CHALMERS

Introducing Lean in Motor Carrier Firms through Continuous Improvements

Master's Thesis in Production Engineering

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CHALMERS UNIVERSITY OF TECHNOLOGY
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Abstract

Earlier research has used Lean principles, as shown successful in other industries, to identify and classify waste in carrier processes. A large potential for increased efficiency has been found.

The purpose of this report is to test if continuous improvement work (Kaizen), based on Lean philosophy, may be applied to motor carrier firms in order to reduce waste in the operational processes and to increase customer value. This is done by first proposing a framework for how to introduce continuous improvement work in motor carrier firms and then by testing the framework on a specific motor carrier firm. The assumption that systematic problem solving involving all employees can be used also in carrier firms will consequently be tested.

The framework has been developed through interviews, observations and data from carriers in Sweden and Switzerland. It consists of an assessment method, a visualization model which motivates for improvements and a framework for prioritizing different improvement alternatives. The framework is validated through practical improvement work in Sweden, with the aim to reduce waste, involving three pilot teams and a total of 15 drivers at a carrier firm.

The validation case successfully shows that cost-free improvements in carrier firms can be achieved through Kaizen, resulting in reduced waste and increased customer value. The improvement also resulted in increased employee satisfaction through better communication and understanding and reduced environmental impact from the transportations.

This report contribute with a framework for how to start continuous improvement work in carrier firms along with proof that improvements can be achieved through simple problem solving and visualization. The authors hope that this will inspire to similar and long term work in other carrier firms. The main focus in this report is on internal organizational aspects, such as standardized work and stable processes; not on lean logistics or supply chain management.

Keywords: Motor Carrier, Lean, Continuous Improvements, Kaizen

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List of Abbreviations

Abbreviation	Explanation
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CHRO	Chief Human Resources Officer
CM	Change Management
KPI	Key Performance Indicator
LSP	Logistics Service Provider
LWA	Larsson Westerberg Assessment
POR	Point of Recognition
SCM	Supply Chain Management
TPM	Total Productive Maintenance
TPS	Toyota Production System
TQM	Total Quality Management
VSM	Value Stream Mapping

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Erik Allenström, Malin Linger

1 Introduction

Applying Lean in motor carrier firms has not to a large extent been explored and tested before. In this chapter the background to and motivation for this master's thesis is given. In order to find a way into this research area the problem area is defined more closely and two research questions are formulated and presented. The chapter is concluded with a section describing Volvo Technology, which together with Chalmers University of Technology has initiated this research.

1.1 Background and motivation of thesis

Motor carrier services, also referred to as road hauler or trucking services, have today become an integrated part of the society (McKinnon, 1995). A large part of all goods transportation is carried out on the roads. In Sweden, motor carriage account for over 80% of the domestic transportation and is completely dominant in short and medium distance transportation (Swedish Association of Road Haulage Companies, 2008a).

The transport sector and especially the motor carrier industry has not to a large extent developed its way of operations over the last decades (Rask, 1984, Arnäs, 2007). Firms that operate in the same field of business tend to mimic each other which create homogeneity between firms (DiMaggio and Powell, 1983). Motor carrier firms have not developed in pace with their surrounding actors, and many of them face what has been described as structural poverty (Rask, 1984). In order to stand a chance on such a commoditized market as the transport market, the motor carrier firms need to increase their internal efficiency by developing certain skills, practices and routines, to gain competitive advantages. It is the usage of resources, including human resources and process routines that gives each firm its unique character and may lead to differences in competitive performance across an industry (Wernerfelt, 1984).

There is an ongoing trend in the motor carrier business towards firm growth. Small independent actors, often handling only one or a few trucks, are replaced by larger companies operating a greater number of trucks (Swedish Association of Road Haulage Companies, 2008a). A parallel trend is that deliveries tend to become smaller but more frequent which makes planning more complex and call for a more resourceful administration, even if the actual goods flow does not increase (Kanflo, 1999, Trappey et al., 2004, AlRifai, 2008). The two trends combined, larger companies and more complex planning, stress the importance of more effective and efficient internal processes. To realize the benefits from large scale operations, motor carriers need to develop their own processes along with their growth.

Motor carrier firms today typically show low profit margins (Karis and Dinwoodie, 2005, Marchington et al., 2003, U.S. Department of Transportation, 2008). They are also affected by many external factors outside their immediate control, such as national and international competition, fuel prices and political development with its following regulations. The costs for salaries and administration make up 45-65% of the motor carrier firms' total expenses (Swedish Association of Road Haulage Companies, 2008a). Therefore, any serious attempt to cut costs and increase profitability in motor firms must involve the operational activities. This involves both the distribution and administrational operations, as well as in the interaction between them.

Earlier research has clearly showed that the motor carrier industry to a high degree suffer from inefficiencies. Those inefficiencies are present in all parts of the organizations: from the administration and traffic control down to the actual distribution (Sternberg et al., 2008, U.S. Department of Transportation, 2008). Given the above facts it stands clear that there is a potential for operational improvements that can make motor carrier firms more profitable reducing costs and offer better service to their customers. What can be seen as an impossible paradox, to save money while improving customer service has been proved possible in the production industry

with the help of the Lean theories (Liker, 2004).

In an earlier master's thesis, Larsson and Westerberg (2009) developed a methodology to identify and measure inefficiencies in motor carrier firms in the form of Lean waste, by the Lean theory. Waste leads to increased costs, reduced service levels and lower process stability. The inefficiencies are costly also in an ecological sense, where poor planning result in unnecessary transportation which in turn increases the emission levels.

Identifying waste is the first step in any improvement initiative. The next step on the way to create an efficient motor carrier organization is to reduce the waste; a problem that this thesis will address. By adapting Lean tools that has already been shown powerful in other organizational settings, such as the production and healthcare industry, the intention is to develop a methodology to lead motor carrier organizations towards a more economically and environmentally sustainable position. Lean is sometimes defined as a systematic approach to continuous improvements, and this thesis aims at introducing the same philosophy to the motor carrier industry.

1.2 Problem area

Lean philosophy has successfully been adapted to several fields of business outisde the typical production environment, for instance service organizations (Swank, 2003), customer relations (Womack and Jones, 2005) and healthcare (Jacobsson, 2010). So far no known case of Lean implementation, in the sense of systematic continuous improvements, in motor carrier firms has been found by the authors. In research, adapting Lean philosophy to motor carrier firms is a relatively new field and the available research has mainly focused on identifying and classifying inefficiencies. These researches have however found a large potential for increased internal efficiency in motor carrier firms. Trying to adapt Lean in motor carrier firms in order to increase efficiency is of interest due to the large potential found in earlier research. Implementing Lean in an organization is however a long-term commitment and not even the company who was the original inspiration of Lean see themselves as fully learned (Liker, 2004). Therefore no attempt to fully implement Lean in a motor carrier firm will be made in this research, but it will be introduced and the outcome will be studied. Motor carrier firms have in general no tradition of working with continuous improvements involving all employees. The drivers often execute their work alone and team work involving the drivers are rare. The assumption that systematic problem solving involving all employees can be used also in motor carrier firms is therefore relevant to test. The focus on this study is how continuous improvement work may be adapted to motor carrier firms, and not on finding the optimal way to increase efficiency. The attempt is to learn more about the nature of motor carrier organizations and the authors do not see themselves as experts in the field of road distribution.

1.3 Purpose

The purpose of this report is to develop a method to explore and test if continuous improvement work (Kaizen), based on Lean philosophy, may be applied to motor carrier firms. This will done by first proposing a framework for how to introduce continuous improvement work in motor carrier firms and then by testing the framework on a specific motor carrier firm. The purpose of improving is to remove problems that prohibit the firm from doing what it wants to do; a problem is a gap between the current and the wanted situation (Jonassen, 2000, Ammerman, 1998). In Lean, problems are often made visible through the term waste (Liker, 2004).

1.4 Research questions

In order to create a more practical way to approach the purpose, two research questions are constructed to guide both the reader and the researchers through the process. Each research question is followed by a brief description and motivation. The research questions will work as the base for the proposed framework for introducing continuous improvement work in motor carrier firms.

RQ1: How can problems in a motor carrier firm be presented in order to motivate for improvement?

The purpose of presenting organizational problems is to establish a common understanding of the organization's situation and motivate for improvements. An assessment of a firms' operations is carried out with the purpose of finding waste and problems in its processes. The assessment is done by only a few individuals and they must be able to convey their findings to the rest of the organization in a clear and easily understood way. Research question one aims at proposing a model or methodology that can be used to fulfil this.

RQ2: How to decide in what order to reduce waste in a motor carrier firm?

When waste in a firms' operations is found and presented a decision has to be made about where to start the improvement work. It is not possible to start with all identified problem areas momentarily; hence there is a need to decide where to focus the efforts. Research question two aims at proposing a framework for deciding where to start the improvement work in a motor carrier firm.

1.5 Delimitations

The focus in this research is on internal organizational aspects, such as standardized work and stable processes; not on lean logistics or supply chain management. The research will not attempt to identify and deploy best-practice in motor carrier firms but to let the personnel themselves develop such practices based on the circumstances of their own firm.

1.6 Report disposition

The structure and disposition of this report is presented below in order to make it easier for the reader to know what to expect and where to find relevant information.

1. **Introduction**
   This chapter introduces and motivates for the conducted research. It also presents the problem area, purpose, research questions, limitations and the company initiated this master's thesis.

2. **Frame of reference**
   This chapter defines and describes the different concepts and methods used throughout this master's thesis.

3. **Research Method**
   This chapter introduces the research method used in this master's thesis and presents a discussion about the reliability, validity and objectivity of the research.

4. **Interview study**
   This chapter presents the outcome of the interview study conducted in this master's thesis.

5. **Analysis**
   This chapter presents the proposed frameworks for introducing continuous improvement work in motor hauler firms. The results from the research questions are presented and included in the complete framework.

6. **Validation**
   This chapter describes the test of the proposed framework on a real motor carrier firm in Sweden.

7. **Results**
   This chapter presents the outcome of the introduction of continuous improvement work from the validation chapter.

8. **Discussion**
   This chapter includes discussions regarding the following areas; the validation case method and results, if the improvements will sustain, the research questions, if lean is suitable for motor carriers and further research.

9. **Conclusions**
   This chapter presents the conclusions from this master's thesis.

1.7 Volvo Technology

Volvo Technology is the centre of innovation, research and development within the Volvo Group. The mission is to develop existing and future technology areas of high importance to Volvo. The customers include all Volvo Group companies, Volvo Cars and some selected suppliers. Volvo Technology participates in national and international research programmes, involving universities, research institutes and other companies. The competencies are many and include e.g. telemetric, ergonomics, logistics, combustion, electronics and mechanics.

One of Volvo Technology's missions is to secure the strategic concepts for the Volvo Group. Volvo Group is facing challenges and must like many other companies improve performance and continuous search for new markets and opportunities to gain higher profits from their business (Volvo Group, 2007).

Volvo Group has begun the journey from delivering stand-alone products to complete solutions. The intention by Volvo Group is to position itself in relation to its competitors and develop a closer relation to its customers. The master's thesis is a part of Volvo Groups intention to strengthen the understanding of the customer needs.

2 Frame of reference

In this chapter different concepts and tools used throughout this thesis are defined and described. The motor carrier industry with its actors and relations is described and the concepts of customer and value are defined in this context. Also the present economical and political situation for carrier firms in Sweden is summarized. Following is a summary of Lean Philosophy and the concepts borrowed in this thesis from this management theory are described. After this the different components and stages in the process of problem solving is defined and at last an assessment method for finding problems in carrier firms is described.

2.1 Motor Carrier

Everyone can relate to the motor carrier industry, also referred to as haulage or trucking, by simply looking at the streets around us seeing all the trucks delivering different kinds of goods. Before digging into the world of motor carrier operations it is important to take a step back to understand motor carriers in a larger context: what their purpose is, their environment and its actors.

2.1.1 Motor Carrier Companies' context

A term commonly used in this context is *supply chain management* (SCM). SCM can be defined as a broad term for the management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers (Harland, 1996). It spans over all movement and storage of raw materials, work-in-process, inventory and finished goods from point of origin to point of consumption.

Within supply chain management lays *logistics*. Logistics may be defined as *"that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements"* (CSCMP, 2010).

The term *distribution* is used for all activities involving the movement of goods from the point of production to the final point of sales and consumption (McKinnon, 1988). Distribution includes transportation, transshipment and warehouses services but also trade, wholesale and, in principle, retail (Hesse and Rodrigue, 2004). Those value adding activities often take place at and include receiving and shipping of fast-moving products in small quantities.

Transportation is the part of logistics and distribution that deals with the physical movement of goods from one point to another. Encyclopedia Britannica defines transportation as *"the movement of goods and persons from place to place and the various means by which such movement is accomplished"*.

2.1.2 The carrier environment

Simply put, a carrier company delivers goods from one place to another. This can be done in different ways involving different actors and ways of communication. Stefansson (2006) has constructed a three stage model for the logistics system that carrier companies act within.

Motor Carrier

The simplest type transport setup is the point-to-point service. The transport operator, the carrier company, ships products from one point (shipper) to another (receiver). This can be done either with a single stop at one receiver or with multiple stops at several receivers. The flows of

information and goods in this setup are show in Figure 2.1.

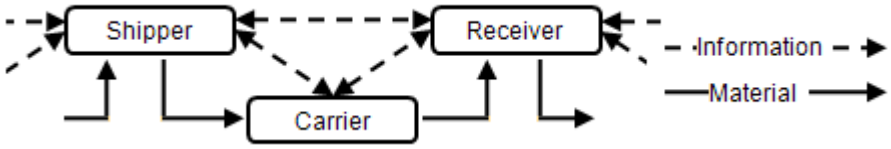


Figure 2.1: Relations in the point-to-point transport setup (Stefansson, 2006)

Logistics Service Provider

Another possible combination of actors in the setup of the transport operations from the shipper to the receiver is by using a Logistics Service Provider (LSP). They provide several additional services to the transportation, such as cross-docking at terminals or consolidation services at distribution centers, storage or integrated-logistics, and value-added services at warehouses and distribution centers (Cooper, 1994, Delfmann et al., 2002, Langley et al., 1999, Lieb et al., 1998, McFarlane and Sheffi, 2003, Sink et al., 1996). The shipper and receiver contact the LSP that in turn contact the carrier company that executes the actual transportation, as shown in Figure 2.2.

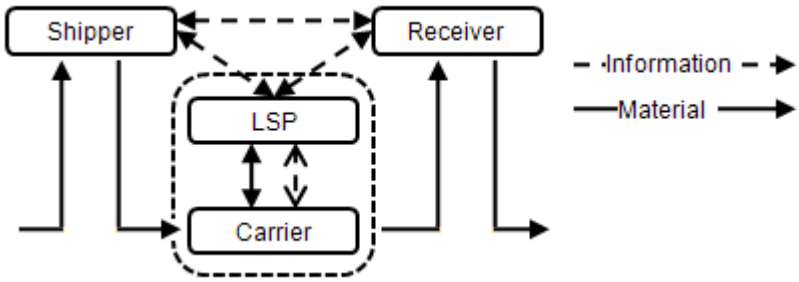


Figure 2.2: Relations in an LSP transport setup (Stefansson, 2006)

It is important to understand that the carrier firm environment contain many actors. Carrier firms play a small role in the logistics setup and must adjust to the demands of others.

2.1.3 Customers and value

The two concepts of customer and value have a tight relation. Bergman and Klefsjö (2003) discusses customer in terms of "the people or organizations that are the reason for our activities" or "those to whom we want to create value". In a traditional trade environment the customer is the one who order, pays for and uses a product or service. For a carrier firm the situation is complex and the definition of customer may be different depending on who you ask. It is seldom the same actor that both request, pay for and in the end use the services provided by the carrier. For example, an shipper may send a transport request to the carrier firm. The transportation is utilized by the reciever, but the LSP is the one actually transferring the money to the carrier firm's account. Depending on their role, different individuals in a carrier firm may define customers differently. The management team may consider the LSP to be the customer, since they often both order and pay for the services provided by the carrier firm, while a truck

driver may consider the receiver to be the customer since they are the ones that benefit from the actual transport.

Defining value in an organization is one of the basic principles of Lean (Womack and Jones, 1996) and a simple way to find out is by asking *"what does the [internal and external] customer want from this process?"* (Liker, 2004). For a carrier firm this is not always simple to answer, since they have several different customers. Coyle and Bardi (1994) defines value added by transportation and distribution as *"the creation of time and place utility"*. Place utility is the value that is added by moving goods from one geographical area to another, by making the goods available at the customers' physical address. Time utility is the value that is added to goods through storage and making it available at the time when the customer wants it. This kind of value is added through distribution and warehouse handling. Also soft aspects may be considered as value adding in the transport context; the shippers may value if the truck drivers give a good and professional impression at the receivers' site, since is the only regular physical connection point between the two actors.

Liker (2004) describes a philosophy where companies' decisions should aim towards, to an equal extent, benefiting the interest of four groups: customers, employees, community and company. This means that all decisions made need to take the interests of all groups into account when doing business and that focusing on value only to the customer and company is not enough in order to be successful.

2.1.4 Present situation for motor carrier companies

Carrier operations have increasingly been affected by intensified competition, shrinking profit margins (Brehmer, 1999, Swedish Association of Road Haulage Companies, 2008a), a changed market structure (Sheffi, 2005), increased customer preferences (Heikkilä, 2002) and security issues (Ekwall, 2009). As authorities are paying increasing interest to freight transport management in order to ensure environmental and societal sustainability, many carrier operators lack financial sustainability and are going out of business (U.S. Department of Transportation, 2008, Swedish Association of Road Haulage Companies, 2008a). These issues are by no means new and Rask (1984) discusses the concept of "structural poverty" - carrier operators running strategies leading to no or low profitability and running wasteful operations. The situation in other countries is similar, e.g. in the U.S. profit margin fell from 1,6% in 1987 to 1,2% in 2001 (Corsi, 2005). There is a current trend towards fewer and larger carrier companies (Swedish Association of Road Haulage Companies, 2008a) putting increased pressure on effective administrative processes in order to reap the benefits of larger organizations.

In a report from the Swedish Association of Road Haulage Companies (2008a) the cost structure for carrier firms is presented. Staff and diesel are the two largest cost drivers but vary depending on what kind of operations that carrier firms do, as shown in 2.1.

Expense	Local distribution	Long-distance distribution
Staff	55%	40%
Diesel	10%	28%
Tires	3%	3%
Repair and maintenance	5%	7%
Depreciation	10%	12%
Vehicle excise duty	2%	1%
Insurance	3%	2%
Interest	4%	3%
Other administration	10%	4%

Table 2.1: Cost distribution in Swedish carrier firms (Swedish Association of Road Haulage Companies, 2008b)

2.2 Lean Philosophy

The last decades the significant interest have been drawn to the management theories originating from the Japanese car manufacturer Toyota, often labeled Lean Production. Today the concept of Lean has evolved to other fields than production; hence Lean production is only a part of the whole concept. The following section describes the essence and foundation of the Lean concept and this foundation is what the researchers aim at introducing in carrier firms.

2.2.1 History and definition

The Lean philosophy was born in the production environment of physical goods and is based on an industrial concept developed in Japan during the 20th century. The car producer Toyota is often credited to be the founder of Lean Production through its Toyota Production System (TPS) which was developed in the Toyota organization after the Second World War (Shingo, 1989). The actual term Lean Production was invented by the western operations management scientists that studied the Japanese practice in the late 1980s, coined by Krafcik (1988) and made popular by Womack et al. (1990). Even though Lean is often considered to be a new concept in the western world, many of the very same practices have been applied here for a long time. Henry Ford used the concepts of continuous improvement and one-piece-flow in his factories already in the 1920s (Kilpatrick, 2003) and were in turn studied by the Japanese industry that borrowed and later developed those concepts.

Traditionally Lean Production or TPS has been applied in organizations with high volumes, few variants, low degree of customer contact and low fluctuation in demand (Monden, 1983). Today the concept of Lean has evolved from its origins and research have been conducted on adopting it to new settings outside the manufacturing perspective (Hines et al., 2004). It has long been argued that industrial practice can beneficially be applied also to service organizations (Levitt, 1972) and it has been proven that the Lean thinking suits such environments well (Swank, 2003). Other research have applied Lean on areas, such as sales (Kosuge et al., 2009), information management (Hicks, 2007), customer relations (Womack and Jones, 2005) and healthcare (Jacobsson, 2010). Companies, e.g. Fujitsu, have adapted Lean-inspired thinking and successfully derived and implemented new tools and methodologies for the service industry (Marr and Parry, 2004) in order to maximize value for the customer and minimize the operational waste. Apte and Goh (2004) argue that information intense services are very well suited for Lean adaptations and motor carrier operations can be highly information intensive (Nagarajan et al., 2005) with

several inefficiencies related to information deficiencies (Sternberg, 2008). Airline carriers have successfully applied Lean to their operations (Lehman et al., Zea, 2007) and practitioners are arguing that now is the time to take Lean to motor carriers (Taylor and Martichenko, 2006, Bey, 2010) and terminal operations (Rantonen, 2009, Zylstra, 2006).

Since the term Lean Production is created to describe a complete manufacturing philosophy originating from the Toyota Production System there is no single widely accepted definition, and many authors such as Ohno (1988), Shingo (1989), Schonberger (1982), Krafcik (1988), Womack and Jones (2003) and Liker (2004) have given their own similar interpretation of what Lean is. Liker (2004) explains it a *"sophisticated system of production in which all of the parts contribute to a whole. The whole at its roots focuses on supporting and encouraging people to continually improve the process they work on."*

Since Lean as a concept has evolved beyond Lean Production, Hines et al. (2004) have proposed a model of the whole concept. As illustrated in Figure 2.3, a distinction between the strategic level and the operational level to which Lean may be applied is suggested. A common mistake when applying Lean is to only use a set of tools instead of understanding the whole philosophy which may result in short-life sub optimizing (Liker, 2004). Therefore Hines et al. (2004) emphasize the importance of understanding the customer-centered strategic thinking. The strategic level is about the core concept of Lean, to add value, which means it is applicable to every organization that provides customer value where else, the shop-floor tools is not (Hines et al., 2004). On the operational level other methods such as Total Quality Management (TQM) and Total Productive Maintenance (TPM) have been incorporated together with Lean Production.

Lean thinking is about both increasing customer value and reducing waste, and the essence is to understand that these two are not the same. It is possible to increase customer value without reducing waste (Hines et al., 2004).

