



RESILIENCE  
IN TRANSPORT  
SERVICES

— FOCUS ON CONSTRAINTS

BERNT SAXIN



# RESILIENCE IN TRANSPORT SERVICES

— FOCUS ON CONSTRAINTS

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Avhandling: ekonomie doktor (Ph.D. thesis)

*Resilience in transport services — focus on constraints*

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# Abstract

## Resilience in transport services — focus on constraints

The Swedish industry needs fast and reliable goods transport services. In this study, data from transport buying companies are analysed to assess if Transport Providers are able to keep up with industrial Buyers' demands of On-time, door-to-door service. Global coverage and competition are drivers not only for greater complexity, but also for the “leaning” of resources in organisations, both for Transport Buyers and Providers. How does this affect their interaction?

Since services are produced and consumed at the same time, service industries are particularly sensitive to imbalances between the demand for service and the supply capacity. This is especially visible in times when demand is increasing and service production already is at capacity, or in situations when unplanned disturbances occur. The resulting increasing work pressures have to be absorbed somehow, if business opportunities are not to be lost, or if quality is not to suffer.

However, to expand capacity takes time, and meanwhile service organisations have to have other ways to respond. They have to have high response flexibility. An option is to use the available capacity more, i.e. to increase work intensity, another is to spend less time to perform each order. To increase utilization of capacity too much, though, can lead to unwanted constraints, commonly referred to as “bottlenecks”, manifested as queues, or long waiting times, or fluctuating quality of performance.

The purpose of this study is thus to illustrate and discuss unintended constraints in a service industry in the light of a dominating and somewhat misapplied management trend that is likely to affect the long-term development of capabilities, resilience and competitiveness negatively.

Resilience is a property in both natural and man-made systems that can be described as the ability to bounce back in the face of adversity, a type of flexibility that is necessary for responding to increasing pressure and disruptive situations, and for company survival. Resilience is dependent on continual and long-term learning, and development of diverse capabilities, which I summarise as Problem-Solving Skills. I also discuss four principles,

coherence, connectedness, control, and requisite variety, which have been described in literature as necessary for the formation of resilience. These first three can also be explained in the context of information retrieving and communicating, sense making of the system, and adjusting deviations. The fourth principle is the diversity necessary for dealing with complex disturbances.

The main conclusion from the findings is that it is primarily the ability to solve problems, probably in combination with unsatisfactory availability of relevant information and / or communication that lies behind many performance problems. This indicates a “blockage” or bottleneck in the communication or information flow to the decision-makers, and reveals that there is a lack in understanding how the system operates or functions.

This finding is significant because it indicates that some Transport Providers might have a lack of response flexibility, adaptability, and resilience, which could cost them loss in competitiveness and long-term survival.

*Key words: Resilience, constraints, bottlenecks, capacity use, reserve capacity, quality, coherence, problem solving, capability, customer satisfaction, productivity, information, communication, decision-making, policy, systems thinking, complexity, service industries, service operations, capacity management, sustainability, resource-based competition*

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Hajom in May 2013

Bernt Saxin



PART 1  
Background





# 1. Introduction

This study is about the balance between the use of capacity, quality, and resource productivity in service industries, and company survival. The importance of this is supported by the fact that companies today in general are quite short-lived. According to one assessment, the life expectancy of a firm is on average only 12.5 years in much of Europe and Japan (de Geus, 1997).

To illustrate the core of the problem, which are constraints, I have chosen to use data from the goods transport industry, since it is a “pure” service provider, and also an integrated part in most of the world’s goods flows and product supply networks, in other words it has one “leg” in each “world”.

Constraints are the limitations of resources all of us face daily. They are the conditions, rules and resource boundaries of our businesses and organizations, society, and our personal lives, that restrict our actions to certain domains. They help us to focus, give us opportunities to learn and develop deeper knowledge and wisdom, to find solutions to problems, to develop skills and capabilities. Rightly understood constraints can be the driver of innovation, new opportunities, and business development.

However, constraints can also be planned, and deliberate, such as to test something on a small scale, or to keep the price-level up<sup>1</sup>. But they can also be unintended, for example due to bad planning, decisions, design, or other inefficiencies. If constraints cause problems and limit progress they are generally referred to as “bottlenecks” since they can throttle flows. The indication then is that the situation is unwanted; there is some kind of unplanned limitation in the system that is causing a problem, as well as unnecessary costs, however, people might not even be aware of why it is there. Nevertheless, when we operate too near the limits or even cross over them there are consequences, just like breaking rules, laws of the land, or natural laws (like gravity). It is on these unintended and violated constraints and their consequences that this thesis is focused.

