace redesign is necessary.

<sup>\*) The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an **orientation aid**. Basically it must be assumed that as the number of risk scores rises, so the risk of overloading the muscular-skeletal system increases.</sup>

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**Key indicator method for assessing physical workload during manual handling operations**

If a number of different tasks are performed within one working day, they must be recorded separately.

task **TERMINAL C**

Version 2012

**1st step: Determination of time rating points**

Total duration of this activity per shift (up to ... hours)	1	2	3	4	5	6	7	8	9	10
Time rating points	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5

**2nd step: Determination of the rating points for the type of force exertion, gripping conditions, work organisation, working conditions, posture and hand/arm position and movement**

Type of force exertion(s) in the finger-hand area		Holding				Moving					
		average holding time [secs per minute]				average movement frequencies [number per minute]					
Level	Description, typical examples	60-31	30-16	15-4	<4	<1	1-4	5-15	16-30	31-60	>80
<p>low</p> <p>Very low forces e.g. button actuation / shifting / ordering</p> <p>Low forces e.g. material guidance / insertion</p> <p>Moderate forces e.g. gripping / joining small work pieces by hand or with small tools</p> <p>High forces e.g. turning / winding / packaging / grasping / holding or joining parts / pressing in / cutting / Working with small powered hand tools</p> <p>Very high forces e.g. cutting involving major element of force / working with small staple guns / moving or holding parts or tools</p> <p>Peak forces e.g. tightening, loosening bolts / separating / pressing in</p> <p>high</p>		2	1	0.5	0	0	0.5	1	2	3	
		3	1.5	1	0	0	1	1.5	3	5	
		5	2	1	0	0.5	1	2	5	8	
		8	4	2	0.5	1	2	4	8	13	
		12	6	3	1	1	3	6	12	21	
		19	9	4	1	2	4	9	19	33	
	-	-	-	1	1	3	6	12	21		
<p>The work cycle must be observed and the rating points for the force categories marked. Added together (left and right hands separately) these produce the force rating point. To calculate the total point rating values the higher figure must be used.</p>		Rating points of force exertion:		Left hand: 6		Right hand: 6					





Force transfer / Gripping conditions	Rating points
Optimum force transfer/application / working objects are easy to grip (e.g. bar-shaped, gripping grooves) / good ergonomic gripping design (grips, buttons, tools)	0
Restricted force transfer/application / greater holding forces required / no shaped grips	2
Force transfer/application considerably hindered / working objects hardly possible to grip (slippery, soft, sharp edges) / no grips or only unsuitable ones	4

Hand/arm position and movement <sup>1)</sup>	Rating points
<p>Good: position or movements of joints in the medium (relaxed) range / only rare deviations</p>	0
<p>Restricted: occasional positions or movements of the joints at the limit of the movement ranges</p>	1
<p>Unfavourable: frequent positions or movements of the joints at the limit of the movement ranges</p>	2
<p>Poor: constant positions or movements of the joints at the limit of the movement ranges / enduring static holding of the arms without hand-arm support</p>	3

<sup>1)</sup> Typical positions are to be considered. Rare deviations can be ignored.

Work organisation	Rating points
Frequent variation of load situation due to other activities / a number of work operations / adequate opportunity for recuperation	0
Rare variation of load situation due to other activities / few work operations / recuperation times adequate	1
No/hardly any variation of load situation due to other activities / few single movements per operation / high working rate due to high line balancing and/or high piece-work output / uneven work sequence with concurrent high load peaks / too little or too short recuperation times	2

Features not mentioned in the table are to be taken into account accordingly.

Working conditions		Rating points
Good: reliable recognition of detail / no dazzle / good climatic conditions		0
Restricted: impaired detail recognition due to dazzle or excessively small details / draughts / cold / wet / disturbed concentration due to noise		1
<i>Features not mentioned in the table are to be taken into account accordingly. Under highly unfavourable conditions rating point 2 can be assigned.</i>		
Posture <sup>*)</sup>		Rating points
	Good: alternation of sitting and standing is possible / alternation of standing and walking / dynamic sitting is possible / hand-arm rest possible as required / no twisting / head posture variable / no gripping above shoulder height	0
	Restricted: trunk with slight inclination of the body towards the area of action / predominant sitting with occasional standing or walking / occasional gripping above shoulder height	1
	Unfavourable: <u>trunk clearly inclined forward and/or twisted</u> / head posture for detail recognition specified / <u>restricted freedom of movement</u> / <u>exclusive standing without walking</u> / frequent gripping above shoulder height / frequent gripping at a distance from the body	3
	Poor: <u>trunk severely twisted and inclined forward</u> / body posture strictly fixed / visual check of action through magnifying glasses or microscopes / severe inclination or twisting of the head / <u>frequent bending</u> / constant gripping above shoulder height / constant gripping at a distance from the body	5

\*) Typical postures are to be taken into account. Rare deviations can be ignored.