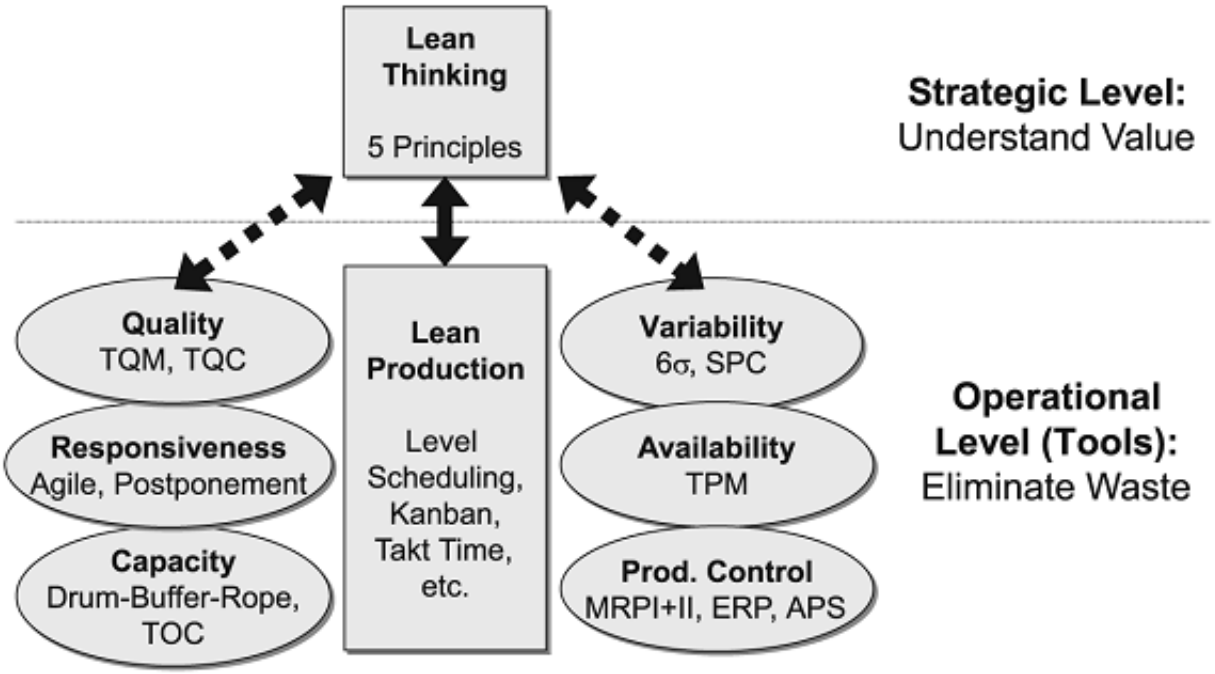


Figure 2.3: Levels of Lean (Hines et al., 2004)

2.2.2 Waste

All activities that do not bring value to the product from a customer point of view are waste (Monden, 1983). The pursuit of eliminating waste is one central aspect of Lean (Åhlström, 2004) and waste is commonly sorted under the three Japanese words muda, muri and mura. All of them are equally important and fit together as a system, even though Lean projects unfortunately often tend to focus only on eliminating muda.

Muda is described by Liker (2004) as *"activities that lengthen lead times, cause extra movement to get parts or tools, create excess inventory, or result in any type of waiting."* This kind of waste found in manufacturing and business processes are divided into eight categories: overproduction, waiting, unnecessary transport, over processing, excess inventory, unnecessary movement, defects and unused employee creativity (Liker, 2004).

Muri can be translated to overburden and is described by Liker (2004) as *"Muri is pushing a machine or person beyond natural limits. Overburdening people results in safety and quality problems. Overburdening equipment causes breakdowns and defects."*

Mura is the third type of waste and means unevenness. This is caused by a shifting demand on the system caused by an irregular production schedule or fluctuating production volumes and appears because *"at times there is more work than the people or machines can handle and at other times there is a lack of work"* (Liker, 2004). Both muda and muri is a result of mura.

2.2.3 Continuous improvement

Continuous improvement, often described by the Japanese word Kaizen, is the constant quest of improving towards the better with the aim on perfection (Imai, 1986). The basis for kaizen is standardized work (Liker, 2004) where all improvements made need to be accepted, spread and standardized before new improvement is possible. Kaizen is a continuous process of performing better and everybody in an organization should be involved (Imai, 1986). It is common that certain improvement teams are set up with personnel on all levels in a company. Those improvement teams are given time and resources to find and solve problems in order to reduce waste and improve the processes. A cornerstone in the kaizen work is the PDSA-cycle (Liker, 2004) that describes the steps of any improvement work or problem solving (Deming, 1986). The four sequential steps of the cycle are Plan, Do, Study and Act. The model can shortly be described, in the kaizen context, as when a problem has been found an analysis is made and a *plan* for how to solve the problem is constructed. This plan is implemented in the *do* phase, and the results then measured in the *study* phase. In the fourth phase, *act*, the improvements are made permanent and standardized so that the achievement will remain (Bergman and Klefsjö, 2003). Kaizen and its relationship to standardized work and the PDSA-cycle is illustrated in Figure 2.4.

2.2.4 Stable processes and process improvement

Many propositions have been made on the definition of the term process. Palmberg (2009) has organized different definitions into five groups depending on their focus: input and output, purpose or value for customer, interrelated activities, horizontal intra-functional or cross-functional, and repeatability. In this thesis a definition towards purpose or value for customer is chosen, and we use the definition of Davenport (1993) of a process as *"a structured, measured set of activities designed to produce a specific output for a particular customer or market."*

Stable processes are a based for all improvement work (Liker, 2004, Monden, 1998). Before the processes are stable and standardized, no real improvement can be made. Using the illustration in Figure 2.4, the improvements need to be standardized or they will fall back down again. Lean

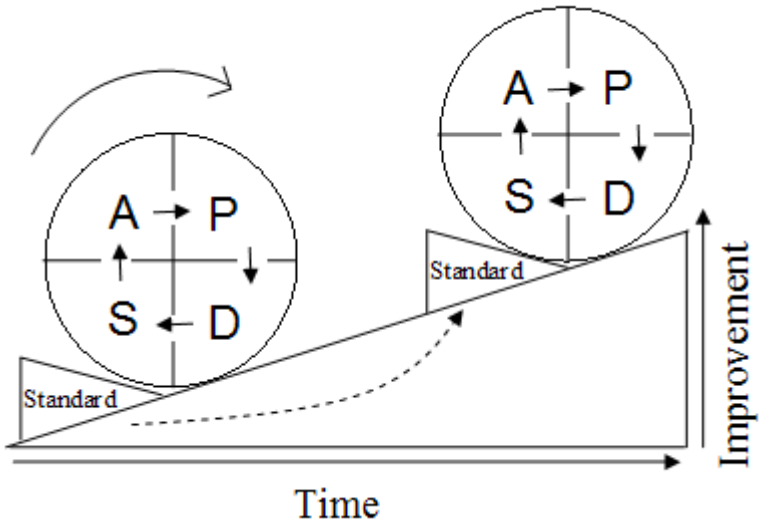


Figure 2.4: Relationship between continuous improvements and standardization

tools such as Just-in-Time, shorter lead times and reduced inventories can be successfully applied only after the processes are stable (Monden, 1998).

Process improvement is a term commonly used in the field of organizational development. One definition of organizational development is *"a system-wide application of behavioral science knowledge to the planned development and reinforcement of organizational strategies, structures, and processes for improving an organization's effectiveness"* (Cummings and Worley, 1997). Several management theories use the approach of process improvement, for instance Benchmarking, Business Process Reengineering, Six Sigma, TQM and Lean (Bergman and Klefsjö, 2003). Andersson et al. (2006) conclude that although the definitions of the different concepts differ, the aim of the different concepts seem to be similar; through improvements minimizing waste and resources while improving customer satisfaction and financial results. In this research the Lean approach towards process improvement is used.

The first step in gaining control over and improving an organization is to know and understand the basic processes (Deming, 1986, Juran, 1988, Taylor, 1911). In Lean, Value Stream Mapping (VSM) is a common tool for doing this and it captures the flow of material and information in a process (Liker, 2004). From originally being used in processes producing physical goods, VSM has been adapted to also map administrative processes. The purpose of a VSM is to give a snapshot of the current situation by visually representing the information and work flow and exposing waste in the processes (Tapping and Dunn, 2006). Once the current state of the process if understood, it can be analyzed and suggestions can be made on how to make improvements and a future ideal value stream map can be constructed to aim changes towards (Liker, 2004).

2.2.5 Visual management

Visual management is about using graphical representations to illustrate and give feedback about a company's performance. The purpose is to establish and reinforce a direct link between people and performance in organizations (Liff and Posey, 2004). The performance shall be aligned with a company's mission, vision and strategies (Liff and Posey, 2004). This kind of visual tools are an essential part of the communication process in many Lean factories but they have also been successfully adapted to other areas (Parry and Turner, 2006). The graphical representations and

information may differ a lot between organizations and departments, but at its basis it shall focus on what is important and be placed on a board where everybody sees it often.

The board may be considered as dynamic measurement system and since it is continuously updated it may be used to predict the probable outcomes if no actions are taken (Parry and Turner, 2006). Hence the board can be used to control that the outcome becomes as desired. The performances measures is recommended to be converted to a level where all employees can relate to them.

2.3 Problems

In every organization there are obstacles, problems that need to be overcome in order to reach a higher effectiveness. In this section a framework for defining those obstacles and issues related to eliminating them are presented.

2.3.1 What is a problem?

The word "problem" originates from the Greek word proballein consisting of the part pro-, meaning before, and -ballein, meaning throw. Combined, a word is formed meaning to *throw before* or *put forward*. In this sense a problem has to be seen in order for it to exist. Only when you see the problem, when it has been thrown in front of you, you can solve it.

A common definition of a problem is simply the difference between the current state and the goal state (Jonassen, 2000, Ammerman, 1998). This means that there must be a social, cultural or intellectual goal of solving the problem. There must be a reason for solving the problem and that reason is the difference, or gap, between the current state and the goal state. If a situation does not show this gap between what is and that is wanted, there is no problem. *"A person is confronted with a problem when he wants something and does not know immediately what series of actions he can perform to get it"* (Newell and Simon, 1972).

Ackoff (1978) conceptualizes a problem into different components. For a problem to exist there need to be a decision maker, someone who is faced with the problem and have the power to in one way or another take action. Connected to the problem are both controllable and uncontrollable variables. The controllable variables can be controlled by the decision maker. The uncontrollable variables can not be controlled by the decision maker, but together with the controllable variables they affect the outcome of his choice. Surrounding the situation there are constraints on the possible values of the controlled and uncontrolled variables.

The possible outcome of the problem solving process is a joint product of the decision maker's choice and the controlled and uncontrolled variables. There must be two or more possible outcomes, otherwise the decision maker's choice would have no effect on the outcome; hence no problem would exist. The different outcomes must also be unequally desirable; otherwise it will not matter to him which outcome occurred.

2.3.2 Placing a problem in a context

When put in front of a problem, the problem solver will create a mental picture of the problem depending on how the problem is represented and conceived. The problem solver then constructs a *problem space* which is a representation of the environment, task and the problem solver's knowledge (Newell and Simon, 1972). It is in this problem space that the problem solving takes places and it includes all possible solutions that the problem solver might consider (Newell and Simon, 1972). Everybody creates an own problem space and it accumulates over time when more knowledge about a situation is acquired.

In a problem solving situation people tend to add *self-imposed constraints* to the problem which decreases the problem space and make less room for creative solutions. These self-imposed constraints limit the creativity (Ackoff, 1978). As an example, children do not add constraints to the same extent as grown-ups do and are therefore in general more creative. However, when children grow up they learn to add these constraints which suppress their creativity (Ackoff, 1978). The problem solver needs also to separate relevant information from irrelevant, and only add this information to the problem space (Jonassen, 2000).

As mentioned above, problem solving involves selection of different courses of action in order to reach a desired outcome. As a consequence, people react to both proposed and implemented solutions according to how the new situation reflects their own desired outcomes (Ackoff, 1978). People's behavior reflects the problem solving environment and their individual goals, which means that people act rational toward a specific goal (Newell and Simon, 1972). It is therefore important to be aware of the objectives of both the people involved in the problem solving process and of the people affected by the solution. In order to predict reactions to the solution it is also vital to understand how the different individuals' objectives relate to each other (Ackoff, 1978). Misinterpretation of others' objectives is especially common were a cultural gap separates the problem solver from those affected by the solution. In such circumstances it is common that those who have authority explain the behavior of others as irrational instead of acknowledging the mismatch of objectives (Ackoff, 1978).

2.3.3 Problem solving

The process of problem solving is complex and must be tailored for each problem faced. But there are some steps and terms that are more general and appear in all problem solving processes that need to be defined so that there is no doubt what is meant in the remainder of this thesis.

First, the term solving itself needs to be defined. Ackoff (1978) talk about three different kinds of approaches to eliminate a problem. The first one, simply named *solving*, is used when the decision maker has selected values for the controllable variables to maximize the outcome. The problem is solved; the decision maker has optimized the situation and the gap between the current state and the goal state is reduced to zero. If the decision maker instead chooses values of the controllable variables so that the outcome is not maximized, but still good enough, the problem is said to be *resolved*. It means narrowing the gap between the current and goal state, but without eliminating it. But there is also third way of dealing with problems: *dissolving* them. This is done by changing the values so that the different possible choices in the situation are no longer meaningful. An example of this could be when the problem of choosing a car to buy is dissolved by instead deciding to use public transport.

The earlier described *kaizen* methodology, small continuous improvement, resembles the resolving approach to problems. The proposed solutions may not in one step lead to the optimized solution, but the iterative process of improvements will lead in that direction.

The process of problem solving is a major part of the Lean literature, and many authors describe the process similarly and with similar terms. The first step in any problem solving process is to understand the problem and to find the true problem. This seemingly simple task is the most important part in solving the problem and it is there that the largest effort should be put (Liker, 2004, Ammerman, 1998). If the conception of the problem is wrong there will be a mismatch between the problem space of the conceived problem and the problem space of the actual problem. Instead of finding a solution for the actual problem, the problem solver might choose a solution which only suppresses the symptoms of the actual problem (Ackoff, 1978). It has been observed that people more often fail to face the right problem than fail to solve the problem they face (Ackoff, 1978). A problem well defined is a problem half solved; when the

problem is properly defined and understood the solution is often obvious (Liker and Meier, 2006). A well defined problem follows the following points (Bicheno, 2004):

- It focuses on the gap between what is and what should be.
- It states the effect.
- It is measurable.
- It describes the pain.
- It avoids "lack of" and "no" statements (that imply the solution).
- It highlights the significance of the effects.

2.3.4 Symptoms

A problem is often discovered through its *symptoms*. They provide supporting evidence that a problem exists (Liker and Meier, 2006) but they are themselves not the true problem. The waste that is discovered through a VSM is symptoms of a problem (Drogosz, 2002) and not the actual problem itself.

2.3.5 Causality

The term *causality* describes the relationship between an act and the effect that it produces. This relationship is highly relevant in problem solving and it is assumed that behind each effect there are several underlying causes. This chain of causes, in theory, ends at one or several so called root causes that need to be identified and solved in order to solve the problem (Bergman and Klefsjö, 2003, Ammerman, 1998, Liker, 2004, Finlow-Bates, 1998). Finding the root cause to a problem is often described by the root cause analysis model "Five why", where the root cause is supposed to be found if you ask "why" five times after the problem has properly been identified. This method often traces the problem upstream in the process (Liker, 2004). Another method of finding the root causes are through a cause-and-effect diagram such as the Ishikawa (or fishbone) diagram. When a problem has been defined the Ishikawa diagram is used to find its underlying causes. Often causes are divided into different categories, for instance the seven M's in Figure 2.5 used to find quality issues in the production industry (Bergman and Klefsjö, 2003):

- Management - Does the management provide sufficient support and information?
- Man - Does the staff have enough knowledge to do the job?
- Method - Is the method of conducting the job correct?
- Measurement - Are the quality assurance test measures correct?
- Machine - Is the machine used in the operations correct?
- Material - Is the material used for production correct?
- Milieu - Are there any external factors that cause problems?

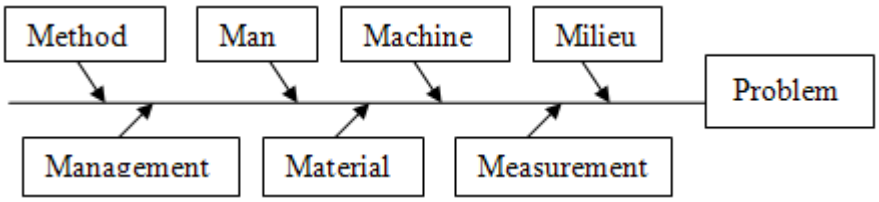


Figure 2.5: Fishbone diagram with the seven M's

Once the root causes are identified, a proper solution can be designed and implemented to eliminate the problem.

2.3.6 Relationships in the problem solving world

Even though it looks simple it is sometimes confusing and hard to know if you stand before a true problem, a perceived problem, a cause, a symptom or a solution to a problem. These terms are all tightly connected, and in this thesis a model by Liker and Meier (2006) is used to illustrate how they all relate. The model range from the true problem on one extreme to the root cause on the other extreme, and is showed in Figure 2.6.

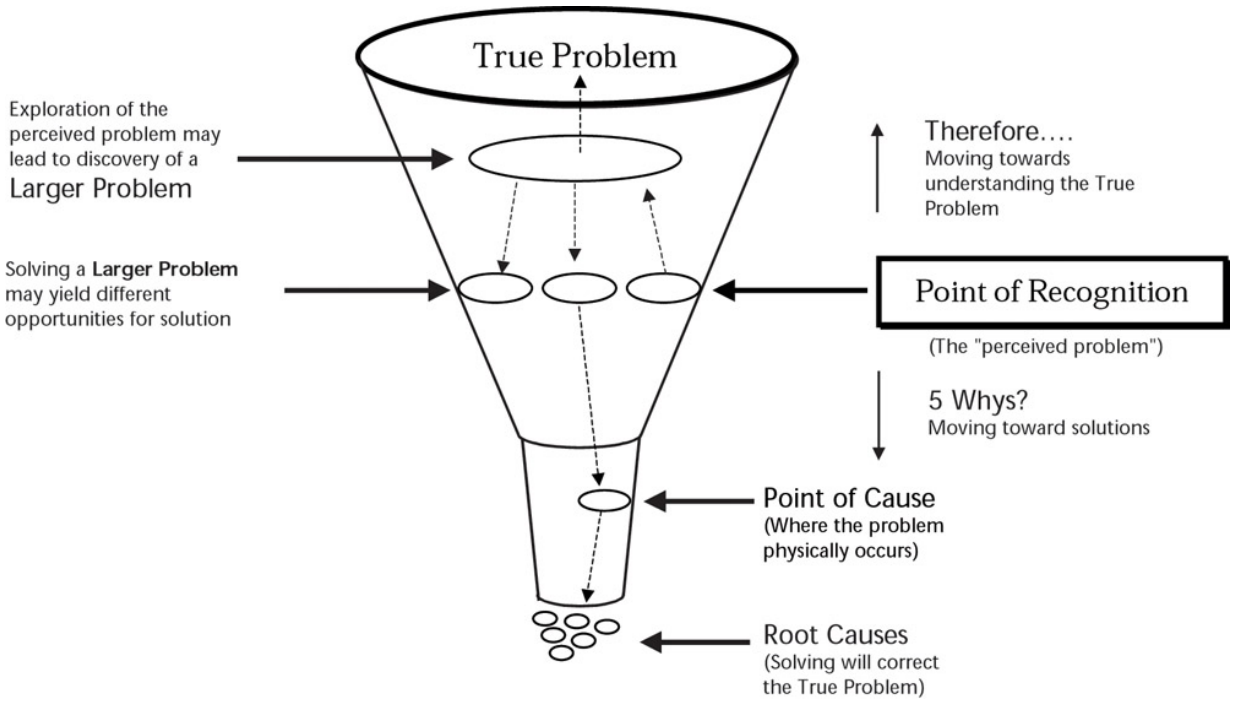


Figure 2.6: Relationships in the problem solving world (Liker and Meier, 2006)

The point of recognition is the point where the problem solver starts; this is where the problem is recognized or perceived. As earlier stated, it is at this point important to take one step back and try to fully understand the true problem. At this point, problem solving, starts by narrowing down the funnel to reach the root causes. Of course this is only a schematic picture of the relations between the point of recognition, the true problem and its causes, and in the reality there may sometimes be hard to distinguish what is what. There are also, as shown in the figure, more than one possible route from the true problem to the root causes.

The term "point of recognition" (POR) will be used in the remainder of this thesis to describe the whole area between the true problem and the root causes, including the waste that is found through the assessment method described in Section 2.4.

2.3.7 Solving the right problem

If an organization is faced with several problems it has to choose which problems to solve first. Liker and Meier (2006) gives the practical guidelines in how to do this selection. Each problem can be evaluated from the three following criteria:

1. Importance, in relation to the customer satisfaction or company goals. Safety problems are automatically of highest importance.

2. Urgency, to solve the problem not to miss for example deadlines.

3. Tendency, if the problem is getting worse. An increasing problem is more important to solve than a decreasing one.

Another way to rank problems against each other is to use the pareto chart. Data is collected about the consequences of different problems and put together, and often the pareto chart shows that very few problems account for a large number of the errors (Bergman and Klefsjö, 2003).

2.3.8 Finding the right solution to solve the problem

The problem solver chooses a course of action that generates a desired outcome that is efficient relative to what the problem solver values (Ackoff, 1978). This product of efficiency and value are defined by Ackoff as effectiveness, and the search for the most effective solution is called optimization. But there is always more than one possible solution to each problem and it is important to verify the effectiveness of the planned solution before implementing it (Liker and Meier, 2006). During the course of problem solving and implementing the chosen solution the performance of the improved process may drop below its initial state for some time before rising to higher levels (Tapping and Dunn, 2006).

2.4 Assessment method for carrier firms

Earlier research has shown that there is potential for improved efficiency in carrier firms. The attempt of this master's thesis is not to develop methods for identifying potential for increased efficiency, but to develop a framework for how to benefit from the improvement potential. However, it is not possible to validate a framework for reducing inefficiencies without first identifying inefficiencies. Available to this master's thesis is a methodology for identifying, visualizing and measuring waste in carriers' operations, developed by Larsson and Westerberg (2009). The methodology uses Lean tools, such as Value Stream Mapping, to expose waste in both the operational and administrational processes in road carrier organizations. It has been both tested and validated by the researchers who developed it, but it has also been used by other researchers that are part of the same research project as this master's thesis. Each time the methodology has been used, a significant level of waste in both the administrative and operative processes has been exposed.

By using the existing methodology it will also be possible to use the already existing data from earlier carrier firm assessments. Since the new data will be collected using the same methodology, comparison between the data sets will be relevant and valid. Also, the existing data can be used for testing the proposed framework in this master's thesis.