It is almost a universally accepted axiom that high capacity utilization is economical, i.e. that the more waste is eliminated in production, the higher the

---

<sup>1</sup> A good example of this is when coffee is destroyed in order to keep the world market price of coffee up.

value is for a resource. For example steel industry in Sweden has had an average capacity utilization rate of 92% for the years 1995-2008, most industries are around 90 %, but fluctuations can be up to 97 % (SCB, 2011)<sup>2</sup>. This means that capacity utilization is very high, getting dangerously near the ceiling. When natural resources are scarce we learn not to waste the material so that as much as possible is coming to use. This makes sense to all of us, and is also a basic meaning of “economy”.

But there is a difference between utilizing as much as possible of the available resources in order to increase resource productivity, and to find ways to make better use of the resources, in other words, to use the resources so that they are more valuable and / or more sustainable. The first is the way of “work harder” (or faster), the other is the way of “work smarter”. Work harder generally has a short-term perspective, work smarter a long-term.

There can also be a development, which starts with “work smarter” then at some point shifts into “work harder”. One such example is lean production.

The lack of materials was for example one reason why lean management was developed by Taichi Ohno and others at Toyota (Hines, Holweg *et al.*, 2004). However, as factor costs increased the focus in lean has moved from using raw materials more efficiently to using the production resources, i.e. people and technology,<sup>3</sup> more efficiently. A trend has thus been to focus on using such production capacity more, i.e. to consider non-value added *time* between processes as waste, in other words to *activate* the production resources more per time unit. It has been noticed, though, that this has increased interdependencies, complexity and vulnerabilities in operations (e.g. Perrow, 1999; Christopher and Lee, 2004; Peck, 2005; Zsidisin, Ragatz *et al.*, 2005), which has not been totally without complications. Slimming time buffers between and within processes presupposes that operations can be planned, mistakes can be eliminated, in other words that predictability can increase by international standardization, and technology development. With the perfectly designed system no mistakes need to be made, no failures need to occur, and everything will be perfectly predictable.

In the best of worlds!

---

<sup>2</sup> Capacity utilization rate defined as the quota between actual use and maximum capacity.

<sup>3</sup> I use the concept technology to represent also other necessary physical resources, such as buildings, infrastructure, not just machines and software.

Combining complexity with predictability is, however, a difficult art. Predictability implies that the future somehow can be foretold or planned with a degree of confidence. Predicting demand accurately is really only possible to do in a very stable environment, such as a highly regulated plan economy with no influence of competition and innovation.

Some things are easier to plan than others. For example the demand for daily, functional, products is generally much more stable than highly innovative and fashion products (Fisher, 1997). Services, though, have even more volatile demand than products, which makes planning and capacity management more difficult (e.g. Armistead and Clark, 1994).

The point here is to illustrate and discuss the difficulty to predict, plan, and control in the context of complexity. Sometimes constraints give unintended and unwanted side effects, such as too much inventory in a production system, or flooding of a river in an ecosystem or an urban area<sup>4</sup>. It is easy to see why flooding is unwanted, but what about inventories? And what about services, what is flooding them?

## 1.1. Research area

Globalization and competition are drivers for companies to become more efficient. Lean thinking in production and distribution has been accepted as a management philosophy to enable businesses to adapt their processes to the increasing pressures of time and costs, not to mention the pressures from stakeholders, such as owners, who want higher dividends, employees, who want more pay, and society, which wants more taxes or regulations to be enforced. No wonder every stone has to be turned to squeeze out the “non-value waste”.

Even in services and the public sector like health care, geriatric wards, and schools lean thinking has entered management, and it appears that the main focus is on eliminating capacity, not only waste. Efficiency is no doubt important, but is high efficiency and optimised yields only measures of a healthy enterprise? Is it leading to long-term resilience and future earnings? What happens to quality?

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<sup>4</sup> Urban floods are generally “manmade” and good examples of constraints and their bad economic (and social) consequences. It is common e.g. that drainages have too little capacity, since pipes, etc. are not updated when cities expand. See e.g. Gupta and Nair, 2010.

### 1.1.1. Going lean

Two forms of lean can be distinguished. The original “Japanese” form developed at Toyota, and the Western, Taylor’s Scientific Management (e.g. Hesse and Rodrigue, 2004; Hines *et al.*, 2004; Chase and Apte, 2007), which is sometimes referred to as “Fordism” (e.g. Hesse and Rodrigue, 2004). According to Hines *et al.*, 2004:1000ff, there has been a development of the lean concept from the Tayloristic philosophy of mass production towards a more “thinking organization”, however there are also signs that no such development really has occurred, the underlying logic is still the same, even though the concept of lean is used (e.g. Hesse and Rodrigue, 2004; Hines *et al.*, 2004; Chase and Apte, 2007; Holweg, 2007).