**3rd step: Evaluation**

Enter the rating points applicable for the activities and calculate the risk score in the diagram.

	Type of force exertion(s) in the finger-hand range	6			
+	Force transfer/gripping conditions	2			
+	Hand/arm position and movement	1			
+	Work organisation	1			
+	Working conditions	1			
+	Posture	3			
=	<b>Total</b>	<b>14</b>	x	Time rating points	1
			=	<b>14</b>	<b>Risk score</b>

On the basis of the risk score calculated and the table below it is possible to make a rough evaluation.

Risk range <sup>****)</sup>	Risk score	Description
1	<10	Low load situation, health risk from physical overload is unlikely to appear.
2	10 to <25	Moderate load situation, physical overload is possible for less resilient persons. For this group redesign of workplace is helpful.
3	25 to <50	Increased load situation, physical overload also possible for normally resilient persons. Redesign of workplace should be reviewed.
4	≥50	High load situation, physical overload is likely to appear. Workplace redesign is necessary.

<sup>\*\*\*\*)</sup>The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an **orientation aid**. Basically it must be assumed that as the number of risk scores rises, so the risk of overloading the muscular-skeletal system increases.

**Key indicator method for assessing physical workload during manual handling operations**

If a number of different tasks are performed within one one working day, they must be recorded separately.

task

**TERMINAL D**

Version 2012





**1st step: Determination of time rating points**

Total duration of this activity per shift (up to ... hours)	1	2	3	4	5	6	7	8	9	10
Time rating points	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5

**2nd step: Determination of the rating points for the type of force exertion, gripping conditions, work organisation, working conditions, posture and hand/arm position and movement**

Type of force exertion(s) in the finger-hand area		Holding				Moving						
		average holding time [secs per minute]				average movement frequencies [number per minute]						
Level	Description, typical examples	80-31	30-16	15-4	<4	<1	1-4	5-15	16-30	31-60	>60	
		Rating points										
low	Very low forces e.g. button actuation / shifting / ordering	2	1	0.5	0	0	0.5	1	2	3		
	Low forces e.g. material guidance / insertion	3	1.5	1	0	0	1	1.5	3	5		
	Moderate forces e.g. gripping / joining small work pieces by hand or with small tools	5	2	1	0	0.5	1	2	5	8		
	High forces e.g. turning / winding / packaging / grasping / holding or joining parts / pressing in / cutting / Working with small powered hand tools	8	4	2	0.5	1	2	4	8	13		
	Very high forces e.g. cutting involving major element of force / working with small staple guns / moving or holding parts or tools	12	6	3	1	1	3	6	12	21		
	Peak forces e.g. tightening, loosening bolts / separating / pressing in	19	9	4	1	2	4	9	19	33		
high	Hitting with ball of the thumb, palm of the hand or fist	-	-	-	1	1	3	6	12	21		
The work cycle must be observed and the rating points for the force categories marked. Added together (left and right hands separately) these produce the force rating point. To calculate the total point rating values the higher figure must be used.		Rating points of force exertion:					Left hand: 6	Right hand: 6				

Force transfer / Gripping conditions	Rating points
Optimum force transfer/application / working objects are easy to grip (e.g. bar-shaped, gripping grooves) / good ergonomic gripping design (grips, buttons, tools)	0
Restricted force transfer/application / greater holding forces required / no shaped grips	2
Force transfer/application considerably hindered / working objects hardly possible to grip (slippery, soft, sharp edges) / no grips or only unsuitable ones	4





Hand/arm position and movement <sup>1)</sup>	Rating points
 Good: position or movements of joints in the medium (relaxed) range / only rare deviations	0
 Restricted: occasional positions or movements of the joints at the limit of the movement ranges	1
 Unfavourable: frequent positions or movements of the joints at the limit of the movement ranges	2
 Poor: constant positions or movements of the joints at the limit of the movement ranges / enduring static holding of the arms without hand-arm support	3

<sup>1)</sup> Typical positions are to be considered. Rare deviations can be ignored.