The assessment methodology includes interviews, data collection and observations through value stream mapping. The interviews are conducting with representatives from each position in the specific carrier firm which includes the CEO and other key individuals, the traffic control, the administration and the drivers. The data collection aims at measuring the Key Factor Indicators, KPI, and the Value Stream Mapping are done to understand the firm's processes. Value Stream mapping are done for both the goods flow and the order to cash process. An overview of the method is presented in Figure 2.7 and described more thorough in the thesis by Larsson and Westerberg (2009).

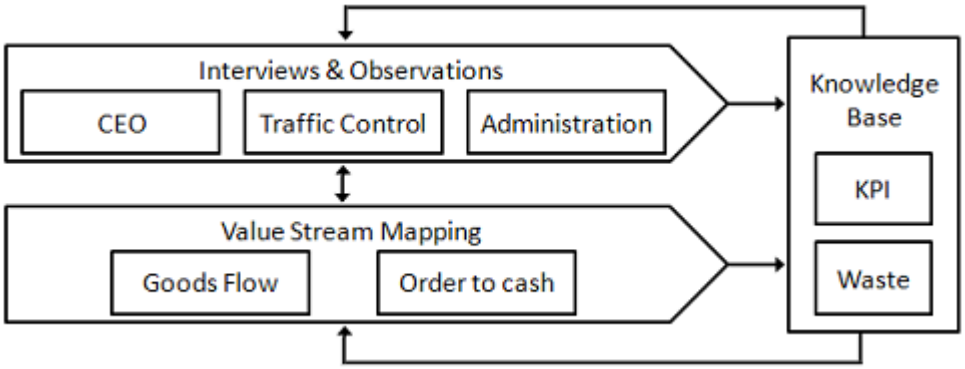


Figure 2.7: Overview of the LWA method to visualize, identify and measure waste

The assessment methodology will be used in this thesis to assess the performance and waste levels of road carrier operations and it will be referred to as the LWA method (from **L**arsson and **W**esterberg **A**ssessment method).

3 Research Method

This chapter introduces the research method used in this master's thesis. First the general research strategy is explained and how the abductive research method has been used. Second, the different sources of data are described followed by a discussion about the reliability, validity and objectivity of this research.

3.1 Research strategy

The general research methodology of this research follows the following steps:

- Problem formulation
  The problem area, purpose and research questions were defined as presented in Chapter 1. Also a brief literature study on the carrier industry was conducted in order to get enough knowledge about the problem area.

- Literature study
  Relevant literature was reviewed and connections were made to the area of research. The researchers prior knowledge about lean influenced the selection of literature, but also other theories were discussed. The results of the literature study are presented in Chapter 2.

- Interview study
  Lack of suitable literature on some areas led to an interview study, found in Chapter 4, to complete the available literature.

- Proposition of frameworks
  Findings from the literature and interview study were combined and an adaption of the theory to fit in a motor carrier context was proposed by a framework for introducing continuous improvements. This consisted of a model for presenting improvement potential and a framework for selecting improvement project, as shown in Chapter 5

- Validation
  The proposed framework was validated through a case study on a carrier firm, presented in Chapter 6

This research process goes well in line with the abductive methodology as described by Kovács and Spens (2005). They discuss the development of new theories in logistics research and suggest the use of abductive research. The steps of the abductive research process is described in Figure 3.1.

In this research the authors had prior knowledge in Lean production theory but applying Lean to carrier firms is a relatively new field and therefore the theoretical framework was not complete.

The first step in this research was therefore to collect data and compare it with existing theory. The data was collected through interviews and observations. The interviews were conducted with stakeholders related to the motor carrier industry and experts in the field of Lean, change management and supply chain management. The observations were done at carrier firms in Sweden.

The empirical data collected showed deviations between the already existing theory and the result of the theory matching showed that there was a gap to fill on order to successfully apply the theory in a carrier context. Therefore an adaption of the theories was made and a framework which answered to the research questions were developed and proposed based on the adapted theory.

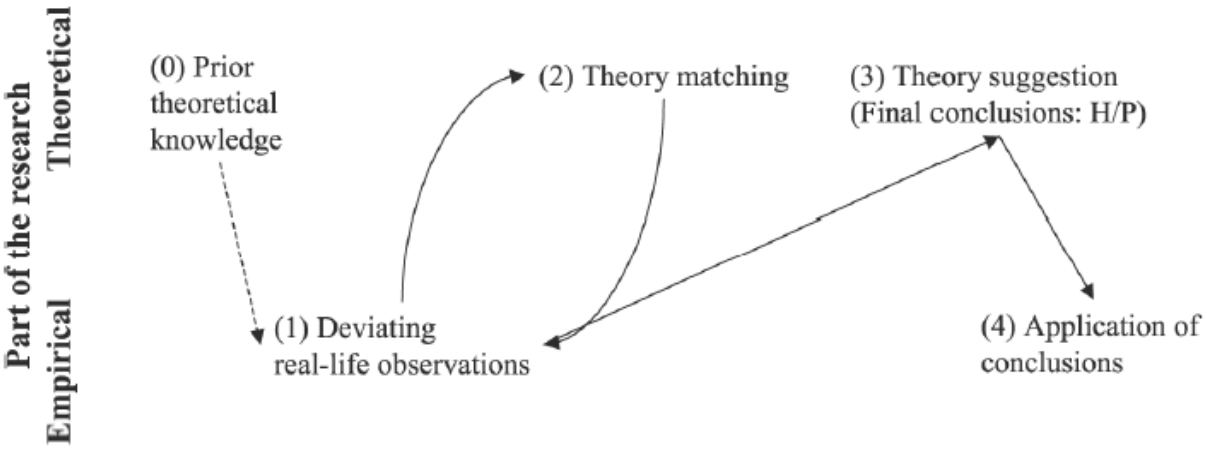


Figure 3.1: The abductive research process (Kovács and Spens, 2005)

To validate the proposed framework built on the adapted theories, the framework was tested. The first part of the framework was tested with data from case studies on carrier firms in Sweden and Switzerland. The complete framework was then validated together on a case study at a Swedish carrier firm through the start-up of an improvement project involving several drivers with the aim to improve the carrier firms operations. Due to the limited extent of this master's thesis the validation case study lasted for only a few weeks. Any improvements and change that are noticed must therefore be put in the light of the famous Hawthorne effect which is a reaction where individuals subjected to study improve or modify their actions that are measured in response only to the fact that they are being studied (Landsberger, 1958). This make it hard to conclude if the means for improvement are correct, or if the improvement is only a reaction to the change.

3.2 Qualitative and quantitative study

In this study both qualitative and quantitative data has been collected. According to Yin (1994) and Bryman and Bell (2002) it is suitable to use a qualitative method when studying changes in a social environment. Trost (2005) expresses the distinction between qualitative and quantitative studies as "the quantitative approach analyses relations between numbers and not people". The interview study and the interviews made during the assessments of the carrier firms were entirely qualitative.

Data from three case studies has been used in this research. The data has been both qualitative, as in case with the interviews, and quantitative, is in the cases with the value stream mappings. The data collected during the value stream mapping has been analyzed quantitatively to show the amount of value adding and not value adding time.

The qualitative data from the interviews were partly made in order to identify problems existing in the carrier firms. The resulting list of problems were analyzed quantitatively, in order to determine to what extent they could be solved from within the organization and what caused them. It is plausible to expect that those problems are of different severity and complexity, which may mean that they should not be treated equally in a quantified analysis. The purpose of the analysis is to show the origin and nature of the problems as perceived by the personnel and since the problems analyzed result from interviews with the personnel, it is judged reasonable and valid to treat them equally.

3.3 Data collection

The data collection consists of both primary and secondary data. The main sources for primary data are interviews, observation and the validation test of the two frameworks. Secondary data has been used in the form of literature and two LWA data sets.

3.3.1 Literature study

The literature study covered a number of different types of literature from various sources. Together with the empirical data, the literature study was used to develop two frameworks. The intention was to use scientific and unbiased books and journal articles. Books were used mainly for theoretical reference while journal articles were preferred since they often provide the latest and most up-to-date information that is seldom published yet in books (Patel, 1994).

3.3.2 Interviews

To gain a holistic view of the carrier firms' environment an interview study was made with professionals in various relevant fields, such as carrier firm executives, transport buyers and a representative from a carrier trade organization. Interviews were also conducted with experts in Lean production, change management and supply chain management with the purpose to be used when developing the frameworks.

If the purpose of an interview is to develop models or to acquire knowledge of particular phenomena, an explorative open form of interview is preferred (Lantz, 2007, Kvale, 1996). Therefore, the interviews were decided to be semi-structured with open-ended questions and the questions were modified to fit the objectives for each interview. All interviews conducted in this master's thesis are listed in Table 3.1. An overview of the conducted interviews is presented in Appendix A.

Code in text	**Area of expertise**
CM Expert 1	Change Management (CM)
Lean Expert 1	Lean Production
Lean Expert 2	Lean Production
Lean & CM Expert 1	Lean & Change management
SCM Expert 1	Supply Chain Management (SCM)
Carrier Expert 1	Education in motor carrier organizations
Carrier Executive 1	Leading motor carrier organizations
Carrier Executive 2	Leading motor carrier organizations
Transport Buyer 1	Transport purchase
Transport Buyer 2	Transport purchase
Transport Buyer 3	Transport purchase

Table 3.1: Summary of interviewees

The way to access the interviewees differed. Most of them were contacted through the researchers' extended social and professional networks. Others were accessed through the companies or organization they presented. In those cases a phone call was made or an email sent to the organizations describing the research and what the purpose of the interview was. The organization then responded with appropriate interviewees. Three interviews were conducted by an external researcher and interviewees selected through that researcher's social network.

By interviewing a range of people with different backgrounds a more comprehensive picture of the situation is given. The purpose of the qualitative research interview is to understand the world from the interviewees' perspective (Kvale, 1996) and the answers are then interpreted by the interviewer. The difference between an interview and a regular conversation is that information is to be obtained about a specific topic with a specific purpose (Kvale, 1996). The interviews in this thesis were structured into three groups: Lean and change management experts, road carriage experts and transport buyers. A short summary of the purposes and planned topics in the interviews follow below.

Purpose of interviewing Lean and change management experts
The Lean experts were interviewed in order to explore the possibilities of implementing Lean into a carrier setting. Also, their view of what practical problems that may appear due to the nature of the organizations were important to the researchers. Since Lean is new to the carrier industry a basic assumption that organizational change should be necessary was made early on in this thesis work. Therefore, change management experts were interviewed with focus on how to start, implement and preserve change in an organization. Also lessons learned from their previous practical experience were sought.

Purpose of interviewing carrier firm experts
Prior to this research the researchers had limited knowledge about motor carrier firms and their operations. Therefore one purpose of the interview study was to obtain an insight into the exciting world of road carriage. Interviews were conducted with people both internal and external to carrier firms. Internally, firm executives were interviewed to understand their view of the industry and how they looked upon the possibility for change in their organizations. This includes cultural aspects such as prevailing attitudes towards change and different stakeholders' potions. Externally, a representative for the Swedish carrier trade organization who manages education in carrier firms was interviewed to get an external view of the same aspects.

Purpose of interviewing transport buyers
A cornerstone in Lean (and many other management principles) is to focus on activities that add value to the customers. Therefore it seemed obvious to also talk to the customers of the road carrier firms to try to understand what they judged as important and characteristic for a good carrier firm. Transport buyers also work in close contact with carrier firms and possibilities are that they have valuable insight into their operations as well.

3.3.3 Interview process

The following process was used during the interview study and resulted in the empirical data .

1. Preparation
   According to Kvale (1996) the first step in the interview process is to thematize and formulate the purpose of the interview before the actual interview starts, as done above. Possible interviewees were contacted and interview questions to the different groups of interviewees were prepared, presented in Appendix A.

2. Execution
   Lantz (2007) emphasize the risk of the data getting systematic reduced if asking questions, listen and taking notes simultaneity. Therefore the authors decided to have one person lead the interview asking questions with the other taking notes. The roles were alternated

for different interviews. The interviews often varied via the dichotomy description - interpretation, where descriptions from the interviewee were followed by discussions with the interviewers to interpret and clarify the descriptions (Kvale, 1996).

3. Transcription
   Directly after finishing the interview the person taking notes wrote a transcription of the interview. The transcription was also read by the person leading the interview, updating it if necessary. In this way the risk of unintentional data reduction was decreased, but there is always a risk of losing details due to the unintentional selectiveness of the interviewers' memory (Kvale, 1996).

4. Approval of transcription
   The transcription was sent for approval to the person who had been interviewed. In this way the person had a second chance to clarify his or hers answers and to correct misunderstandings. This has also an ethic advantage since the interviewee has a chance to remove information that could be personally or organizationally sensitive.

5. Data reduction
   Data reduction includes a systematic way of choosing relevant information and to simplify and abstract raw data (Lantz, 2007). It is, according to Lantz (2007), a creative part of the analysis. It should be done with the purpose and topic of the research in mind and adjusted to the nature of the research material (Kvale, 1996).

   The data reduction in this master's thesis was done in the following steps:

   - Parts that did not answer the research questions were removed.
   - The content from all interviews was rearranged under new categories.

   The rearrangement of data from the interview study was made in a divergent - convergent process, by spreading data on a wall and then looking for themes and categories that the data could be grouped under. After the data reduction was finished all transcriptions were read again to make sure no relevant data that would fit under the established themes had been reduced. According to Lantz (2007) is it important to compare the raw data to the reduced version in order to detect if too much data has been reduced or if the content does not seem alike anymore.

   The interview process of Transport buyer 2, Transport buyer 3 and Carrier executive 2 differentiate from the other eight interviews. They were conducted by an external researcher, delivered to this research already written. The interview with Carrier executive 2 followed the interview guide developed in this research, while the interviews with the two transport buyers were conducted in another format not using the same questionnaire. Any ambiguities regarding those two interviews were solved through discussions with the external researcher.

3.3.4 Observations

In addition to the interviews, observations were made on site at carrier firms in order to get a more comprehensive view of the operations. The obersvations primarily aimed at understanding the industry culture, the specific work tasks and the waste that existed in the operations. In an early stage of the research a day was spent on site at the traffic planner and in the trucks of a carrier firm to follow their work during a day. The researchers did not participate only as observers, but also actively helping with small work tasks. Doing so make the researcher

get a more comprehensive understanding of the object studied, and the researcher got an inside view of, in this case, the work of the truck drivers (Yin, 1994). During the observation sessions constant and informal discussions with the drivers were held, ranging from practical work related issues to more personal reflections about the life as a truck driver. Observations are a good way to understand the context and understand the social reality (Bryman and Bell, 2002). The researchers highly values this chance to get an insight of the world of truck driving and the lessons learned greatly facilitated the rest of the research process.

3.3.5 Data from case studies

Apart from the data collected by the researchers also data from case studies on two carrier firms are available. The data origin from the research group involving Chalmers University of Technology and Volvo Technology that this thesis has been written in cooperation with. The firms are from different countries (Sweden and Switzerland) which make the data more interesting since it can be used to test if conditions are similar in different parts of Europe. The characteristics of the two companies assessed are listed in Table 3.2.

	Carrier firm A	**Carrier firm B**
Country:	Sweden	Switzerland
Number of employees:	30	50
Number of trucks:	15	33
Operations:	General cargo and trailers	General cargo less than truckload
Date of assessment:	April 2009	March 2010
Annual turnover:	32 MSEK	12 MCHF (˜84MSEK)

Table 3.2: Characteristics of the two carrier firms that generated the data sets

The data from the two firms have been collected using the LWA methodology. Since the same methodology has been used in both case studies for collecting data the data sets can be seen as comparable. This makes it possible to use them for testing and validation purposes of any proposed model or method. Important to note is that Carrier executive 2, questioned in the interview study, also works at Carrier firm B. However, since the interview was conducted prior to the execution of the LWA, this should not affect the validity of this data.

3.4 Reliability, Validity and Objectivity

All research need to be critically evaluated and here follow the researchers' view of the reliability, validity and objectivity of this research.

3.4.1 Reliability

Reliability amount to the level of random errors and if a study conducted under similar circumstances would give the same result. A study with high reliability would give the same result if repeated. The goal of reliability is hence to minimize errors and biases in the study (Yin, 1994).

The reliability in an interview study refers to the degree of consistence (Kvale, 1996). In this research the interview study, although semi-structured, has followed a framework. All interviews have been prepared beforehand and been transcribed into text shortly afterwards. The transcript has been double-checked both by the second researcher participating at the interview and by the actual interviewee, to make sure that what has been said has been interpreted in a similar way.

All interviews with the Lean and change management experts has followed a strict framework and the same questions have been asked in the same order. Also the interviews with the carrier experts have followed a common framework. The interviews with the transport buyers differ, since Transport buyer 2 and Transport buyer 3 has been provided by one of the supervisor. Any possible biases in the material used from those reports have been discussed with the researchers conducting those interviews, to increase reliability.

Interviewing individuals with different relations to carrier firms has triangulated the data. This gives a more comprehensive view of the topic and decreases the risk of getting one-sided data.

The last step of the research has been to test the findings on a real carrier firm. The testing activity has followed a strict and documented procedure that can be repeated similarly on another carrier firm. Such a repetition following the same strict methodology would result in a similar way, calling for high reliability.

3.4.2 Validity

Validity is a measure of how well the researcher manages to study what is intended to be studied. A simple explanation of validity by Gummessont (2000) is the metaphor of how well the map corresponds to the reality. In qualitative studies, such as this study, it is important that the processes of data collection and analysis can be followed (Bryman and Bell, 2002).

The level of validity of an interview study depends on if the study really investigates what was intended to investigate (Kvale, 1996). In this research the purpose of the interview study has been well defined from start. Interviewees have been informed about the purpose of the entire study prior to the interview start. This increases validity; the interviewees have known what field of information the interviewers have been interested in and the risk of misunderstanding the topics have decreased.

Yin (1994) uses the term "external validity" when discussing the possibilities to generalize the findings outside the current case study. Although several carrier firms have been used to test parts of the study, the complete end result of this study has been validated on only one carrier firm. This may reduce validity since all carrier firms do not have to be similar to the one in the case study. But all material up until the validation case has been derived from several carrier firms in, both in Sweden and abroad. The study has also several times showed that carrier firms to a very large extent tend to have the same work processes and culture. This make the researchers strongly believe that the model and framework for initiating improvement work in carrier operations will be valid also in other carrier firms.

3.4.3 Objectivity

This research has been initiated by Volvo Technology with supervision from Chalmers University of Technology. The two parties have previously jointly conducted research in the field of motor carrier operations. There is an obvious risk that the initiator may influence the researchers in a certain direction to fulfill the initiators' demands or to give the initiator "what it wants to hear". This is discussed by Paulsson (1999) who argues that it is important to listen and take advice from the initiator but that all decisions must be taken by the researchers.

The entire research process in this master's thesis has been done in parallel and together with closely related research at Chalmers University of Technology. The collaboration with the supervisor has been an integral and the cooperation between the supervisor and the thesis writers has been mutually constructive. This has called for strict objectivity and scientific method from the initial stage of the research.

During this research both Volvo Technology and the supervisor at Chalmers University of Technology has contributed with significant and helpful feedback. The close collaboration with both supervisors, especially in the beginning of this research, made it possible to fulfill the high demand from both an academic and industrial perspective without having to compromise.

4 Interview study

During the initial phase of the research a total of eleven interviews were conducted with various professionals to listen to their opinions and knowledge about the carrier industry, Lean and change management. The aim of the interviews was to gather knowledge about both the carrier industry and conditions for improvement work in such organizations to complete the existing theories of Lean and process improvement to fit in the carrier context. A summary of the interviewees and their background along with questions asked are presented in Appendix A. The findings have been divided into three main categories with the following themes: factors that are specific to improvement work in motor carrier firms, factors that drive improvements, and factors to consider when choosing improvement projects. All the empirical data deal with conditions that are unique to carrier firms.

4.1 Factors specific to improvement work in motor carrier firms

One of the main topics derived from the empirical study are factors that make improvement work in carrier firms special. Below five factors are described that are important to consider when designing an improvement project. Some aspects are valid for many types of organizations while others are more unique to the carrier industry. All interviewees have not commented on all aspects since they have only been interviewed in their field of expertise.

4.1.1 Understand and convey the current situation

Management experts	- Analyze and understand the current situation. - Surface vital problems to make the visible and measurable. - Present a common and understandable picture of problems. - Convey the waste that is present in the organization. - Involve personnel in finding a showing waste. - Make people understand the possible potential.
Carrier experts	- Make sure to properly understand the system, go with the trucks. - Drivers and traffic control often have a lack of understanding for each others job and problems.
Transport buyers	- Problems are not communicated within carrier firms.

The most important thing to do in the initial phase of an improvement attempt is to analyze and understand the current situation, according to Lean Expert 2, Lean & CM Expert 1 and SCM Expert 1. CM Expert 1 suggests starting with an assessment of the organization to surface the vital problems. When problems are made visible, they are measurable and possible to deal with, says Lean Expert 2. CM Expert 1, Lean Expert 2 and Lean & CM Expert 1 all clearly state the importance of presenting a common and understandable picture of the problems creating waste. Both top management and the rest of the firm's personnel need to understand what waste is and understand in what forms waste is present in their operations, it is common that people are not even aware of the problems around them. Lean Expert 2 suggest involving the personnel in finding and reporting waste in an early stage of the improvement work to create an understanding of its presence and inspire the work to eliminate it. The motor carrier firm, that typically has used the same working methods for a long time, needs to understand the possible potential, says Lean & CM Expert 1. This common picture of the problems will help in creating a culture where problem solving comes from the own organization and not from outside consultants. Carrier expert 1 agree that properly understanding the organization is vital and suggest to sit in a truck for a day to understand all parts of the operations. Drivers and traffic control

often have a lack of understanding of each other's job, says Carrier expert 1. Transport buyer 1 discusses the problem that problems do not seem to be conveyed within the carrier operations, that a problem that drivers discover do not reach the ones that can solve it. This tends to be worse in larger firms than in small firms.

4.1.2 Present everybody's role in a larger context

Management experts	- Create an understanding of how everybody's actions affect other processes. - Put different people together to increase understanding. - Mix people to solve problems. - Fragmented nature of carrier firms may make people feel isolated. - Value stream map the main processes. - Understand the larger picture in its context. - Operational processes are the mirror of the firm.
Carrier experts	- Drivers are well aware of their role. - Drivers sometimes not identify themselves as representatives of the company.

A large part of a firm's problems become visible in the operational processes, says Lean & CM Expert 1. In the motor carrier business the operational processes are the actual pick up, transport and delivery of the goods. Problems that stem from earlier processes, for example incomplete addresses submitted from the shippers, show and create waste in the operational part. Therefore the largest portion of the problems revealed in an assessment is visible in those operational processes, says Lean & CM Expert 1. Solving those problems in order to reduce waste will therefore to a large extent be done in earlier processes likely by other individuals. This makes it vital to create an understanding of each individual's role and how their actions affect the larger picture, says CM Expert 1. Personnel from different processes have to communicate and together solve problems. Lean & CM Expert 1 expresses this with the expression "help your neighbor, and they will help you". The fragmented working conditions in carrier firms may make people feel isolated and not part of a team, says CM Expert 1, something that may disrupt improvement efforts. Carrier executive 2 says that although most drivers know their role, they can not always identify themselves as representatives of the company.

A powerful tool to understand how people and processes are connected and dependent on each other is through a value stream mapping, says Lean Expert 1 and SCM Expert 1. Here the information flow and physical flow is made visible from order to customer, and the responsibilities and possibilities to help the next person in the value stream are made obvious. The larger picture has to be known in order to understand and solve local problems, says Lean Expert 2.

4.1.3 Graphically visualize the problems

Management experts	- Use pictures and symbols to convey information to drivers. - Document problems with a digital camera and present to everyone. - Gather people around a board on the wall. - Show list of problems. - Use visual management system.
Carrier experts	- All drivers not comfortable in using written communication. - Uses billboard to convey information. - Hard to gather people physically.

A good way to show problems in order to create a common picture of them is to use a list

or graphical presentation of the problems, says Lean & CM Expert 1. A physical list makes it obvious that the problems need to be solved. This goes in hand with a Visual Management System that has proved to be a powerful tool in the work of eliminating waste. A board with the problems found can physically be placed in a location where drivers often come to so that they also understand what problems the organization face, says Lean & CM Expert 1. A big problem in doing improvements in motor carrier organizations is that the work force is scattered and work alone all day in their truck. This makes it even more suitable to use a graphical presentation, that can be viewed individually when there is time, says Lean & CM Expert 1. Lean Expert 2 suggest that problems can be documented with a digital camera and presented to everyone, and CM Expert 1 agree that using obvious pictures and symbols may be extra valuable in motor carrier organizations since the drivers probably live in a concrete world where abstract models may be misunderstood. Carrier expert 1 describes that all drivers are not comfortable and used to writing and communicating through text, hence other methods should be used to convey information. There is also a problem to physically gather people. Transport executive 1 uses a billboard with where information to drivers is posted.

4.1.4 Categorize problems

Management experts	- Thematize different improvements. - Categorize problems and present the vital few. - Decide if problems are technical, organizational or administrational. - Start from the customer and go backwards. - Some problems require too large investments to solve. - Distinguish problems caused by customers.

In order to make the large amound of identified problems more understandable among all employees, CM Expert 1 suggests categorizing them. An initial short analysis about the nature of each point of recognition can be made, for example if they are to be dealt with by technical, administrational or organizational means. CM Expert 1 continues by proposing improvement possibilities to be thematized, based on their type. Some problems might be too hard to deal with for a small carrier firm, for example if they involve a large investment in new technical tools, says SCM Expert 1. Such problems can be separated from the rest. Lean Expert 2 and SCM Expert 1 mention that other problems may be because of external factors, such as customers or suppliers, and that such problems could be worth separating clearly. You want to see what problems you can solve yourself, by using personnel, material and other resources better, says SCM Expert 1.

4.1.5 Use a pragmatic approach

Management experts	- No omnipotent way to design improvement work. - Dig where you are standing, deal with the problems that appear.

There is no general way to decide where to start with improvement work, each firm is unique and several parameters need to be considered when planning the improvement program, says CM Expert 1. Lean & CM Expert 1 agree, saying that the way of prioritizing issues to deal with are unique to each firm and that there is no general way to start. The empirical findings clearly state the importance of being pragmatic and to *"dig where you are standing"*, according to Lean Expert 1 and Lean & CM Expert 1. Lean & CM Expert 1 use the expression *"the best is the enemy of the good"* to illustrate this, meaning that there is a risk of spending too much time on finding the optimal solution resulting in no action taken at all. A pragmatic approach

is preferred in front of finding the optimal solution at once, something that is in line with the kaizen methodology of small continuous improvements.

4.2 Factors driving for improvement in carrier firms

The second theme that arose from the interview study is the parameters to improve in a carrier firm, meaning what the improvement efforts aim at.

4.2.1 Cost

Management experts	- Focus on the right things and cost reduction will follow. - Study largest flows to reduce cost.
Carrier experts	- Transport buyers choose the cheapest alternative. - Price is important to customers.
Transport buyers	- Cost is the most important factor when buying transportation.

SCM Expert 1 suggest a study of the largest flows and costs, and then to look at the cost for each step. Money is a result of what you do according to Lean & CM Expert 1, and therefore focusing on doing the right things will enhance cost savings in the long run. Transport buyer 1 repeatedly state that cost is extremely important when choosing a transport partner. Carrier expert 1 and Carrier executive 1 both agree that price is by far the single most important factor for the customers.

4.2.2 Quality

Management experts	- Internal problems should not affect customers. - Reduce variations. - Hard aspects easy to measure, but soft aspects are still important.
Carrier experts	- Carrier firms follow up customer satisfaction and delivery precision.
Transport buyers	- Delivery precision important when selecting transportation partner. - Driver is the contact point with the customers.

Customer value has both *hard* and *soft* aspects according to Lean & CM Expert 1, and it is important to be aware of and measure both. Hard aspects are easy to measure, for instance goods damages or being on time. However, customers more often judge by the soft aspects, as for example the behavior of the drivers. A nice and service minded driver increases the quality and therefore the customer value. SCM Expert 1 states the importance of not letting internal problems affect the customer and to reduce variations in the operations. Transport buyer 1 defines quality in the form of delivery precision to be one of the most important aspects when selecting a transport partner. Another very important quality related aspect is the driver's behavior at the receiving end of the transport; this is according to Transport buyer 1 an important contact point with their customers. Transport buyer 2 and Transport buyer 3 also mention several quality aspects as important attributes for motor carriers, such as thoroughness when dealing with bills of carriage, good order in the trucks, short stops and punctuality. Carrier executive 1 says that they follow up on customer satisfaction and delivery precision.

4.2.3 Flexibility

Management experts	- Purpose is to shorten time from customer contact to payment. - Reduced lead times make firms more flexible less vulnerable to customers' mess. - Other firms' reduced lead times also affect carriers. - Flexibility very important in transportations.
Transport buyers	- Flexibility is important.

Lean & CM Expert 1 defines Lean as a structured way of working with continuous improvements with the aim of reducing the time between customer contact and when money can be seen on an account. Also SCM Expert 1 stresses the importance of reducing lead times. CM Expert 1 states that shortening the reaction time gives the company a chance of being more flexible and thus handling late changes from customers in a better way. For instance, a shorter order handling process leads to a longer planning window which increases the ability of being flexible and doing better route planning. This might also improve quality and reduce cost.

Carrier firms become affected when more and more companies use Lean philosophy and require smaller but more frequent deliveries, according to SCM Expert 1. This puts high demand on transportation when it comes to flexibility and dependability. At the same time carrier firms needs to be able to handle momentary capacity changes, which makes it difficult to level the work flow, SCM Expert 1 also tells. Transport buyer 1 think flexibility is important when choosing transport partners.

4.2.4 Environment

Carrier experts	- High demands from customers on environmental care. - Political as well as personal interest in reduced emissions. - Customer not willing to pay for reduced emissions. - Almost all trucks are Euro 5. - All drivers are educated in eco-driving.
Transport buyers	- Want to work tight with carrier firms to reduce emissions. - Looks over their transportations regularly due to environmental aspects. - Demand that their motor carriers use Euro 5 trucks. - Demand that the trucks are always fully loaded.

Also motor carrier firms participate in the global effort to reduce the impact on our environment. Carrier expert 1 and Carrier executive 1 describe the increased pressure on carrier firms from its customers to reduce their emissions and they both realize that in order to stay competitive, along with the general responsibility to preserve this earth for future generations, it is vital to work hard with sustainability issues in the everyday operations. Still they both discuss the problem with increased costs when reducing emissions and say that customers are seldom willing to pay for it. Transport buyer 1 agrees that the environmental performance of a carrier firm is an important parameter, and that they are willing to work hard together with their transport partners to reduce emissions. Also Transport buyer 2 continuously collaborates with their carriers to reduce emissions. Transport buyer 3 demands from their carriers that they are Euro 5 (at present the highest environmental rating of a truck) and that they always travel with full load. Carrier executive 2 point out that almost all their trucks are Euro 5 and that all their drivers have a eco-driving education with the purpose to reduce fuel consumption.

4.3 Choosing improvement projects

The two prior themes from interview study has dealt with how to and why start up improvement work. In this section certain parameters that have been identified when choosing between different problems or alternatives are presented. This section of the interview study has only been derived from the data from the management experts. The interviews with Carrier executive 1 and Carrier executive 2 contained questions about this subject, but there were either no answers given or they misunderstood the questions. The answers that were given did not contain any information about the nature or conditions for improving, only about the results such as cost reductions. The questions were not asked to the transport buyers.

4.3.1 Measurability

Management experts
- Set quantified goals.
- Goal fulfillment must be clear and unquestionable.
- Base decisions on facts.
- Important to know if a project is successful.

To state if a true problem really exists it is necessary to be able to measure the present state before initiating an improvement project. Lean & CM Expert 1 point out the importance of taking decisions based on facts. Measurability is also important during and after the improvement project in order to know the outcome of it. Lean Expert 2 and Lean & CM Expert 1 stress the importance of setting goals so that the involved personnel know if their efforts have been successful. Goals should be quantified, according to Lean Expert 2, so that it is clear and unquestionable when they have been met. A problem easily measured is hence more suitable to solve than one that is not. It is also important to be able to show progress in numbers to the entire company, says Exert 4.

4.3.2 Visibility

Management experts
- Everybody must agree that a problem exists.
- Start with the most visible problems.
- Make problems visible they are not already.
- Obvious problems obviously need to be solved.

Chances of an organizational-wide approval of a problem solving effort are increased if the problem itself is clearly visible. Lean & CM Expert 1 say that it is important that everybody agrees on the existence of a problem that a firm faces and suggest starting with the most visible problems. It is not enough that only a small part of the firm or only the consultants see the problems, everybody need to see them. If not already visible, Lean & CM Expert 1 suggest that they are made visible through meeting or a message board. If a problem is obvious, it is also obvious that is need to be solved. Lean Expert 1 says that even though improvements should be measurable it is not vital that they can be translated into monetary terms.

4.3.3 Management support

Management experts
- Make a detailed plan together with top management.
- Make top management understand the potential for change.
- Improvements are investments and not costs.
- Involving top management is a prerequisite for successful improvement work.
- The most important is that the carrier firm understands the potential.

In any improvement work it is vital to have full support from the top management team. When choosing between different improvement projects this has to be considered. According to CM Expert 1 and Lean Expert 1 the involvement and approval from top management is a precondition to make improvement work possible. Lean & CM Expert 1 says that it is important to show top management the possible potential of improvements. CM Expert 1 agrees on this and adds that top management need to see an improvement program as an investment and not as a cost. CM Expert 1 suggests that top management should take part in the detailed planning stage of the improvement project. The whole firm needs to agree on the problems they face to create a common picture of the challenges, according to Lean & CM Expert 1, and this also include top management.

4.3.4 Complexity

Management experts
- Do not try to super-optimize by tackling large problems.
- Use low hanging fruits to enthuse people.
- See the optimal solution and iterate towards it with small continuous steps of improvements.
- Start with small problems in the initial phase of an improvement effort.
- Small carrier firms may not have the resources to make big changes.
- Small improvements make it possible to go back if not efficient.

When choosing a problem to tackle one must consider the complexity of solving it. CM Expert 1 describes the dangers of attempting to solve too large problems as "if you always try to super-optimize improvement work will be slow". CM Expert 1 instead suggests making small continuous improvements to iterate toward the optimal solution. Lean Expert 2 says that it is important to understand the big picture when formulating a problem, but sometimes solving that big true problem is not possible. If not, still start by solving the small problem. Lean Expert 1 also talks about the importance of seeing the optimal solution. It may be a too large step to take today, but will serve as a base to discuss around and as a goal that can be reached by smaller and easier changes. SCM Expert 1 describe that a small carrier firm may not have the possibility or resources to invest in new technology, and that they instead will have to start with other solutions. In the initial phase of an improvement program it is good to start working with smaller problems according to CM Expert 1 and Lean & CM Expert 1. This is because a successful solution is important to motivate the personnel to continue the improvement work. It is also easier to accept and try solving a problem if it is clear that if the attempt fails, it is possible to go back to the original state. CM Expert 1 says that this is the strength of doing small changes, since you can always go back if it does not work.

4.3.5 Control and access

Management experts
- Solve problems where it is possible to reserve time and resources. - Always start improvement work internally. - Do improvements where you can access. - Efficiency potential in internal processes. - Internal processes can primarily be affected.

It is easier to solve a problem isolated within the firm than involving other actors, such as customers and suppliers. SCM Expert 1 says that there are always efficiency gains to make in the internal processes, and that this is the efficiencies that motor carrier firms primarily can affect. Lean & CM Expert 1 agree that improvement work should always start with looking internally, before you reach a certain point where other actors can be involved by saying "cLean in front of your own door before asking your neighbor to cLean in front of his". Lean Expert 2 describe that sometimes it is preferable to first solve a problem internally that is caused by a supplier or customer. Once solved, the cost of the problem is easily calculated and presented to the other actor. Internal improvements should also be done where it is possible to reserve time and resources for problem solving, says Lean Expert 2.

4.3.6 Frustration

Management experts
- Consider the symbolic message of solving a specific problem. - Symbolic value can be more important that real efficiency gains. - Most individuals have certain things they want to change. - Local optimization can be sought in order to show that change works.

The frustration and anger among personnel toward a certain problem can be used as fuel in the problem solving process. CM Expert 1 suggest looking at the level of symbolism of different changes to create involvement and commitment; this is sometimes more important than the effect of the actual change. CM Expert 1 says that all individuals often have a list of about ten things that they want to change. Lean Expert 2 even suggest that a problem with a high symbolic value should be solved even if risk to lead only toward local optimization.

4.3.7 Personal interests

Management experts
- Do not blame individuals for problems; the important thing is what is wrong with the system that made it possible. - Individual change risk becoming slow and complicated. - Carrier drivers do not belong to a natural team; there is a risk of change in carrier firms becoming too individual. - Group people together, it is generally it is not good to use individual goals. - Personnel must feel safe and secure to make change possible. - Changes that lead to individual loss of power or privileges will be obstructed. - Dangerous to exclude middle management.

It is preferable to start with problems that are not connected to the actions of a specific individual, says CM Expert 1. Solving problems with a too high level personal connection may lead to slow progress, so CM Expert 1 instead suggest grouping personnel together to solve problems on a team level. Lean Expert 2 believes that personal goals are generally not good and

that the personnel must feel safe and secure to enable improvements. Lean & CM Expert 1 talk about the risk of exposing certain people to uncomfortable situations and that it is the managers' job to avoid blaming individuals. If a problem appears, do not focus on the person committing the mistake. Instead evaluate what is wrong with the system that made the mistake possible, says Lean & CM Expert 1. Before starting solving a problem any personal interests or internal politics that might infer on the implementation of the solution has to be evaluated. According to CM Expert 1 it is common that middle-management is left out in the improvement work with may lead to them working against the changes. Any individual secretly opposing the change may significantly sabotage the process, according to CM Expert 1. Changes may lead to individuals losing power or privileges, which will make them work against the change.

5 Analysis

In this chapter the theoretical framework together with the empirical study will be the base for answering the two research questions. The chapter is divided into two parts, one for each research question. Research question one leads to a graphical model to present waste that is tested with data from a Swedish and a Swiss carrier firm. Research question two leads to a framework for deciding where to start improvement work in a firm. The chapter starts with an overview of the complete proposed framework.

5.1 Overview of framework for introducing continuous improvement

For the reader in a rush to start up the improvement program, a summary of the proposed steps are presented in Figure 5.1. The framework includes the LWA method and the answers to both research questions which will be presented later in this chapter. In Chapter 6 the validation of this framework on a Swedish motor carrier firm will be presented.

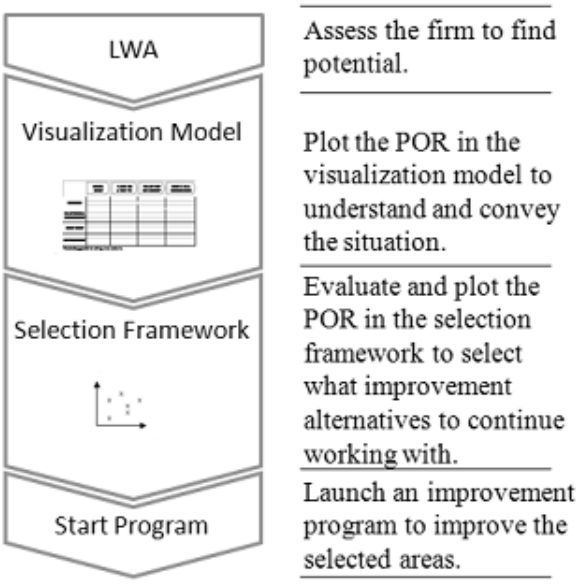


Figure 5.1: Proposed steps for improvement work in carrier firms

5.2 RQ1: How can problems in a motor carrier firm be presented in order to motivate for improvement?

The purpose of presenting problems that exist in an organization is to show that there is potential for improvement. The interview study has shown that motor carriage organizations in general are not used to organized improvement work and that they operate the way they have always done. It is hence important to find a way to convey the problems that the organization has, and might already be aware of, in a way that motivate for improvement.

Actions affect other people

The nature of carrier firms make people work in isolation. Drivers work in their trucks geographically separated from other drivers and the rest of the personnel. This geographical separation

makes it harder to see the direct consequences of your work on other people, for instance the interview study mention that there is a lack of understanding between traffic planners and drivers regarding their jobs and problems. It is hence important to show how their actions affect each other, and how they can help each other in their daily work.

Problems caused in environment can be solved internally

Many problems in organizations are caused by actors in the environment located in upstream processes. In a company that produces physical goods those actors would have been suppliers. If a production company has a problem in one of their processes due to raw material of inferior quality, they can solve this by making their supplier improve quality or simply choose another supplier. Since the production company is the customer who pays the raw material supplier for its product, the supplier will most likely be interested in improving or it will lose its customer. This is the normal relationship between actors in a market economy. In a carrier firm, the situation is different. The actor upstream in the process of transporting goods is the one shipping the goods. But the one shipping the goods is also, normally, the one paying for the shipment and can be considered to be the customer of the carrier firm. This puts the carrier firm in a delicate position, since tougher demands on the actor upstream in the process may lead to a lost customer. Therefore, carrier firms to a large extent have to solve problems internally even if the real cause behind a problem is someone else. Because of this there is an obvious risk that carrier firms see problems clearly, but believe that they can only be solved by their customers upstream, not by the carrier firm themselves. The interview study suggest that problems first should be solved internally before involving external actors, and it is hence important to show carrier firms that this is possible in their case. From the theories about problem solving the different acts of solving, resolving and dissolving problems are discussed. Even if a carrier firm can not solve problems that are caused by external actors they may resolve or even dissolve them themselves.

Improvements with low cost preferred

Carrier firms that are not used to improvements and show low profit margins may not be willing to do large monetary investments if the outcome is not guaranteed. The interviews mention the possible reluctance to investments. But many improvements can be made that do not require monetary investments but only investments in time. Personnel can be trained and routines can be modified, and if this can be done during normal working hours the "cost" of improvement will not show. It is important to show to the organization what can be done with the resources already available.

Problem solving through collective effort

Problems that for one person seem impossible to solve can sometimes easily be solved through a collective process. This phenomenon is described through the theories about problem space introduced by Newell and Simon (1972) introduced earlier. Each problem solver creates their own problem space depending on how they conceive a problem. A truck driver see a problem in one way that may be different from how a traffic planner or the administrative personnel see a problem, since they all have different problem spaces. The problem space decreases by self-imposed constraints which limits the creativity (Ackoff, 1978). By enabling an overall understanding of the problem and making everybody's role clear in a larger context, the total problem space for all involved thus will increase. When seeing problems in a larger context, the room for creative solutions will increase along with an increasing problem space. By simply putting together different people from a fragmented organization such as the carrier firm they may be able to solve problems that none of them has been able to solve by themselves.

5.2.1 Creating a visualization model for presenting improvement potential

The above limitations and possibilities call for a way to present problems that motivates personnel in carrier firms for improvements. From the empirical study, four recommendations have been formulated: understand and convey the current situation, graphically visualize the problems, present everybody's role in a larger context, and categorize problems. In this section a graphical model aiming at fulfilling this is proposed.

An LWA of a carrier firm will result in a list of POR. A framework to graphically visualize the POR is suggested and presented in Figure 5.2. The visualization model is a matrix with two axes; a horizontal axis with the process of where the POR was found, and a vertical axis that puts the problem into a category.

	SHIPPER	ORDER ENTRY	PLANNING & TRAFFIC CONTROL	TRANSPORT EXECUTION	INVOICING & REGISTRATION
ROUTINES					
MANPOWER \& MANAGEMENT					
EQUIPMENT					
ENVIRONMENT					

Figure 5.2: Visualization model without assessment data

Horizontal axis: Process

As stated earlier, both Lean Expert 1 and SCM Expert 1 suggest using Value Stream Mapping (VSM) as a powerful tool to illustrate how people and processes are connected and dependent on each other. VSM is one of the methods used when conducting a LWA at a carrier firm which means that it is obvious to the person making the assessment from which process the identified POR stem. The processes identified in the VSM will therefore serve as the base for the proposed visualization model. The POR will be plotted in the process where they were visible. Normally, the first process studied in an assessment is the core process, spanning from initial customer contact to payment. However, it may also be other processes such as customer complaints, maintenance or salary administration. If several different processes are assessed there should be one graphical model for each, to clearly show their independence from each other. The core process may look different in different carrier firms, for example depending on if they are connected to a third party logistics provider. The first process, *shipper*, is a process that lay outside the carrier firm. This is the upstream actor whose acts also have consequences for the carrier firm.

Vertical axis: Problem Category

It is also useful to do a second classification of the POR into different categories. Doing so will

give a clearer view of which areas the most problems stem from, and give an initial idea of which problems to deal with first. Some problems may deal with for example the physical resources, such as the trucks or fork lifts, while others simply regard compliance with defined routines. Those two groups of problems are of completely different nature and it is helpful to separate them from each other since they have to be dealt with in different ways, probably by different people. Inspired from the 7 M's often used in Ishikawa diagrams and based on observations and data from carrier firms, four possible problem categories are proposed. They are designed to fit problems in carrier firms and are described below.