Work organisation	Rating points
Frequent variation of load situation due to other activities / a number of work operations / adequate opportunity for recuperation	0
Rare variation of load situation due to other activities / few work operations / recuperation times adequate	1
No/hardly any variation of load situation due to other activities / few single movements per operation / high working rate due to high line balancing and/or high piece-work output / uneven work sequence with concurrent high load peaks / too little or too short recuperation times	2

Features not mentioned in the table are to be taken into account accordingly.

## D. Appendix

Working conditions		Rating points
Good: reliable recognition of detail / no dazzle / good climatic conditions		0
Restricted: impaired detail recognition due to dazzle or excessively small details / draughts / cold / wet / disturbed concentration due to noise		1
<i>Features not mentioned in the table are to be taken into account accordingly. Under highly unfavourable conditions rating point 2 can be assigned.</i>		
Posture <sup>**)</sup>		Rating points
	Good: alternation of sitting and standing is possible / alternation of standing and walking / dynamic sitting is possible / hand-arm rest possible as required / no twisting / head posture variable / no gripping above shoulder height	0
	Restricted: trunk with slight inclination of the body towards the area of action / predominant sitting with occasional standing or walking / occasional gripping above shoulder height	1
	Unfavourable: <b>trunk clearly inclined forward and/or twisted</b> / head posture for detail recognition specified / <b>restricted freedom of movement</b> / <b>exclusive standing without walking</b> / frequent gripping above shoulder height / frequent gripping at a distance from the body	3
	Poor: <b>trunk severely twisted and inclined forward</b> / body posture strictly fixed / visual check of action through <b>magnifying glasses</b> or microscopes / severe inclination or twisting of the head / <b>frequent bending</b> / constant gripping above shoulder height / constant gripping at a distance from the body	5
<sup>**) Typical postures are to be taken into account. Rare deviations can be ignored.</sup>		

### 3rd step: Evaluation

Enter the rating points applicable for the activities and calculate the risk score in the diagram.

	Type of force exertion(s) in the finger-hand range	6			
+	Force transfer/gripping conditions	2			
+	Hand/arm position and movement	1			
+	Work organisation	1			
+	Working conditions	1			
+	Posture	3			
=	<b>Total</b>	<b>14</b>	x	Time rating points <b>4,5</b>	= <b>63</b> Risk score

On the basis of the risk score calculated and the table below it is possible to make a rough evaluation.

Risk range <sup>***)</sup>	Risk score	Description
1	<10	Low load situation, health risk from physical overload is unlikely to appear.
2	10 to <25	Moderate load situation, physical overload is possible for less resilient persons. For this group redesign of workplace is helpful.
3	25 to <50	Increased load situation, physical overload also possible for normally resilient persons. Redesign of workplace should be reviewed.
4	≥50	High load situation, physical overload is likely to appear. Workplace redesign is necessary.

<sup>\*) The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an **orientation aid**. Basically it must be assumed that as the number of risk scores rises, so the risk of overloading the muscular-skeletal system increases.</sup>

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**Key indicator method for assessing physical workload during manual handling operations**

If a number of different tasks are performed within one one working day, they must be recorded separately.

task **TERMINAL E**

Version 2012

**1st step: Determination of time rating points**

Total duration of this activity per shift [up to ... hours]	1	2	3	4	5	6	7	8	9	10
Time rating points	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5

**2nd step: Determination of the rating points for the type of force exertion, gripping conditions, work organisation, working conditions, posture and hand/arm position and movement**

Type of force exertion(s) in the finger-hand area		Holding				Moving					
		average holding time [secs per minute]				average movement frequencies [number per minute]					
Level	Description, typical examples	60-31	30-16	15-4	<4	<1	1-4	5-15	16-30	31-60	>60
<p>low</p> <p>high</p>		Very low forces e.g. button actuation / shifting / ordering	2	1	0.5	0	0	0.5	1	2	3
	Low forces e.g. material guidance / insertion	3	1.5	1	0	0	1	1.5	3	5	
	Moderate forces e.g. gripping / joining small work pieces by hand or with small tools	5	2	1	0	0.5	1	2	5	8	
	High forces e.g. turning / winding / packaging / grasping / holding or joining parts / pressing in / cutting/ Working with small powered hand tools	8	4	2	0.5	1	2	4	8	13	
	Very high forces e.g. cutting involving major element of force / working with small staple guns / moving or holding parts or tools	12	6	3	1	1	3	6	12	21	
	Peak forces e.g. tightening, loosening bolts / separating / pressing in	19	9	4	1	2	4	9	19	33	
	Hitting with ball of the thumb, palm of the hand or fist	-	-	-	1	1	3	6	12	21	
<p>The work cycle must be observed and the rating points for the force categories marked. Added together (left and right hands separately) these produce the force rating point. To calculate the total point rating values the higher figure must be used.</p>		Rating points of force exertion:				Left hand: 8		Right hand: 8			