- **Routines**
  Problems that stem from insufficient routines and lack of standardized work.

- **Manpower and management**
  Problems caused by bad management, insufficient training of personnel or failure to apply to the established routines.

- **Equipment**
  Problems caused by inferior equipment, such as the trucks or IT-system.

- **Environment**
  Problems that arise from external factors, such as customers, traffic situation or weather.

Some of the original 7 M categories have been discarded since they are designed to use for production companies. One fundamental difference between carrier firms and production companies is the form of the value adding activities. In a company producing physical goods the value is added through machining and assembling while a carrier firm adds value by transporting products from one place to another. Carrier companies add value through place and time utility and this difference from a regular production company has some consequences on how the categories can be used.

The category *routines* contain problems that stem from inferior working procedures. Such problems can be solved by changing the way of working and spreading new practice to be followed by the people in the firm.

The two categories *manpower* and *management* are as relevant in a carrier firm as in a production firm. In the model presented in this thesis they have been combined since it may be difficult to distinguish them from each other and since the aim is to design an easily understood model. Manpower contains issues such as failure to comply established routines or lack of education, while management is a wide category that contain for example leadership.

Both production companies and carrier firms use resources in the form of machines and other equipment to perform value adding activities. Essential in carrier firms are for instance trucks and equipment to move goods with. Also IT-systems such as route planning, invoicing software and handheld computers are proposed to belong to the same category that in this model is named *equipment*.

Carrier firms are also affected by external factors, which in the 7 M's fall under the category milieu. Such factors may be the traffic situation, weather or the cooperation with other actors. In our model the term *environment* is used to describe external factors.

Two categories from of the 7 M's have been discarded. The first one is material. In production the raw material has a large effect on the finished products and therefore material is a relevant category. For a carrier firm it is not, no raw material is used. It can be claimed that the shippers use material to protect the goods and that for example poor tape or cardboard would be material problems, but in this model those issues would fall under the category environment since they are caused by an external actor.

The second discarded category is measurement. Being able to measure the manufactured or assembled products' quality is important in the production industry. In a carrier firm however, the quality of the transported goods does not affect the quality of the value added work in the form of transport and place utility. Therefore, the category measurement is not as necessary as in a producing company. Carrier firms do spend some time measuring, for example the amount of goods sent to make sure it matches the amount specified in the invoice sent to the customers. But problems with this more suitably fit under the categories routines, if routines for measuring is missing, or equipment, if there is a lack of proper equipment to measure the goods.

It is important to clarify that no attempt to conduct an actual Ishikawa analysis should be made. The Ishikawa methodology should be used to find the causes behind a true problem. The model proposed above contains not only true problems, but all types of POR. As the empirical findings show, Ishikawa diagram is too time-consuming to use in an early state of the improvement work. Instead, the attempt was to take inspiration from the categories often used in Ishikawa diagram to find relevant categories for carrier firms which enhance a broader understanding of the current state. The aim was to find categories as mutually exclusive as possible, however some overlap is inevitable.

Visualizing causality and control

The purpose of the graphical representation model presented is to do a rough categorization of the POR to enable a clearer view of the present situation and motivate for improvement work. But it is also to show how problems arise from earlier processes and to distinguish what problems that can be solved internally and what can be solved only by involving external actors, such as the shipper of the goods. Each POR should be analyzed with the purpose of determining if the problem can be solved in the actual process where it was discovered, or in which earlier it can be solved. In the visualization model, a line should be drawn from the POR to the process in which the cause behind the problem lies. If the problem can be solved in the actual process, no line is drawn. Doing so will show what problems that need to be solved in earlier processes and what problems that can be solved isolated in the current process.

5.2.2 Placing the data into the model

The purpose of the graphical representation model presented is to do a rough categorization of the point of recognitions to enable a clearer view of the present situation and motivate for improvement work. The model shall be used pragmatic. If analyzing each POR too much, the plotting into the model will become very time consuming. Below the methodology for using the model is described. For the confused reader, do not worry, two examples will follow when testing the model with data from real carrier firms. The LWA results in a simple list of POR. Examples of such lists are shown in Appendix B. Placing each POR in correct place in the model is done by asking two simple questions.

1. *In which process was the POR visible?*
   The answer should be obvious to the person conducting the assessment. If a POR is discovered for instance during the VSM in the truck, the process should be "Transport execution". If instead the POR is discovered during an interview with the transport planners, the process should be "Planning". The answer will tell in what column to put the POR in the model.

2. *In what main category does the POR belong?*

The categorization above resulted in the four categories routines, man and management, equipment, and environment. Placing the POR into categories can be done by asking the below questions.

- Is the problem solved by changing the existing routines?
- Is the problem solved by education, change of attitude or by changed management?
- Is the problem solved by modifying old or introducing new equipment?
- Can the problem only be solved by involving external actors?

If the most obvious cause lies in another (earlier) process, this should be marked by drawing a line to that process. Doing so will show the causality of actions in the firm and what problems that can be solved internally.

Answering the question to which category a POR belongs is subjective and may not always be obvious. For example many problems that can be blamed on environmental factors, such as traffic congestions, can be solved by changing routines such as working hours or choose different routes. As mentioned, the model should be used in a pragmatic manner. Properly defining the true problem behind each POR and finding the true cause for all of them is, as mentioned earlier, very time consuming and not suitable in this early stage of improvement.

5.3 Testing the visualization model with data from carrier firms

Before using the visualization model in a real case in a carrier firm it is tested with available data from two earlier assessments. LWA data sets in the form of a list with POR from two different motor carrier firms, one in Sweden and one in Switzerland, are used to test the model's capability to present problems. The different entries of the list is analyzed one by one by following the methodology in Section 5.2.2, placing them on the correct place on the horizontal and vertical axis. Since the LWA from which the data sets stem were not conducted by the authors, both test cases were validated by the actual individuals conducting the assessments. The original data sets are presented in Appendix B and the result, when plotted in the visualization model, is presented in Figure 5.4 and Figure 5.6.

5.3.1 Model test case with data from Swiss carrier firm

The model with the plotted data is shown in Figure 5.4. Some POR had direct causes lying in earlier processes and are marked by a line ending at a box with a number, with a corresponding explanation.

When plotting the POR in the model it becomes possible to do some calculations. The model itself work as a tool for analysis, and the results are presented in Table 5.2. During the assessment the drivers' work was analyzed with the aim of showing the amount of value adding work. One driver was followed during a full day of work and the findings are presented in Figure 5.3. It is reasonable to believe that the detected problems, shown in Figure 5.4, are some of the causes behind the waste, shown in Figure 5.3.

Total number of POR	19	100%
POR that can be solved partly or fully within the organization	14	74%
POR that need to be solved in earlier processes	7	37%
POR that stem from insufficient routines	10	53%
POR that stem from manpower and management	3	16%
POR that stem from equipment	2	11%
POR that stem from environment	4	21%

Table 5.2: Statistics from Swiss test data

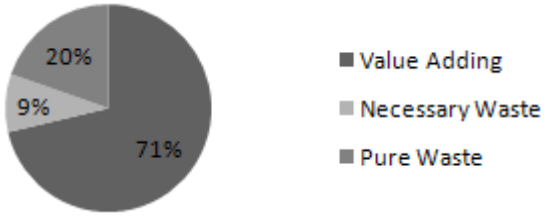


Figure 5.3: Amount of value adding, non-value adding and waste of the drivers' working hours in Switzerland

5.3.2 Model test case with data from Swedish carrier firm

The model with the plotted data is shown in Figure 5.6. Some POR had direct causes lying in earlier processes and are marked by a line ending at a box with a number, with a corresponding explanation.

When plotting the POR in the model it becomes possible to do some calculations. The model itself work as a tool for analysis, and the results are presented in Table 5.4.

Total number of POR	15	100%
POR that can be solved partly or fully within the organization	13	87%
POR that need to be solved in earlier processes	3	20%
POR that stem from insufficient routines	6	40%
POR that stem from manpower and management	4	27%
POR that stem from equipment	3	20%
POR that stem from environment	2	13%

Table 5.4: Statistics from Swedish test data

During the assessment the drivers' work was analyzed with the aim of showing the amount of value adding work. Two drivers were followed during a full day of work and the findings are presented in Figure 5.5. It is reasonable to believe that the detected problems, shown in Figure 5.6, are some of the causes behind the waste, shown in Figure 5.5.

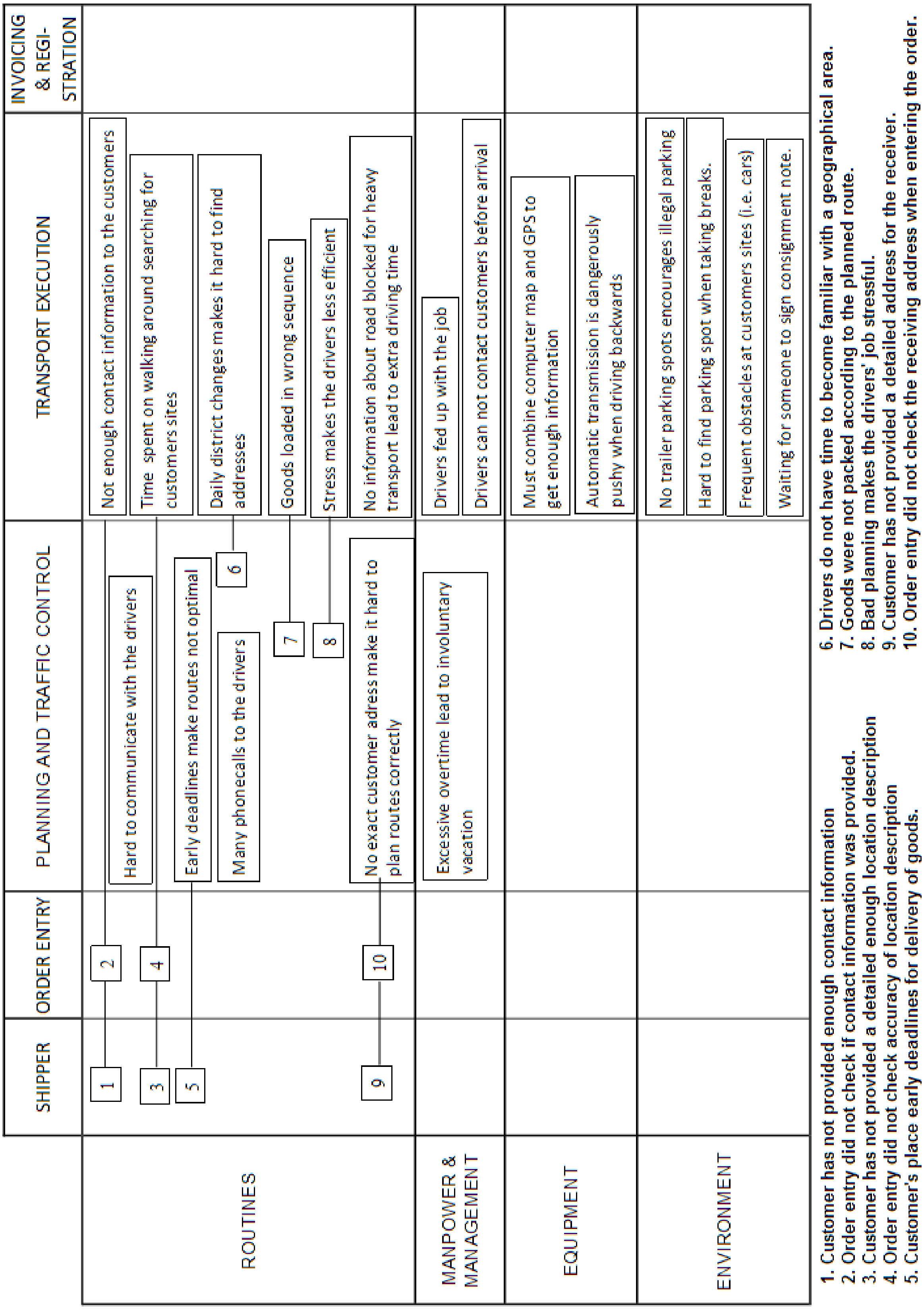


Figure 5.4: Data from Swiss firm carrier firm inserted in model

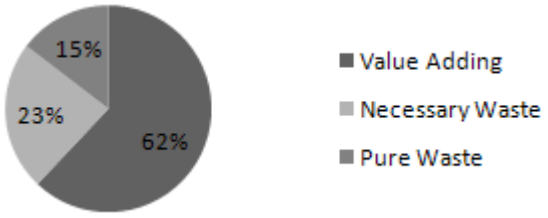


Figure 5.5: Amount of value adding, non-value adding and waste of the drivers' working hours in Sweden

5.3.3 Summary of test cases

As can be seen in Figure 5.4 and Figure 5.6 most POR end up in the *Transport execution* process. This corresponds well with the empirical and theoretical study saying that the problems show in the value adding process, the production is said to be the mirror of the whole organization. Figure 5.4 and Figure 5.6 indicate that the same is true about the transport execution in carrier firms. This demonstrates the importance that all employees know who their next internal customer is and how their work affects others.

The statistical data from the two data sets are combined and presented in Table 5.6.

Total number of POR	34	100%
POR that can be solved partly or fully within the organization	27	79%
POR that need to be solved in earlier processes	10	29%
POR that stem from insufficient routines	16	47%
POR that stem from manpower and management	7	21%
POR that stem from equipment	5	15%
POR that stem from environment	6	18%

Table 5.6: Statistics from the two test cases

The visualization model has shown that there is good potential for improvements in carrier firm and should work as a tool both for showing problems and to motivate for improvements and some specific conclusions can be drawn.

Problems can be solved by the carrier firm
Data from the test cases show that 79% of the problems that had been discovered can be solved (fully or partially) within the organization. This is calculated by removing the POR in the environment category and POR that have causes lying only in the external shippers process (upstream from the carrier firm). This finding clearly show that there is potential for improvements and that even though many problems are caused by outside actors, they can still be prevented by resolving or dissolving internally.

Problems are often caused in earlier processes
The data also show that 29% of the POR stem from actions made in earlier processes. This makes it obvious that personnel in different positions within the carrier firm must cooperate and solve problems together. They need to consider the next internal process as their customer and

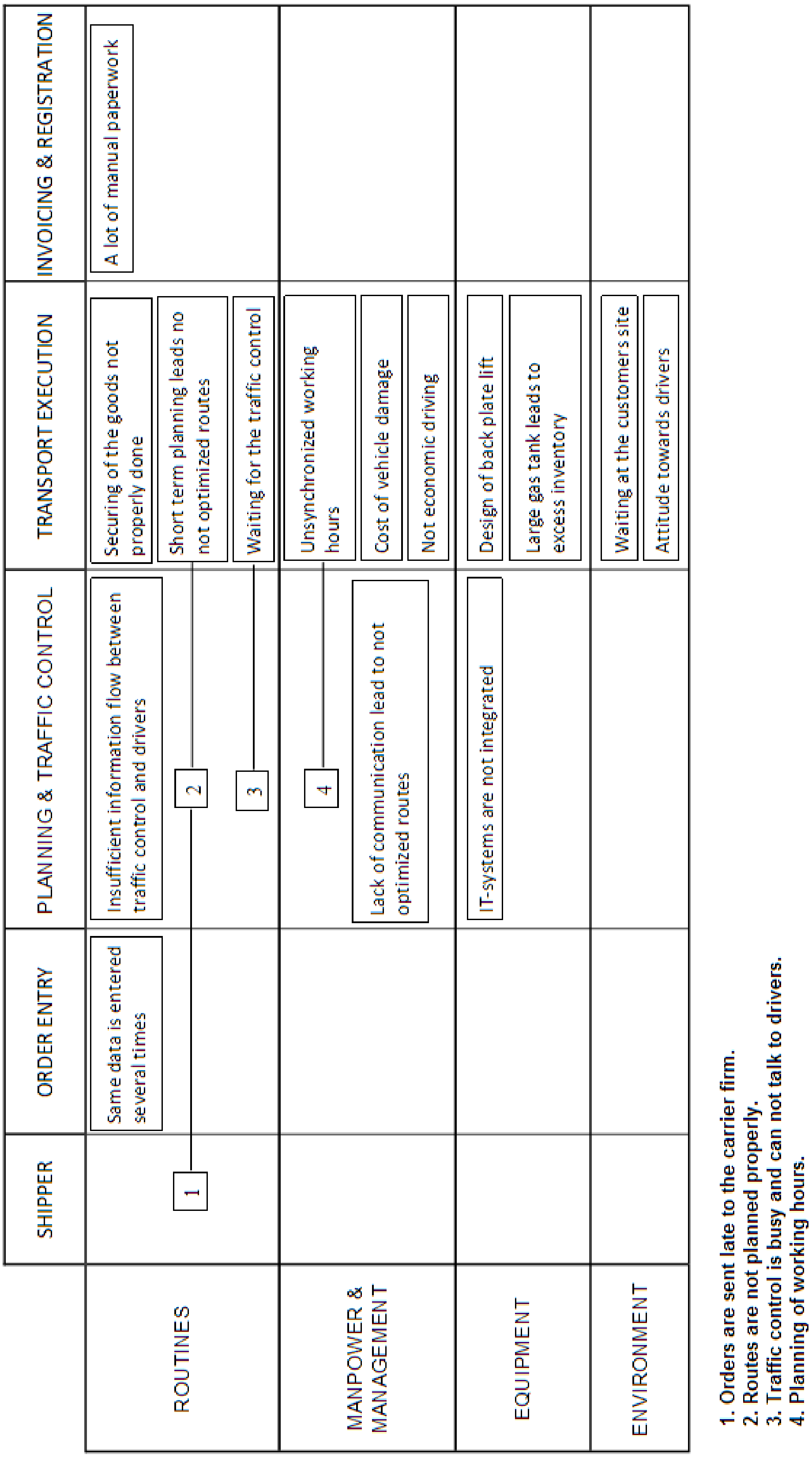


Figure 5.6: Data from Swedish firm carrier firm inserted in model

give them correct information and service.

Improvement potential with low investment cost
The results point towards a large potential for improvements that will bring no extra cost except time allocated. 68% of POR ends up in the categories *routines* and *manpower & management*, and no large investment should be necessary to solve these. Standardized work including new routines, involvement and communication would probably eliminate most of the POR presented in the two categories.

With this data it should be obvious that improvement can be made and that it is up to the carrier firm to make them.

5.4 RQ2: How to decide in what order to reduce waste in a motor carrier firm?

When a common overall view of the problems in an organization has been established, the next step is to choose where to start making improvements. As the interviews show in Chapter 4 there is no single way of doing this, several parameters unique to the actual organization need to be taken into account.

5.4.1 Introducing the selection framework

To answer research question two a framework is proposed that can be used to rank different improvement alternatives in a carrier against each other in order to decide which to start with. Based on the theoretical and empirical findings a framework used to rank different improvement alternatives has been developed. After an assessment and visualization of a carrier firms' POR, the present improvement alternatives can be evaluated with this framework in order to decide where to start. The framework is illustrated through a simple graph, with two dimensions. The two axes in the graph are labelled *value* and *chance of success*, described below.

Value
Improvements are made to make the situation for the carrier firm and its different stakeholder better. From theory presented earlier there are four different groups to consider when making decisions. Those are customers, employees, community and company. Any improvement activity in a company shall aim towards increasing value for those four groups. The interview study revealed that parameters for increased customer value in the carrier industry are cost, quality, flexibility and environmental care. Value to employees may be creating a less stressful working environment and increase safety. The community may as well benefit from better working conditions and an increased environmental care, just like the customers. The company will benefit from reduced cost and from healthy and motivated personnel. It becomes obvious that what is value to one group is almost always value to the other three. What brings value to an individual firm vary depends on that firm's individual vision, strategy and values. As Liker and Meier (2006) states, is it also important to take into account what happens if not making an improvement. Therefore the urgency and the tendency of a problem also need to be considered, to make sure that effort is put a problem that need to be solved and that will not solve itself with time.

Chance of success
The horizontal axis is used to evaluate the chances that an attempted solution is successful. There are many aspects that may help or obstruct change efforts. From the interviews seven different

parameters have been extracted that should be considered before trying to implement change. The seven parameters are divided into three groups: feedback, difficulty and acceptance.

The suggested parameters also relate to the problem solving theory. For instance, control and access of a problem have to do with the amount of uncontrollable variables affecting the problem. Ackoff (1978) discuss the fact that a person's reaction to the solution to a problem depend on that person's personal objectives. In order to succeed with an improvement project it is therefore necessary to take into account the acceptance of the solution, if for instance individual's personal interests differ from the overall objective of the carrier firm.

According to Liker (2004), standardization and compliance with standardized working procedures is a prerequisite for continuous improvements. Without knowing how people work today, it is hard to decide upon improvements for how to work in the future. Establishing routines and make everybody follow them is a way to standardize. The PDCA cycle that can be used in improvement projects includes measuring both present and future state. If the outcome of the project has been successful the new way of working shall be standardized. It is important to not see standardization as something fixed and unchangeable, instead it shall be seen as the best known way of working at the moment.

In Figure 5.7 seven parameters to consider when evaluating the chance of success for an improvement initiative is proposed.

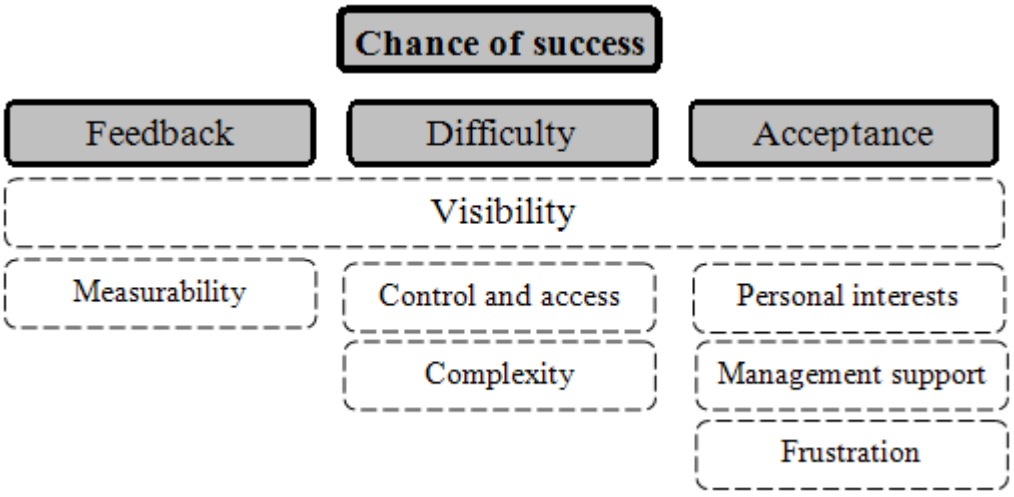


Figure 5.7: Seven parameters to consider for determining success chance for improvement projects

5.4.2 Using the selection framework

The different improvement alternatives are evaluated according to the earlier mentioned parameters for *value* and *chance of success*, and plotted in the graph. Determining the values on each axis has to be a subjective process and the accuracy is dependent on the evaluators' skill and level of understanding the current organization and its situation. To increase accuracy the evaluation team should consist of multiple people from cross-functional areas with different backgrounds. Some or all of the improvement alternatives that has been identified should be plotted in the prioritization model.

After plotting the alternatives in the graph the next step is to decide which alternative to start with when launching an actual improvement program. The most preferred improvement

projects will be found in the upper right corner as illustrated in Figure 5.8. Those improvement projects have a high chance of success and will also lead to a high increase in value, but depending on the type of firm and its level of maturity to change the decision have to be made differently.

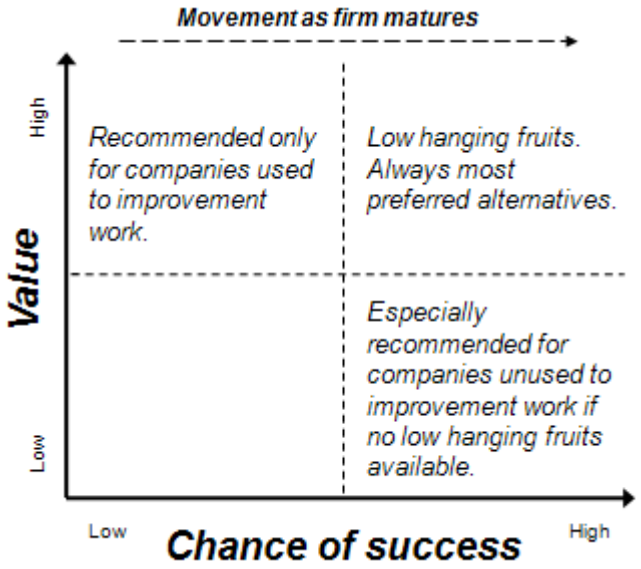


Figure 5.8: Different areas of the selection framework

Choosing improvement project in a firm *not used* to change
Companies with no culture of continuous improvements have a high need for clear proof that the isolated improvement action will be profitable. It is also important find a pilot project with a high chance of success in such companies. It may therefore be even more important for companies not used to improvement work to choose improvement projects on the right hand side of the graph than for companies used to improvement work; else they might lose motivation for conducting improvement work. This means that focus should be on improvement alternatives on the right hand side to gain organizational confidence in improvement work before taking on alternatives to the left. As the empirical study clearly has shown, this is most likely the situation for motor carrier firms.

Choosing improvement project in a firm *used* to change
Companies used to improvement programs might already have harvested the "low hanging fruits" in the top right corner and therefore need to take on alternatives more to the left in the graph. Since an improvement failure will not negatively affect their motivation as much as it would in a company not used to improvement work, they can afford working with improvement more to the left in the top of Figure 5.8. But of course, the "low hanging fruits" in the top right corner are still preferred.

Organizational maturing
From the interviews with change management experts it is revealed that after successfully going through organizational change, a firm will get more used to improvements and is said to become more mature. What happens then is that the organization's capabilities of improving increases, the chances of success grows, which causes all improvement alternatives in the graph to move to

the right, as shown by the arrow in Figure 5.8. This is due to increasing acceptance to changes in the organization and parameters such as personal interest will be less dominating when employees feel more secure with the organizational changes. However, it might not always be that straight forward, the problem picture may look very different after conducting an improvement program since some problem areas might disappear as an unexpected consequence of the program and some new may pop up.

Improvement alternatives in the bottom left corner of Figure 5.8, with low success chance and low potential to increase value, are unattractive and only recommended if no other improvements are available and definitely not suitable for firms unused to improvement work.

As stated before, measurability is a prerequisite to know if a true problem has been found. Before starting up an improvement work the present state should be measured and goals be defined, otherwise there is a risk of solving a non-existing problem. The simple *gemba* approach, to go and see the actual problem, should always be applied. Decisions to start improvement should be based on facts, hence the importance to measure the problem.

Since the aim of the framework is to create a systematic but yet pragmatic approach, the improvement alternatives might not have been measured yet. Instead only a subjective evaluation has been used to define the potential for increased value. If not done at this point in time, it is time to measure the most attractive alternatives now before taking the final decision on which improvement project to choose.

6 Validation

In this chapter the graphical model developed under research question one and the selection framework developed under research question two are validated under real circumstances on site at a carrier firm. During one month the entire process from assessing to starting up improvement work at a carrier firm was conducted. The work method was based on the findings so far in this research and the ultimate criteria for validation was to see if any improvements by involving the personnel could be achieved.

6.1 Selecting a carrier firm for validation

To properly validate the findings in this research a real carrier firm had to be used. Although executing similar work tasks, there are many different types of motor carrier firms. Three criteria were set up to select a suitable firm:

1. **Size**
   The firm had to be big enough for internal processes and routines to exist, but still small enough so the operations remained simple enough to be understood fairly quickly by the researchers. A suitable size was decided to be less than 100 trucks.

2. **Type of operations**
   Carriers operate in many different ways, for example local distribution of general cargo, long range transport, waste management, transportation of fuel etc. In the validation case it was judged suitable to use a general cargo less than truckload distribution carrier firm, since their operations are strictly defined and easy to assess due to their geographical concentration.

3. **Managerial interest**
   The managers of the carrier firm should have an interest in trying new things, be open-minded and allow external people to gain access to their operations.

From the above criteria a carrier firm was selected and contacted. The managers of the firm showed great interest in the validation project and after a short introduction a decision was made to go on with the first step: assessing the carrier firm in order to find improvement potential. The general data of the firm is presented in Table 6.1.

Country	Sweden
No of employees	60
No of trucks	30
Operations	Distribution and inter-city transport
Annual turnover	70-80 MSEK

Table 6.1: Data for carrier firm used for validation

The carrier firm is contracted to a major Logistics Service Provider (LSP). This means that some of the activities that a carrier firm normally does is taken over by the LSP, such as customer contact, contracting and order entry. The carrier firm distributes goods (pickup and delivery) in four geographical areas and transport goods between warehouses in those four areas.

6.2 Assessment

The LWA method was used in order to find improvement potential in the carrier firm and the activities in Table 6.3 were made.

Day	Activity
1	Interview with Chief Executive Officer (CEO)
1	Observations of goods flow in warehouse
1	Observations in office to understand the order to cash process
2	Interview with CFO / CHR (Chief Financial Officer / Chief Human Resources Officer)
2	Interview with administrational personnel
3	Value stream mapping of goods flow in trucks
3	Interview with truck drivers at site one
4	Interview with traffic planning and control at site one
5	Interview with traffic planning and control at site two
5	Interview with drivers at site two

Table 6.3: Activities during the assessment of validation firm

The LWA resulted in a deep understanding of the carrier firm's operations and in a list of POR, point of recognitions, for improvement potential. The list of POR is the base used for selecting improvement projects together with the employees of the carrier firm.

6.3 Validation of research question one - the graphical model

The model with the plotted data is shown in Figure 6.2. Some POR had direct causes lying in earlier processes and are marked by a line ending at a box with a number, with a corresponding explanation.

When plotting the POR in the model it becomes possible to do some calculations. The model itself work as a tool for analysis, and the results are presented in Table 6.5.

Total number of POR	23	100%
POR that can be solved partly or fully within the organization	19	83%
POR that need to be solved in earlier processes	15	65%
POR that stem from insufficient routines	11	48%
POR that stem from manpower and management	8	35%
POR that stem from equipment	1	4%
POR that stem from environment	3	13%

Table 6.5: Statistics from validation firm assessment data

During the assessment the drivers' work was analyzed with the aim of showing the amount of value adding work. Two drivers were followed during a full day of work and the findings are

presented in Figure 6.1. It is reasonable to believe that the detected problems, shown in Figure 6.2, are some of the causes behind the waste, shown in Figure 6.1.

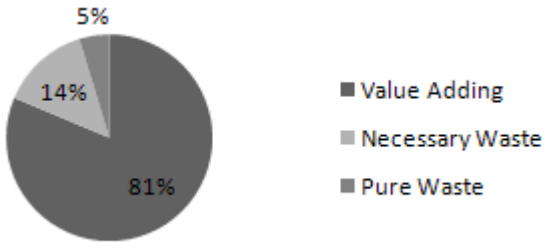


Figure 6.1: Portion of value adding, necessary and pure waste of the drivers' working hours in validation firm

The model with the plotted POR was presented to the managers at the carrier firm. Showing the model for the management team enabled discussions about their organization and the environment in which the firm operates. Not only did these discussions give a clearer view of the firm's problems and limitations, it also gave a better understanding of the people in the management team and their personal interests, frustrations and visions. Discussions during this session made the researchers identify a few further areas that needed to be studied.

The purpose of presenting the model was to validate its capabilities of presenting the improvement possibilities. A discussion was initiated around the different entries, and the model showed to be a good base for discussing different problem areas. The managers agreed on the POR and how it was presented within their organization. A discussion was initiated on how POR that show in the transport execution most of the time are caused by activities in earlier processes, and the model thereby fulfilled its purpose of placing problems in a context and showing their relation to other activities in the company. On a direct question from the researchers about the pedagogical strength of the model, all managers agreed that the model was a good way to present problems. The separation of problems that stem from within the organization from the ones caused by external factors (either in the *environment* category or in external upstream processes) was especially appreciated.

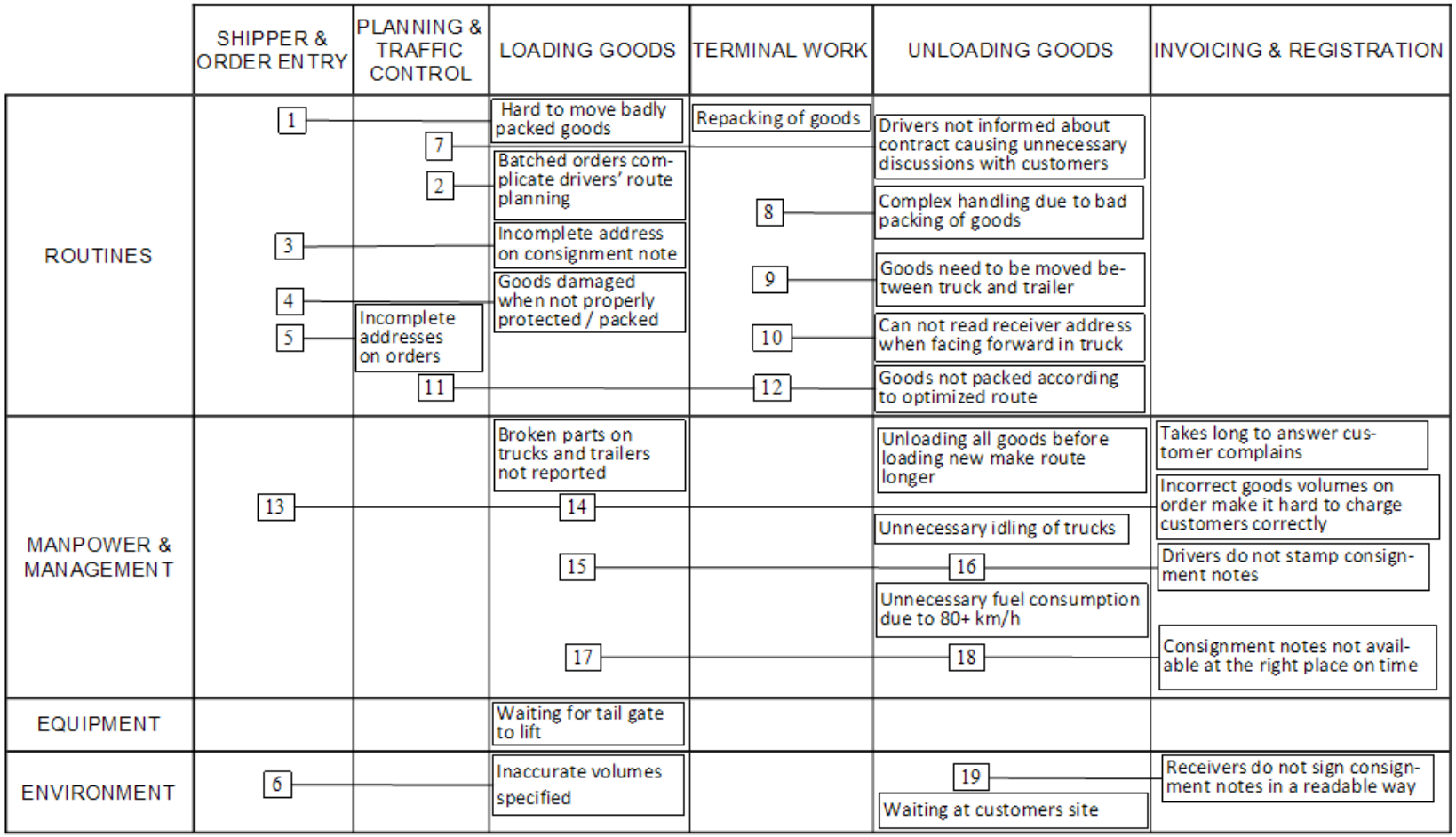
In future work, it may be a good idea to involve the management team already in the placement process to integrate them further in the process. The reason for not including the management team in the process of placing the POR in the model was that the researchers wanted to validate the model themselves to have the opportunity to study the response of the management team when the model was shown to them.

Placing the POR into the model also helped the authors to arrange their thoughts and to establish a common view of the current state and how problems were related to each other. The model also forced the researchers to really understand the processes of the studied carrier firm when defining the categories on the horizontal axis. This gave room for creative and interesting discussions which may not have been brought up if only studying a list of problems not having to take the valuable decisions on how to place them into the model.

This proves that the model is indeed useful when presenting problems in a carrier firm and the researchers conclude that the intended functionality of the model is *validated*.

6.4 Validation of research question two - the selection framework

With the POR plotted in the graphical model the next step is to decide where to start an improvement initiative. In total 23 POR has been identified and it is not possible to start



1. Goods packed in a way by the shipper that make handling complicated
2. Traffic control send several orders to the trucks at the same time
3. Shipper do not print correct address on the consignment note
4. Shipper do not protect goods before transport properly
5. Shipper do not provide correct address when placing order
6. Shipper do state incorrect goods volume in order
7. Traffic control do not inform drivers about specic contracts
8. Terminal workers pack goods improperly
9. Goods not packed in good order
10. Goods pack with address notes forward in the truck
11. Traffic control do not provide enough information of how goods should be packed
12. Terminal worker do not know what order to pack goods
13. Shipper specify wrong goods volumes
14. Drivers do not update goods volumes on consignment note when loading goods
15. Drivers do not stamp consignment notes with their name when loading goods
16. Drivers do not stamp consignment notes with their name when unloading goods
17 & 18. Drivers do not return consignment notes correctly
19. Drivers do not remind receivers to sign with a readable signature

Figure 6.2: Data from validation firm inserted in model

working with all of them at once. To simplify the selection process the POR in the model is analyzed based on their internal relations and grouped together into six different improvement alternatives. The improvement alternatives are presented below and how these relate to the POR is presented in Appendix B.

1. **Information from customers**
   Purpose: Together with the customer come up with routines which improve the information from the customers for example regarding addresses and data about goods.

2. **Consignment notes**
   Purpose: Make all employees follow the routine regarding the consignment note.

3. **Equipment**
   Purpose: Increase efficiency with the help of equipment, for instance by remote controls for tail gate lifts. Also have better routines for reporting broken parts of the equipment.

4. **Handling goods at terminal**
   Purpose: Reduce unnecessary handling of goods and unnecessary driving due to not optimized packed trucks.

5. **Lower fuel consumption**
   Purpose: Reduce fuel consumption by no driving over 80 km/h and no unnecessary idling driving.

6. **Route planning**
   Purpose: Reduce driving time by better optimized routes. For instance by, when suitable, starting to load before finished loading.

6.4.1 Evaluating improvement alternatives

After establishing the list of improvement alternatives, the researchers evaluated the value and chance of success for each alternative. The researchers had a pragmatic approach and did rough estimations based on their knowledge form the carrier firm. Especially rating chance if success could only be made through the thorough understanding of the carrier firm's operations and culture which the researchers had gained during the LWA, interview and observations. The many hours in the office, at the terminals and in the trucks turned out to be well spent.

Table 6.6 presents the outcome and Figure 6.3 shows a plot of the alternative relative to expected value and chance of success.

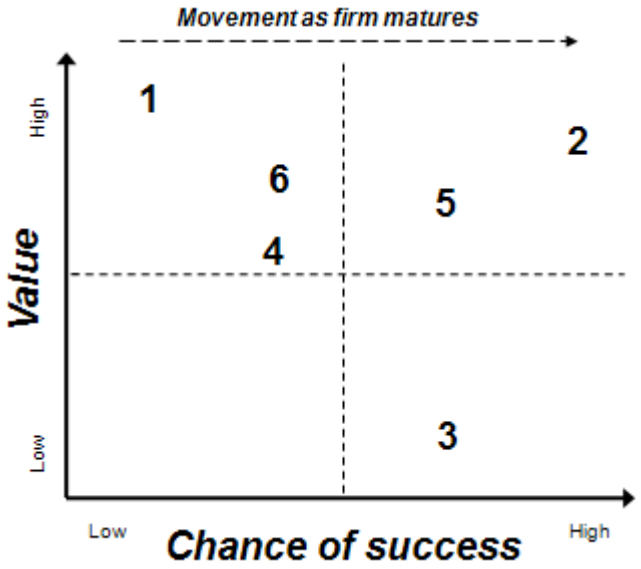


Figure 6.3: The six improvement alternatives plotted by Chance of Success and Value

As explained in previous chapter the most attractive alternatives to start with are found in the upper right hand corner in Figure 6.3, and in companies unused to changes it is preferable to choose alternatives with a higher chance of success than alternatives with lower chance of success but higher expected value. Since the studied carrier firm may be defined as unused to changes, the researchers searched for alternatives to the right but with a relatively high expected value. Further, since a pragmatic approach has been used to estimate the expected value it may be preferable to rely on the parameter chance of success since more effort have been put to prioritize according to that.

Looking at Figure 6.3 it is can be seen that the alternatives concerning the consignment notes and lower fuel consumption are closer to the upper right hand corner than the others. Both alternatives also include standardization which is a foundation for continuous improvements according to Liker (2004). The alternative *Information from customer* has the highest expected value but because of the low chance of success, which is caused by the need to involve many external actors, it is unwise to start with it. The same goes for *handling of goods at terminal* and *route planning*, they are too difficult to start with.

Table 6.6: Chance of success and value of improvement alternatives

	Feedback	**Difficulty**	**Acceptance**	**Value**
1. Information from customers	Possible to measure by going through consignment notes afterwards to see correctness.	Low control and access since it includes external actors (LSP and customers). Constantly changing customers make it hard to implement solutions. Low complexity.	Includes external actors that may not see the obvious gains from improvements. Shippers understate goods volume on consignment notes to save money.	Correct information from the beginning eliminates several problems. Easy to charge correctly.
2. Consignment notes	Easy to measure by analyzing old consignment notes to see if they have been handled correctly.	Control and access is high, except concerning signatures from goods receiver since it includes external actors. Low complexity.	Depending on how the change will be communicated to the drivers. Some frustration has been identified which enables changes.	Drivers know who handled goods before them, speeds up processes and helps traffic control. Right payment from customer. Easier and faster customer complaint handling. More accurate information to customer. LSP demand readable signatures.
3. Equipment	Possible to measure for example number of reports on broken equipment. Hard to measure gains from new equipment such as tail lifts.	Low complexity and high control and access.	High acceptance among drivers but low among management since could be expensive.	Time saved.

4. Handling goods at terminal	No straight forward way of measuring, but indicators can be used to see result.	Rather complex to decide the most optimal order to pack the goods (it differs from day to day and is highly connected to route optimization). Control and access is high although it concerns several drivers handling the same goods.	This is the drivers' specialty, it might be difficult for the researchers to gain respect with new ideas in this field. The drives do not see the problem themselves, which may reduce acceptance.	Reduced driving distance and goods handling time. Quicker deliveries. Reduced fuel consumption.
5. Lower fuel consumption	No way to measure idling at the moment. Driving time over 80 km/h is measurable through software connected to GPS in trucks.	Both problems have low complexity, high control and access.	Highly connected to the driving style of individuals. No frustration from drivers since it does not affect them directly. High support from management to reduce fuel costs.	Reduced fuel consumption reduces emissions and costs. Good image for LSP when trucks do not break speed limits.
6. Route planning	The distance of the routes for each day can be measured, but it is difficult to compare data due to different senders and receivers each day (the route will never be the same).	Very high complexity but also high control and access.	The drivers have an old habit of unloading all goods before starting to load, and it might not be easy to make everybody willing to change.	Reduced driving distance and time saves fuel. Faster and more stable processes.

6.5 Final decision of improvement projects

From the framework two alternatives were selected, *Consignment notes* and *Lower fuel consumption*. All parts of the alternative *Consignment notes* had relatively high chance of success but the researchers decided to focus on getting the drivers to mark the consignment notes (either by using their personal stamps or by writing a signature) after loading and unloading (named Project 1) and to gain readable signatures from goods receivers (named Project 2). To further increase the chance of success for the alternative *Lower fuel consumption*, the idling time was removed since it is not measurable. This leaves trying to reduce speed during inter-city transport to 80 km/h (named Project 3).

The three selected improvement projects all regard following already established routines. This may seem simple, and it may be argued that "real" improvement should involve setting up new processes and routines leading to quick economical gains. In this project another approach was made. The purpose of the research has been to see the appropriateness for introducing Lean in a long-term perspective. Any change or improvement must start with standardizing to establish stable processes and routines. Hence, the decision to do three projects aiming at following already defined routines is a natural start. Project 2, regarding customer signatures, was also interesting since carrier firms tend to blame their customers for many problems. This project would show if the drivers could affect and solve problems caused by actors in their environment. Improvement Project 3, reduced fuel consumption, showed a lower chance of success than the other two projects due to its very individual nature and the night drivers' high level of isolation both from each other and from the researchers. However, this was seen as an interesting experiment.

Before taking any final decision regarding the choice of improvement projects, the researchers measured the present state and compared it to the desired state. All consignment notes from one week were studied and so was the driving speed during two nights. By doing this it was clear that true problems had been found and that solving these would lead to a significant increase in value. The improvement suggestions were presented to the management team and a decision to carry out the pilot projects was taken. Table 6.8 presents the details of the chosen projects.