Force transfer / Gripping conditions	Rating points
Optimum force transfer/application / working objects are easy to grip (e.g. bar-shaped, gripping grooves) / good ergonomic gripping design (grips, buttons, tools)	0
Restricted force transfer/application / greater holding forces required / no shaped grips	2
Force transfer/application considerably hindered / working objects hardly possible to grip (slippery, soft, sharp edges) / no grips or only unsuitable ones	4





Hand/arm position and movement <sup>1)</sup>	Rating points
<p>Good: position or movements of joints in the medium (relaxed) range / only rare deviations</p>	0
<p>Restricted: occasional positions or movements of the joints at the limit of the movement ranges</p>	1
<p>Unfavourable: frequent positions or movements of the joints at the limit of the movement ranges</p>	2
<p>Poor: constant positions or movements of the joints at the limit of the movement ranges / enduring static holding of the arms without hand-arm support</p>	3

<sup>1)</sup> Typical positions are to be considered. Rare deviations can be ignored.

Work organisation	Rating points
Frequent variation of load situation due to other activities / a number of work operations / adequate opportunity for recuperation	0
Rare variation of load situation due to other activities / few work operations / recuperation times adequate	1
No/hardly any variation of load situation due to other activities / few single movements per operation / high working rate due to high line balancing and/or high piece-work output / uneven work sequence with concurrent high load peaks / too little or too short recuperation times	2

Features not mentioned in the table are to be taken into account accordingly.

## D. Appendix

Working conditions		Rating points
Good: reliable recognition of detail / no dazzle / good climatic conditions		0
Restricted: impaired detail recognition due to dazzle or excessively small details / draughts / cold / wet / disturbed concentration due to noise		1
<i>Features not mentioned in the table are to be taken into account accordingly. Under highly unfavourable conditions rating point 2 can be assigned.</i>		
Posture **)		Rating points
	Good: alternation of sitting and standing is possible / alternation of standing and walking / dynamic sitting is possible / hand-arm rest possible as required / no twisting / head posture variable / no gripping above shoulder height	0
	Restricted: trunk with slight inclination of the body towards the area of action / predominant sitting with occasional standing or walking / occasional gripping above shoulder height	1
	Unfavourable: <u>trunk clearly inclined forward and/or twisted</u> / head posture for detail recognition specified / <u>restricted freedom of movement</u> exclusive standing <u>without walking</u> / frequent gripping above shoulder height / frequent gripping at a distance from the body	3
	Poor: <u>trunk severely twisted and inclined forward</u> / body posture strictly fixed / visual check of action through magnifying glasses or microscopes / severe inclination or twisting of the head / <u>frequent bending</u> / constant gripping above shoulder height / constant gripping at a distance from the body	5
<i>** Typical postures are to be taken into account. Rare deviations can be ignored.</i>		

### 3rd step: Evaluation

Enter the rating points applicable for the activities and calculate the risk score in the diagram.

	Type of force exertion(s) in the finger-hand range	8			
+	Force transfer/gripping conditions	2			
+	Hand/arm position and movement	1			
+	Work organisation	1			
+	Working conditions	1			
+	Posture	3			
=	<b>Total</b>	<b>16</b>	x	Time rating points <b>3</b>	= <b>48</b> Risk score

On the basis of the risk score calculated and the table below it is possible to make a rough evaluation.

Risk range ***)	Risk score	Description
1	<10	Low load situation, health risk from physical overload is unlikely to appear.
2	10 to <25	Moderate load situation, physical overload is possible for less resilient persons. For this group redesign of workplace is helpful.
3	25 to <50	Increased load situation, physical overload also possible for normally resilient persons. Redesign of workplace should be reviewed.
4	≥50	High load situation, physical overload is likely to appear. Workplace redesign is necessary.

*\*) The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an orientation aid. Basically it must be assumed that as the number of risk scores rises, so the risk of overloading the muscular-skeletal system increases.*

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