Project	**Overall purpose**	**Specific goals**	**Participants**
1	Make all employees follow the routine regarding the consignment note	Increase the number of stamped or signed consignment notes.	Day team site 1 Day team site 2
2	Make all employees follow the routine regarding the consignment note	Increase the number of readable receiver signature.	Day team site 1 Day team site 2
3	Lower the total fuel consumption of the carrier firm.	Reducing the speed to maximum 80 km/h during inter-city night transports.	Night team site 1

Table 6.8: Overview of improvement projects

6.5.1 Setting up teams

Improvement teams are a foundation for continuous improvement according to Lean theory. But how can teams be formed in carrier firms where drivers work alone all day? The researchers

grouped drivers and formed teams of 5-6 individuals after geographical closeness and similarities in work tasks.

The day team at site one was formed easily, there was already a natural team with a traffic planner as team leader. A team spirit was quickly established despite the fact that the drivers were unused to be part of work teams and that they only met occasionally during breaks. Still, they had a geographical meeting point in the office were they could eat, drink coffee etc. So even if they only met occasionally, they still had time to discuss the improvement program with each other. A board to place feedback to the team on was placed outside the office.

At site two the situation was different, where 15 drivers seemed to work together. But after closer investigation, they could be separated according to the origin and destination of the goods they distributed, making it possible to form a pilot team of five drivers that worked in close relation to the drivers at site one. A problem at site 2 was that there was no natural physical meeting point. The drivers occasionally met each other in the traffic planner's office, in the terminal and when they happened to eat lunch at the same restaurant but there was no regular meeting place for drivers to take a coffee and socialize. There was no obvious location for to place a board with feedback but eventually it was decided that it had to be placed outside the traffic planner's office.

It was harder to set up a team and establish a team spirit among the night drivers in Project 3. They only met at the terminal before and after driving long distances. Also, changing their way of driving would not affect anyone else in the organization, only the amount of fuel consumption and their personal safety.

6.6 Executing the improvement projects

The execution processes for the respective teams are presented in Table 6.10. The researchers' approach was to meet the drivers in their own environment and rather wait for a spontaneous moment than to arrange meetings with the drivers. The processes for day team 1 and 2 were rather different since no opportunity was given to have a workshop with all drivers at once at site 2. Due to the geographical distance, the researchers only visit site 2 two times while visited site 1 almost daily during the projects. Unfortunately did the researcher never meet all drivers at site 2 in person and therefore they sent a letter to all members of the day team at site 2 where they introduced themselves and the project. The researchers emphasized the importance that the drivers who did meet them, introduced the projects to the other members of the team.

The execution of Project 3 differed to the other ones. Here the focus was more on individuals than on teams and the researchers communicated almost entirely through written information. Further, the researchers had problems finding a suitable place for the feedback where the drivers went daily since the carrier firm was not allowed to have a board in the terminal. This caused a delay in feedback since the drivers did not go and collect their individual feedback each day. One of the drivers never picked up the individual feedback. Mainly focusing on written information goes against the empirical findings from this research but the researchers found it interesting to test this method as well.

Day team site 1	**Day team site 2**	**Night team site 1**
Start-up workshop	Letter with information about the projects.	Letter with information about the projects.
Individual talks with some drivers.	Individual talks with some drivers.	Individual talks with some drivers.
Visualization board updated with continuously feedback on group level.	Visualization board updated with continuously feedback on group level.	
Individual feedback.	Individual feedback through letters and SMS messages to work phones.	Individual feedback.
Visualization of the consignment notes flow and why it is important to mark it and to get readable signatures from the receiver.	Visualization of the consignment notes flow and why it is important to mark it and to get readable signatures from the receiver.	
Summary of what the drivers were expected to do, especially designed for temporarily drivers.	Summary of what the drivers were expected to do, especially designed for temporarily drivers.	

Table 6.10: Activities with the three improvement teams

A couple of days into the project the two day teams started to receive feedback both on how their team performed and on how the corresponding team at the other site performed.

7 Results

In this chapter the results from the improvement projects carried out at the carrier firm is presented. The improvement projects regarding the consignment notes (Project 1 and 2) are presented first, followed by the project for reduced fuel consumption (Project 3).

7.1 Results of Project 1 and 2

The aim of the two projects, both lasting for two weeks, was to make the drivers follow the existing routines regarding the consignment notes.

The goal of Project 1 was to increase the number of stamped or signed consignment notes that makes it possible to track them back to the drivers picking up and delivering the goods.

The goal of Project 2 was to increase the number of readable receiver signature on the consignment notes to be legally able to show that the shipment has been delivered in case of a conflict with the receiver.

Data was collected during five consecutive working days before project start and during the last five consecutive days of the project for both Project 1 and Project 2. The data before and after the projects is presented in Figure 7.1.

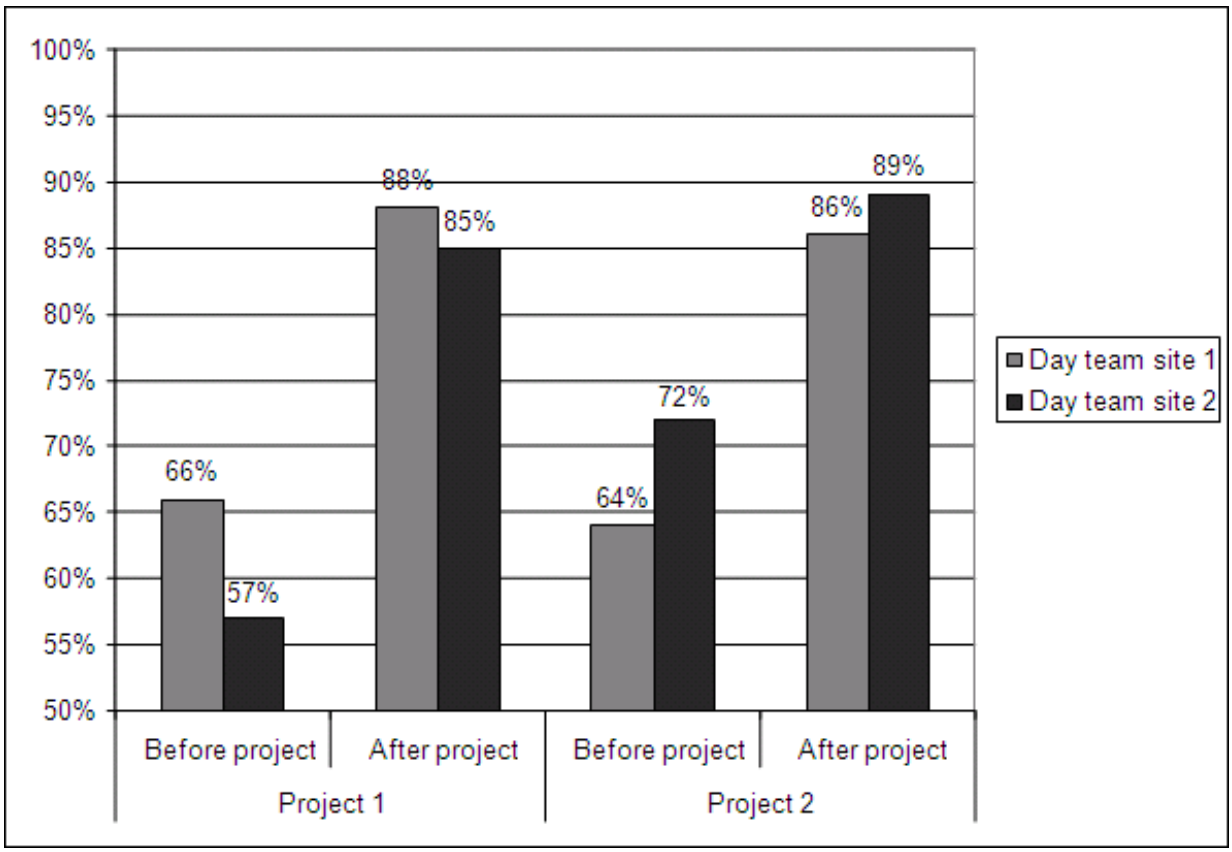


Figure 7.1: Results from Project 1 and 2

As can be seen in Figure 7.1 both projects at both sites were successful. The largest part of the remaining incorrect handling were due to temporary drivers that did not recieve proper information regarding the routines. The improvement projects included discussions and workshops

with the teams at the two sites. Those discussions resulted in a number of findings, presented in Table 7.1, about the problem situation.

Table 7.1: Findings during Project 1 and 2

	Finding	**Comment**
1	It was unclear to the drivers why marking consignments notes and making sure to have readable receivers' signatures is important. The drivers did not know how their job affected other peoples' job in later processes.	During the workshops and discussions this was made clear to the drivers. A simple Value Stream Map of the consignment note's life was made to illustrate the importance of handling it correctly and what consequences follow if not.
2	All drivers did not know where and when to mark the consignment notes.	Drivers were educated in person and by simple material of how to do.
3	No one saw themselves responsible for explaining routines for temporary drives who only worked extra from time to time for the carrier firm.	The researchers encouraged the drivers to take own responsibility and talk to the extra drivers when given the opportunity. It is a problem that drivers work along and do not have a natural meeting point during their work. The researchers' recommendation is that the traffic planners take on this responsibility.
4	There was a negative attitude among some employees that some drivers, especially the temporary drivers, would never understand and follow the routines.	The researchers developed a summary of what the temporary drivers were expected to do. One specific driver considered to be the worst ended up with among the best statistics at the end of the improvement projects.
5	The drivers found it silly to ask goods receivers who they meet daily to write a readable signature.	Explaining the reason behind the signatures for the goods receiver makes this easier.
6	Some goods receivers refuse to write a readable signature.	Drivers came up with the idea to ask for a name and print it clearly themselves next to the signature. If the receivers refuse to give up their name they can write a description of the person, place and time. Last alternative is to refuse unloading the goods.
7	At project end almost all missing stamps and bad signatures were made by temporary drivers (that had not been involved in the workshops and discussions).	The problem with the regular drivers was solved. A new smaller problem that arose; finding a method to convey the information to the temporary drivers to make them follow routines.

7.1.1 Gains from Project 1 and 2

Several positive things will result from the improvements, both with hard and soft aspects. Hard aspects are presented in Table 7.2 and soft gains include reduced frustration from administrative personnel regarding routine compliance and a more positive attitude among drivers and management to improvement projects.

Table 7.2: Gains from Project 1 and 2

Before improvement	**After improvement**	**Comments**
Administrative personnel spend two hours per week to identify drivers that has handled goods subject to customer complains. This time would be 0 if the consignment notes were stamped. Often the driver is never identified.	Project 1 increased the number of stamped consignment notes with 25 percentage points. If implemented firm wide, it would save the administrative personnel 30 minutes per week or 25 hours per year.	Also frustration from drivers and administrative personnel is reduced. Drivers and traffic control do not need to spend time and effort on trying to find out who handled what goods.
Driver need to go through traffic control to get in contact the one loading goods from shipper to ask questions. Driver 1 to Traffic planner to Driver 2	Project 1 made direct communication between drivers handling the same goods possible since it is more often possible to see who handled the goods before. Driver 1 to Driver 2	No data was available on the number of calls going through the traffic planner hence no calculation of time savings possible. Drivers do not have individual mobile phones today but there is a plan to introduce it. This is a prerequisite to gain full effect from the improvement.
Unreadable receiver signatures make the carrier firm legally responsible for the goods even after having unloaded it.	Increase of readable receiver signatures with 20 percentage points reduce risk of being responsible to pay for goods that receiver claim never arrived.	No data available to calculate fiscal value of savings. It is however of great value to the LSP who puts high demands on the carrier firm.

7.2 Results and gains from Project 3

The purpose of Project 3 was to lower the total fuel consumption of the carrier firm by reducing the speed to maximum 80 km/h during inter-city night transports. Drivers based on site 1 driving between site 1 and 2 were included in the project.

The gains from the project are several. Reduced speed increases safety for both the driver and for the surrounding people on the road. Reducing speed to 80 km/h saves fuel which reduces fuel consumption and saves money.

Detailed speed data was collected through a GPS system provided by the LSP one week before project start. During two nights six trips between site 1 and site 2 by four different drivers were analyzed. The project was initiated and data was collected for 11 new trips between site 1 and site 2. The reliability of the data can be questioned due to the small sample size. The reason

behind this is that data had to be extracted manually in a very time consuming process from a visual fleet management system provided by the LSP that was not intentionally designed for this kind of data extraction.

Data extracted before and after the project is presented in Figure 7.2.

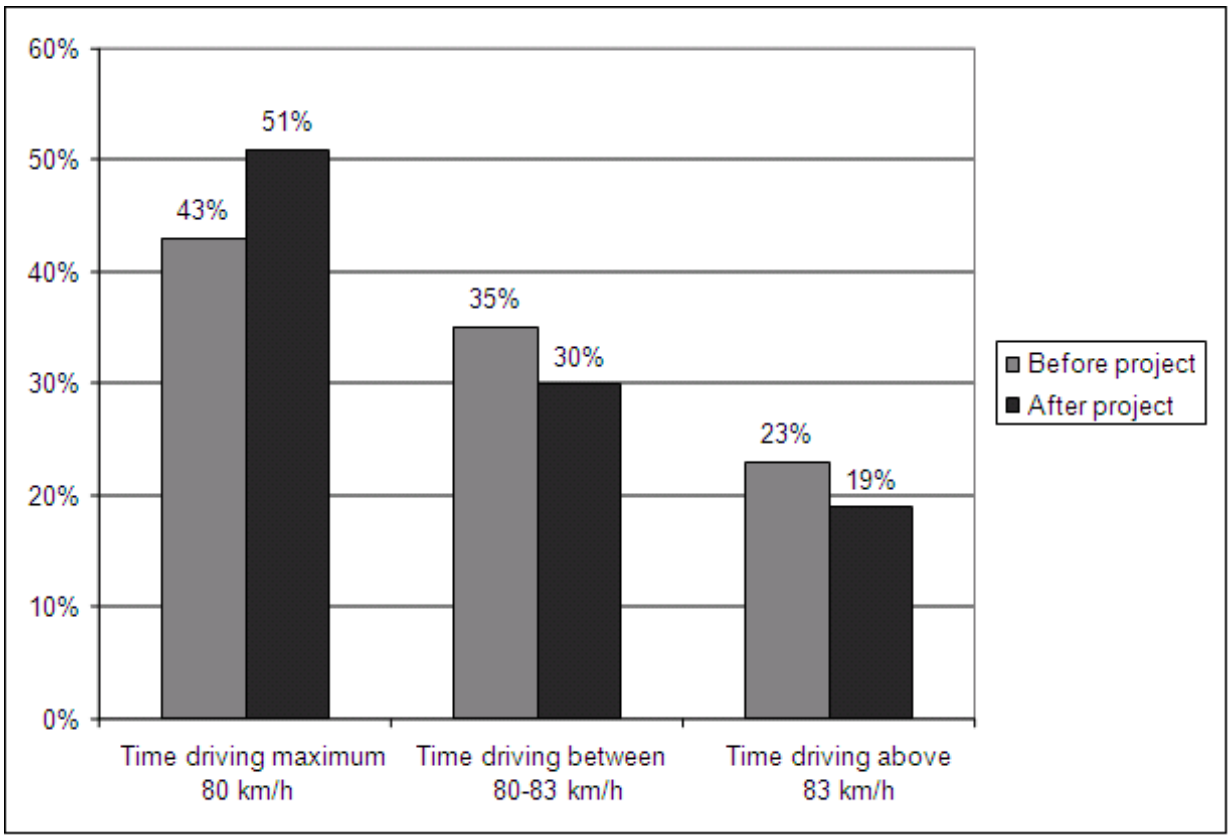


Figure 7.2: Results from Project 3

As can be seen in Figure 7.2 the amount of time the drivers kept the legal speed limit of 80 km/h increased from 43% to 51%, or by 18,5%. The speeding above 83 km/h was reduced from 23% to 19%, or by 17,4%. Rough calculations on the data revealed that the improvements yielded a fuel consumption decrease by 0,75%. If implemented firm wide, the improvement from Project 3 would reduce costs for the firm by approximately 85 000 SEK annually. Still, the researchers do not consider the project as a complete success since there were potential for much better improvements.

8 Discussion

This chapter begins with a discussion regarding the validation case which focuses on the method and execution of the three improvement projects, the results and the sustainability of the achieved results. This follows by a discussion of the visualization model and selection framework which answering to research question one and two. Then the researchers give their view of whether lean is suitable for carrier firms and conclude with recommendation for future research.

8.1 Validation case method and results

It cannot be emphasized enough that the improvement program with the three pilot projects shall only be seen as a test for introducing continuous improvement in a carrier firm. The researchers aim was to create an interest for Lean philosophy and to set up the first stones in a foundation for it; not to attempt a full Lean transformation. The term Lean was only used when talking to the management team and not discussed with the drivers. The reason for this is to not make the activities of solving organizational problems together, which really only is common sense, sound complicated. Making things unnecessarily complicated may do more harm than good if some people in the carrier firm had misinterpreted the term Lean to be something bad. The term "Lean" may be used as a positive buzzword in some cultural settings, but it was judged that in a carrier firm, there was a risk that "Lean" was perceived negatively. Carrier firm staff and especially drivers live in a hands-on world, so why use a fancy American label on a Japanese concept that, when it all comes down, really only involves common sense and team work towards improvement?

In Project 1 and 2 the researchers were positively surprised by how little time and simple improvement methods that were needed to gain results. The researchers visualized routines, had discussions and a workshop with the drivers and gave feedback. The researchers' approach was to talk to the drivers in their own environment. Instead of arranging meeting where the drivers might feel uncomfortable, the researchers waited in the office and at the terminal and talked spontaneously to the drivers as the came. This lead to relaxed conversations and the researchers tried to not tell the drivers what to do but instead present problems and than discuss causes and possible solutions.

Despite the fact that the routines were old and that the management team claimed to have both talked and sent instructions to the drivers several times, some drivers did not know how to follow the routines or why they should be followed. This was particular true at site 2 and the researchers believed the main cause to be lack of leadership. The management team is stationed at site 1 and seldom meets the drivers at site 2. The drivers at site 2 have not even met all persons in the management team. The geographical proximity to the management makes it easier for the drivers at site 1 to get natural and quicker feedback. The management team often communicates to the drivers at site 2 through the traffic planner. However, the researchers got the impression that the traffic planner at site 2 had no intention to be a leader and was not comfortable with this. Lack of defined leadership lead to a lack of defined responsibility, for instance about explaining routines to both temporary and regular drivers.

Project 1 and 2 can be seen as successful while Project 3 did not reach it full potential. Why this happened may have several reasons.

The management team of the carrier firm believes that the success of Project 1 and 2 has much to do with the researchers coming from outside the organization. This may be an advantage as long as the outsider is accepted by the employees. The researches had a very low profile and spent a lot of time listening to the drivers and meeting them in their own environment. The researchers did never claim to be experts in the field of transportation and were honest about

their limited experience from carrier firms, and did of course not charge the carrier firm anything for working with the organization. Since the purpose of the study was to conduct a base and an interest for continuous improvement and not to increase the efficiency as much as possible, the researchers did not see any problem with not being experts in the field of transportation. In their roles as students, interested in the carrier industry, the researchers established a mutual respect with the drivers where hopefully both parts learned from each other. Irrespective of the researchers' approach, what is most interesting is the potential for reaching high goals with such little effort and that the drivers were willing to change as soon as they knew the reason, and when they got continuous feedback. The researchers believe that a large explanation in the success of Project 1 and 2 is the individual and team based feedback. If the feedback is given on a company level, as it had been before, it is impossible for the individual driver to know how it performs. Also, even if improving individually, the results on company basis will hardly be noticeable.

So why was Project 3 involving the night drivers not as successful? Differences between the project with the night drivers and the other two are both related to the type of project and the execution of the project. The task in Project 3 was not related to a process improvement in the sense that if one person change the way of working it will be easier for someone else. Project 1 and 2 was much about informing the drivers about the overall process and how their work affected the rest of the organization, but Project 3 was about informing the night drivers about how their way of working affected cost and environment impact. The Project 1 and 2 was about small changes, adding small tasks, but Project 3 was about changing the way of driving which is the main task for the night drivers. Despite that, the researchers believe the execution of the project is the main cause of the low result. It was not enough to only give feedback in written form. To really succeed, the researchers would have needed to put much more effort on talking to the drivers as it the two other projects. Also, the delay and frequency of feedback was an important factor. The night drivers only got individual feedback two to three times each during the project which was not enough. It is however important to highlight that some drivers performed an excellent result and some drivers did not improve at all. Having the chance of continuing the improvement project the researchers would have spent more time with the drivers discussing why and how to improve and focus particularly on two drivers that stood for most of the driving time above 80 km/h.

Improvement Project 3 showed that it was not enough to come outside and tell the drivers to improve; the willingness to improve must come from within the organization. The strength of team based improvements as used in kaizen or continuous improvement is that it uses the potential of all employees by including them in the problem solving process and not just forcing a change onto them.

Another important success factor was the support from management and the access to the whole organization given to the researchers. The researchers had access to all relevant data and were allowed to talk to all employees and to follow the drivers in their daily activities. Without such complete access it would have been more complicated to identify improvement potential. Also, the necessary meetings and discussions with the drivers took time away from their work; hence the management's commitment and support was a prerequisite for the whole program.

All drivers that researchers talked to seemed to appreciate the attention given to them and this probably had a positive effect on the team spirit and the outcome of the project. They were all very open and honest, especially when talking to them individually.

It is interesting that the drivers succeed to get more readable signatures from the goods receiver even thought it involved external actors. The researchers believe it has much to do with the confidence of the drivers. During the observations the researchers noticed how important it was for the drivers to be service minded when meeting the goods sender and receiver and it is therefore understandable that the drivers feel an unwillingness to fight with them. However, if

explaining clearly to the receiver why it is important with readable signatures, with the support from both the LSP and the carrier firm, a fight should not be needed.

8.2 Will the improvements sustain?

As the Lean philosophy is interpreted in this thesis it is about having a long term focus on small continuous improvements. Therefore a relevant question is if the results from the improvement program will sustain.

It is difficult to forecast if and how long the improvement will sustain. If the drivers actually got a deep understanding of why the changes were important, than it might be sustained without any further work. None of the improvement projects made the work much more time consuming or harder for the drivers. However, the risk of Hawthorne effect must also be considered. Hawthorne is a term for identifying short-lived increase in productivity that is caused by the employees' need of attention rather than an actual change. In this research there is a risk of that the drivers' motivation for improvements came from the extra attention given to them instead of the method used by the researchers. However, since the aim was to test the possibility to conduct small team based improvements in carrier firm and not to test different methods for conducting improvement programs, the risk does not affect the outcome of this report to any large extent. Still, it may affect the sustainability of the results from the improvement program. For instance, if the drivers never really understood the reason behind the changes, than they might fall back to old habits right after the project ends.

The chance of sustaining results to a high degree depends on the management team. If they continue to give feedback to the drivers the result will have a much greater chance to sustain. Also, the researchers hope that the management team will continue doing small improvement projects by following the methods used in the improvement program. As stated before, the researchers only introduced continuous improvements and it is now up to the management team to continue the work. Right now, when the drivers have succeeded with these three projects, the researchers advised the management team to instantly introduce a new improvement project before the drivers lose their motivation. In order for the management team so succeed with continuous improvement they need to include the drivers when establishing new routines. As the researchers found out during the first visits at the carrier firm, the management has set up elaborated routines, but their problem is to introduce these to the drivers and gain compliance. But if they start involving the drivers they will not only succeed better with the implementation of the routines, they might also get smarter routines since they would take advantages of the drivers' knowledge and experience.

8.3 Research questions

The research questions were useful as a starting point for this research in order to know where and how to start conducting improvement projects towards continuous improvement.

8.3.1 Visualization model

The interview study clearly showed the advantages with a graphical representation when aiming for establishing a common view and this was also confirmed during the validation case. The researchers showed the complete problem picture for the management team but showed a simplified version included only the problems related to the improvement projects for the drivers. As stated earlier, did the management team and drivers only have positive comments regarding the visualization model and no improvements were suggested. The conclusion that can be drawn

from this is that the visualization model fulfilled its purpose but it might be possible to improve it further. Maybe if the researchers had given the management team and the drivers more time to consider improvement potential they would have come up with new ideas. Further, if the researcher would have asked for improvement suggestions before explaining and discussing it, perhaps more constructive critic would have been given. Before using the visualization model at the carrier firm, the model was tested on two validation cases and showed to the people having conducted the LWA on the respective carrier firm. At that time no ideas or misunderstandings came up either.

Calculation of the result from the visualization models were made to show how the potential looked like in the respective carrier firm. It is important to note that the researches are aware of the uncertainty of this numbers and that they should only be considered as indicators. When calculating, the researcher only considered the amount of POR and causes, and not the effect of each of them. There is also no guarantee that all problems in a carrier firm are discovered during an LWA. However, since the same method, LWA, was used in both test cases and in the validation case, is it possible to do a comparison of the three data set and draw some conclusions from it.

8.3.2 Selection framework

The selection framework was developed based on interview with different management experts. If different interviewees had been selected, the outcome may have been different and there is a risk that important aspects are missing. To validate the framework it was used to select improvement alternatives on a carrier firm. The projects that were judged easy to implement, according to the selection framework, were indeed successful. This indicates that the selection framework and its parameters are valid. It was also a valuable tool when planning the actual improvement work, to make sure that no important aspects were forgotten or neglected.

It is important to understand that using the framework is a subjective process and that the outcome is dependent on the degree of understanding of the subjected organization.

8.4 Is Lean suitable for carriers?

Lean is a wide concept that stem from Lean Production as influenced from Japanese industrial practices in general, and the Toyota Production System in particular. As discussed in the introductory chapters, this thesis approaches only a limited part of the Lean philosophy, considered to be the core concepts of Lean. Those aspects include: a process view towards maximizing value, systematic problem solving through continuous improvement, and respect to humans. In this section those three concepts will be evaluated in a carrier context.

8.4.1 Process focus to increase value

Using a process approach in carrier firms seem to be beneficial for several reasons. In this thesis data from three carrier firms of different nationality have been analyzed. The data clearly shows that carrier firms use a clear main process and that the process approach to their operations is suitable. The problems and waste found in the carrier firms is to the largest part seen in the operational part, but are often caused by earlier processes, both internal in the carrier firm and by external actors, such as the shippers of goods. By introducing the process view as suggested by Lean theory (among others) the internal relations and dependencies in the large process of delivering goods becomes more obvious. People in carrier firms to a large extent work in isolation; the drivers spend most of their time alone in their trucks or visiting various customers. This could be a cause for lack of understanding of the work other people in the firm do. In the same way,

administrational personnel that do not have a background as drivers may not understand the drivers' situations and the problems that they face daily. A process approach conveyed to the organization help people understand how their actions affect others later in the chain. In this thesis, a model for plotting organizational problems according to where they are observed and what causes them is developed. The model showed successful in conveying processes and internal dependencies to the management. A simplified version of the model, with only a few selected problems inserted, was shown to the driver and was also successful in conveying the internal dependencies.

8.4.2 Systematic problem solving

Truck drivers are natural problem solvers. Spending a few days in the trucks together with the drivers, as the researchers has done, show their excellent problem solving skills. Handling, moving and packing large amount of heavy goods along with the large and complicated machines and equipment cause a large amount of problems; problems that are solved with different means in different creative ways by the drivers. The problem, as has become during this thesis work, is that the constant problem solving is made *individually*, not making it possible for good solutions to be standardized procedure. What is missing in the carrier firms that have been observed in this study is a structured way of absorbing and spreading good practice. Introducing a structure for improvements in a carrier firm would likely result in great gains. As shown in the work with the improvement projects in the validation chapter of this thesis, great gains are made when drivers together can work towards solving a problem. When sitting down with drivers in a workshop-like environment several ideas about solving constant problems came up. There is a huge waste of employee creativity. Even though it is the drivers' creativity that is wasted, the authors suggest that the utilization of their creativity has to be initiated top down. The lack of leadership and clear communication to the drivers should be replaced by honest attempts to listen to their ideas. The authors have heard several ideas from drivers about how to improve operations during the course of this thesis, but none of them have been realized. It would be a good idea to set up a structure for improvements where everybody is given *time* and *resources* to standardized spread good practice. To make improvements grow bottom-up from the ground a seed must first be planted by the management above, and they need to constantly nourish the process with support.

A problem with introducing such an improvement structure in carrier firms may be that drivers in a firm seldom meet in big groups. They work alone on the roads all days, and gathering them all would be costly to the firm since the value adding activities of moving goods would have to be stopped. But during the study the authors have had no problem gathering a group of about five people. It was done early in the morning before the drivers left the terminal. Such meetings 30-60 minutes could be held for instance one a week to jointly solve problems. With time, there is no obstacle to developing this into structured team based problem solving with the aim of continuous improvement.

8.5 Further research

Adapting Lean to the carrier industry is a new field and therefore relatively little research has been done so far. This master's thesis has introduced continuous improvements which only constitutes for a small part of the entire Lean Philosophy. It is also important to point out that only an introduction and no implementation was made. Only one cycle of improvement work was done during the validation test and naturally several iterations are needed before the improvements may be defined as continuous.

Adapting Lean to a new context calls for a new set of definitions. All definitions from the field of production are not applicable to the carrier industry. An example of a clear difference is regarding transportation. Transportation, which is the main value adding activity for a carrier firm is defined as waste in Lean Theory. Without proper definitions and adoptions of Lean tools it becomes unnecessary complicated to teach and introduce it to carrier firms.

To study the suitability of Lean in carrier firms more thorough more tests and measurements are needed. It is also relevant to do a clearer alignment between the overall company vision, strategy and goals and the results from improvement programs. Larsson and Westerberg (2009) propose a set of Key Performance Indicators (KPI), in their master's thesis. It would have been interesting to translate this to a lower company level and to investigate the possibility to connect this to goals for improvement programs.

Even though the field of adapting Lean to carrier firms is relatively new, extensive research has been done on adapting Lean to several other fields. Exploring the possibility of learning from Lean implementations on other fields than production is therefore relevant. Also, benchmarking different carrier firms could lead to interesting results.

Further, it would be interesting to test the suitability of the framework proposed in this master's thesis at more carrier firms with different sizes, operational processes and in different countries. To be able explore the benefits with continuous improvements involving all personal more extensively, tests during longer time periods is needed. Also more complicated improvement projects involving more problem solving would have been interesting. Further, to be able to draw conclusions regarding sustainability, the outcome of improvement program needs to be measured during longer time. When more research has been done related to continuous improvement it will be time for more Lean methods to be tested and adopted to fit the environment of a carrier firm. Having a supply chain focus and studying the effect of Lean on the interactions between the different actors will also lead to a better understanding.

9 Conclusions

The deep case study at the carrier firm as described in the validation chapter together with analysis of data from two other carrier firms has revealed a number of interesting aspects of the carrier industry. Looking at the findings from a Lean perspective, a number of conclusions can be drawn.

9.1 There is a potential for improvement in carrier firms

Studies at two carrier firms in Sweden and one Switzerland have shown that there is a large potential for improvement. Analysis of the drivers' daily work reveals a value adding time of 72% while 28% is necessary and pure waste.

A large part, 73%, of the discovered problems stem from a lack of routines or inadequate compliance with existing routines. This show that significant improvements can be made with only organizational development without need for investments in new expensive equipment.

Many problems that carrier firms face in the daily operations stem from external actors in the carrier firm environment. Common problems are lack of information from shippers or receivers that the carrier firm has to solve. The situation becomes even more complicated if the carrier firm is connected to a LSP since that adds yet another actor in the information flow. Observations and discussions on carrier firms conducted in this study agree with this and both drivers and management blame, often completely correctly, other actors for their problems. Carrier firms may have a large number of different customers that order transportations infrequently, which make it hard to make them follow routines. It also seems to be a lack of feedback; the daily problems that the carrier firms have to solve are not correctly evaluated which make them appear over and over again.

Albeit many problems stem from external actors' behavior, 91% of the problems that have been identified in this study are deemed possible to solve or resolve from within the carrier firms. Carrier firms act in an environment where they heavily depend on external actors, such as shippers and receivers, and factors, such as traffic, laws and regulations. It is easy for everybody, including carrier firms, to blame problems on external issues, but this research shows that carrier firms can make significant improvements own efforts.

Total number of POR	57	100%
POR that can be solved partly or fully within the organization	52	91%
POR that need to be solved in earlier processes	25	44%
POR that stem from insufficient routines	27	47%
POR that stem from manpower and management	15	26%
POR that stem from equipment	6	11%
POR that stem from environment	9	16%

Table 9.2: Statistics from three sets of assessment data

In the analysis chapter of this thesis two frameworks for improvement work in carrier firms were developed. A model was proposed to illustrate problems and motivate carrier firms for improvement. A methodology was proposed when choosing between different improvement alternatives in order to select suitable projects for improvement. The data analysis and the case study at a carrier firm have shown that both the visualization model and the selection methodology can be helpful aids in the early stages of improvement work at carrier firms.

9.2 Lesson learned from the improvement program

The list below summarizes the most significant recommendations and conclusions from the improvement work in the validation study. Carrier firms are not used to improvement work but the methods commonly used in other business types proved themselves successful also in this context.

- Base decisions on facts
  To be sure that an actual, and not a perceived problem, has been found it is important to measure the true extent of the problem. Without an initial state as a baseline to compare the future state with, it will not be possible to know if an improvement has been achieved. Further, measurement is a prerequisite to be able to give fair and correct feedback.

- Focus on a few problems at the time and set up clear goals
  Continuous improvement is about doing many small changes which together constitutes to significant improvements. Too many improvement projects simultaneously might be difficult to handle and therefore result in no improvement at all. It is better to draw the attention to a few problems at the time and let the employees focus on solving them before continuing with other problems. A clear and measureable goal gives the improvement group something to aim for and it will be possible for everybody to know if the outcome was successful or not and when the goal has been reached.

- Let everybody be involved and take advantage of all employees' creativity and problem solving skills
  Truck drivers are natural problem solvers. During the course of this master's thesis this has become more and more obvious to the researchers. Even though the drivers often end up in complicated situations, often because of someone else, they find a way out of them. It is therefore a big waste no to use this fantastic creativity and problem solving in a structured way and to let the good solutions become new standards. Further, by letting the employees be part of the process of designing new routines it will give a greater understanding and consequently the compliance with the routines will be easier.

- Visualize - everybody shall understand why and how
  Improvement work often makes people change their way of working. Achieving this can be hard if it is not obvious why this change of routines is necessary. This is especially problematic in carrier firms where people work in isolation and cannot see how their actions affect others. Using visualization techniques, for example by showing simplified flowcharts of the processes, has proven to be a good base for explaining and discussing the different routines. When people really understand their role in a larger context both motivation and ability to come up with good improvement suggestions increase. Visualization is however not enough; it shall only be seen as a compliment to discussions and other types of involvement.

- Give continuous feedback on individual and group level
  Continuous feedback makes it possible for the employees to know have they have performed. Feedback might both be positive or negative, the important part is that it should be fair and based on facts. The feedback should be on a level to which the employees can relate to. If the feedback only is given on a company level it might be hard for the employee to see its own role in it. In the improvement work conducted through this thesis the drivers really appreciated the feedback and requested it after the project was finished.

- Respect to all individuals
  Especially when coming outside the organization to start up improvement work it is very important to respect, listen and try to understand the people and the culture within the

organization. The drivers are the experts on their job and the strength with continuous improvement is that the solutions and improvement work should come from within the organization. What the organization might need help with is therefore to learn and implement a methodology for continuous improvement and not a complete solution for how to optimize the organization. Trying to tell people how to do their work is not a good way since doing this would neglect their skill and craftsmanship, instead present the problem and trust their ability to solve their own problems.

- Improvements in carrier firms can be made with small means
  The improvement work conducted at a carrier firm in this research was successful. Significant improvements regarding routine compliance were achieved in two of the three projects. The firm had struggled with those issues for several years but the introduction of the new simple tools and techniques made it possible to change the drivers' behavior quickly. This shows how powerful the methods used in this thesis is and how little effort is needed to change if the communication channels are right.

9.3 Lean philosophy can be adapted to carrier firms

The strategic dimensions of Lean can be adopted into carrier firms. No obstacles to have a value and process based strategic approach have been identified. The operational work processes of the three carrier firms assessed are simple and show significant similarities which mean that carrier firms could easily adapt a process oriented approach. Many of problems in daily operations appear since personnel do not understand how their actions affect personnel in subsequent processes; this could be solved by presenting a clearer picture of the processes and dependencies.

Carrier management needs to focus on long term organizational development to create a learning organization. The fire fighting approach to problem solving that is prevailing today should be replaced by long term thinking.

The Lean philosophy has during the last decades been adapted from an industrial production setting to also fit service industries such as healthcare, it management and support services. In this master's thesis the kaizen approach to continuous improvement part of the Lean philosophy have been introduced to a carrier firm environment. Truck drivers are skilled practical problem solvers, but their potential is not utilized properly. In the work of this thesis collective problem solving and team work from a bottom-up perspective combined with visual management and feedback has shown to be a superior alternative to the traditional top-down directive management. The carrot has shown to be more powerful than the stick.

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Appendices

A Interview study

In this appendix a description of the interviewees, the questions asked during each interview and the transcriptions of the interviews are presented.

A.1 Description of interviewees

Below a brief description of the 11 interviewees follow with their background to increase the understanding of what they have based their answers on the interview questions on.

CM Expert 1
Date of interview: 2010-02-25
Lead interviewer: Erik Allenström
Taking notes: Malin Linger
CM Expert 1 has a PhD in change management and several years of working experience with organizational change.

Lean Expert 1
Date of interview: 2010-03-08
Lead interviewer: Malin Linger
Taking notes: Erik Allenström
Lean Expert 1 is a University professor conducting research in the Lean field. Also participating as a consultant in a wide competence-increasing project for the Swedish industry.

Lean Expert 2
Date of interview: 2010-02-25
Lead interviewer: Malin Linger
Taking notes: Erik Allenström
Lean Expert 2 has several years of experience with production development and is currently working at the Lean implementation department in a large industrial corporation.

Lean & CM Expert 1
Date of interview: 2010-02-23
Lead interviewer: Erik Allenström
Taking notes: Malin Linger
Lean & CM Expert 4 has an engineering background including a PhD in the production field with several years of experience from the parcel delivery business. Today working as a Lean consultant in both service and production organizations.

SCM Expert 1
Date of interview: 2010-03-05
Lead interviewer: Malin Linger
Taking notes: Erik Allenström
SCM Expert 1 is working as a senior consultant in the fields of economics, production, logistics and business development at a large industrial corporation.

1.1 What methods do you use to identify problems in an organization?
1.2 How can you tell that you have found the real problem and not a symptom?
1.3 What methods do you use to find the cause or source to a problem?
1.4 How do you do to place a problem in the organization to look for solutions in the right place?
2.1 How do you determine what problem to deal with first?
2.2 Is there a way to determine on what level to solve the problem or how deep into the causes to go?
2.3 Do you use a method to assure that local optimization is avoided?
3.1 How do you start up a change program with the personnel?
3.2 How do you set up goals and visualize those goals to the people involved in the change process?
3.3 How do you determine who should have what role in the change process?
3.4 How do you follow up the changes to see if the program has been successful?
3.5 What road haulage firm characteristics do you think might influence a change process there?

Name	1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	3.5
CM Expert 1	x	x	x		x	x	x		x	x	
Lean Expert 1	x	x	x	x			x			x	
Lean Expert 2	x	x	x	x	x	x	x	x	x	x	
Lean & CM Expert 1	x	x	x	x	x	x	x	x	x	x	x
SCM Expert 1	x	x	x	x	x	x	x				

[x] = responded, [o] = not able to respond, [ ] = question not asked.

Table A.1: Lean and Change Management Experts' responses

Carrier Expert 1
Date of interview: 2010-03-04
Lead interviewer: Erik Allenström
Taking notes: Malin Linger
Carrier Expert 1 has a degree in Business Administration and is today working with educational issues at the Swedish Association of Road Haulage Companies, representing approximately 9 300 members and 37 000 vehicles. Carrier Expert 1 has a lot of experience from educating both drivers and administrative personnel in carrier firms.

Carrier Executive 1
Date of interview: 2010-03-04
Lead interviewer: Malin Linger
Taking notes: Erik Allenström
Carrier Executive 1 grew up in a road carriage family and has done every aspect of the road carriage business: truck driving, maintenance, traffic planning and starting up and leading a carriage firm. Today Carrier Executive 1 work as fleet manager at a major carriage firm in Sweden.

Carrier Executive 2
Date of interview: Spring 2010 Interviewer: Henrik Sternberg
Carrier Executive 2 is CEO at a middle-sized carrier firm in Switzerland.

Transportation buyer 1
Date of interview: 2010-02-26
Lead interviewer: Erik Allenström
Taking notes: Malin Linger
Transportation buyer 1 has over 20 years of experience at the receiving and shipping end of distribution. From working on the shop floor as a truck driver to the present position as chief of logistics and Vice President in a firm in the packaging business, Transportation buyer 1 has a lot of experience in dealing with carrier firms.

Transportation buyer 2
Date of interview: 2010-02-03
Interviewer: Henrik Sternberg
Transportation buyer 2 has over 30 years of experience from transportation in the food industry and is currently chief of transportation at a large company responsible for the local distribution of goods to grocery stores and gas stations in Sweden.

Transportation buyer 3
Date of interview: 2010-02-01
Interviewer: Henrik Sternberg
Transportation buyer 3 has been working with logistics the last seven years and is today responsible for warehousing and transportation of goods in the food industry.

B Data from assessments of carrier firms

B.1 List of POR from Swiss assessment

The below list of POR results from an LWA of the Swiss carrier firm used when testing the models in Section 5.3.1.

Hard to communicate with the drivers
Not enough contact information to the customers
Times spent on walking around searching for customers' sites
Early deadlines make routs no optimal
Many phone calls to the drivers
Daily district changes makes it hard to find addresses
Goods loaded in wrong sequence
Stress makes the drivers less efficient
No information about road blocked for heavy transport lead to extra driving time
No exact customer address makes it hard to plan routes correctly
Excessive overtime lead to involuntary vacation
Drivers fed up with the job
Drivers can not contact customers before arrival
Must combine computer map and GPS to get enough information
Automatic transmission is dangerously pushy when driving backwards
No trailer parking sports encourages illegal parking
Hard to find parking spot when taking breaks
Frequent obstacles at customers sites (i.e. cars)

Waiting for someone to sign consignment note

B.2 List of POR from Swedish assessment

The below list of POR results from an LWA of the Swedish carrier firm used when testing the models in Section 5.3.2.

Same data is entered several times
Insufficient information flow between traffic control and drivers
Securing the goods not properly done
Short term planning leads to not optimized routes
Waiting for the traffic control
A lot of manual paperwork
Lack of communication lead to not optimized routes
Unsynchronized working hours
Cost of vehicle damage
Not economic driving
IT-systems are not integrated
Design of back plate lift
Large gas tank leads to excess inventory
Waiting at the customers' sites
Attitude towards drivers

B.3 List of POR from validation case

The below list of POR results from an LWA of the Swedish carrier firm used when testing the models in Chapter 6.

Hard to move badly packed goods
Repacking of goods
Batched orders complicate drivers' route planning
Incomplete address on consignment note
Goods damaged when not properly protected / packed
Drivers not informed about contract causing unnecessary discussions with customers
Complex handling due to bad packing of goods
Goods need to be moved between truck and trailer
Can not read receiver address when facing forward in truck
Goods not packed according to optimized route
Broken parts on trucks and trailers not reported
Unloading all goods before loading new make route longer
Unnecessary idling of trucks
Unnecessary fuel consumption due to 80+ km/h
Takes long to answer customer complains
Incorrect goods volumes on order make it hard to charge customers correctly
Drivers to not stamp consignment notes
Consignment notes not available at the right place on time
Waiting for tail gate to lift

Incomplete addresses of orders
Inaccurate volumes specified
Waiting at customers' site
Receivers do not sign consignment notes in a readable way

B.3.1 POR sorted into improvement alternatives

Below the same POR as in Section B.3 is presented, sorted under the improvement alternatives described in Section 6.4.

1 - Information from customers
Drivers not informed about contract causing unnecessary discussions with customers
Hard to move badly packed goods
Incomplete address on consignment note
Goods damaged when not properly protected / packed
Incomplete addresses on orders

2 - Consignment notes
Takes long to answer customer complains
Drivers to not stamp consignment notes
Consignment notes not available at the right place on time
Receivers do not sign consignment notes in a readable way

3 - Equipment
Broken parts on trucks and trailers not reported
Waiting for tail gate to lift

4 - Handling goods at terminal
Repacking of goods
Complex handling due to bad packing of goods
Goods need to be moved between truck and trailer
Can not read receiver address when facing forward in truck
Goods not packed according to optimized route

5 - Lower fuel consumption
Unnecessary idling of trucks
Unnecessary fuel consumption due to 80+ km/h

6 - Route planning
Batched orders complicate drivers' route planning
Unloading all goods before loading new make route longer
Goods not packed according to optimized route