The Toyota Production system (TPS) came about after the second world war as a necessity due to problems with inventories of unsellable cars, labour strikes, etc. (Holweg, 2007:421). Taiichi Ohno developed ideas about small-lot production of car engines in the 1940’s, with focus on reducing cost by minimising waste (*ibid.* p. 422). Later on he and others also studied the American car industry, and was influenced by some of their methods, but developed his own e.g. for swift change-overs of machines to allow low-volume production and big variety. There was a clear quality focus in Ohno’s thinking<sup>5</sup>, which even started to influence Western productivity focused thinking in the 1980’s and early 1990’s. However, since then Western form appears to have returned to an underlying focus of productivity and mass-production which thinking also has spread into service sectors (Hines *et al.*, 2004; Chase and Apte, 2007; Holweg, 2007).

#### 1.1.1.1. Lean in services

Such companies as Walt Disney, Reader’ Digest, and McDonald’s have successfully applied Taylor’s scientific management according to Chase and Apte, 2007. For example in the McDonald’s<sup>6</sup> case the formula has been heavy standardization, process simplification, and control:

---

<sup>5</sup> Inspired by Deming, who “targeted wasteful variation associated with non-conformance, reliability and inflexibility under the umbrella of continuous improvement” according to Stratton and Warburton, 2006:669f.

<sup>6</sup> There are those who mean the fast food industry like McDonalds maybe should not be classified as “service”, since it actually operates with an inventory chain (push strategy), i.e. it is more like a manufacturing company, e.g. Anderson, Morrice *et al.*, 2005.

“Application of scientific management to every aspect of restaurant operation was the key factor underlying McDonald’s success. The main principles embodied in McDonald’s operation include: (1) standardizing and reducing the variety of products; (2) simplification, standardization and automation of processes so that workers with limited skills and training can reliably produce quality products and deliver high quality service; (3) monitoring and control of process performance. McDonald’s arguably exhibits better applications of Industrial Engineering to a greater degree than do many manufacturers.” (p 377f.)

Chase’s classification system of services according to the type of contact the service Provider and customer has, from low contact (self service) to high face-to- face, totally customized service (Chase, 1978; Jacobs and Chase, 2008), is shown in Figure 1.

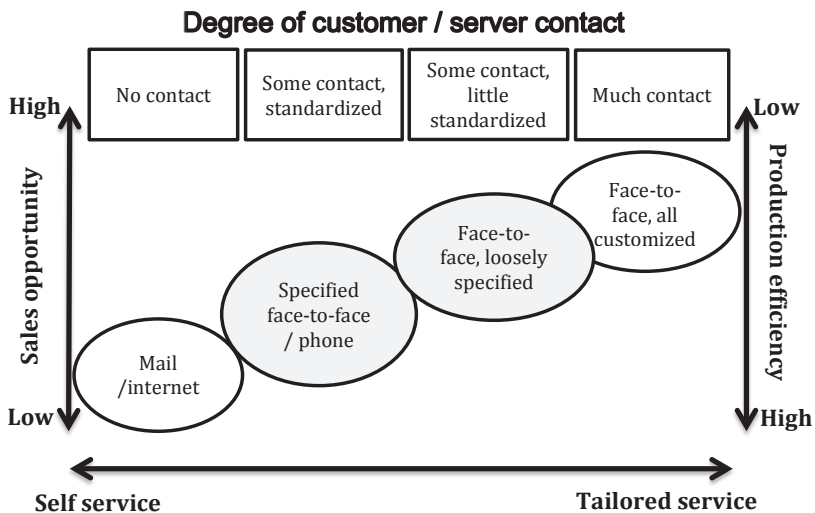


Figure 1: Degree of customer / server contact and customization of service.<sup>7</sup>

This model explains some of the quandary of interacting with customers and productivity (efficiency). High degree of standardization (such as automation) makes high productivity possible (assuming there are no dysfunctions, breakdown of the system, etc.), whereas when there are services with face-to-face interactions and high degree of customization, reserve capacity

<sup>7</sup> After Jacobs & Chase 2008.

is necessary since service time can vary. Jacobs and Chase, 2008, mention McDonald's as an example of face-to face interaction with tight specs.

Chase and Apte, 2007, talk about "poka-yoke"<sup>8</sup>, fail-safe methods to avoid human error (p. 381). This is however mostly only applicable to simpler standardized tasks, not complex (p. 383).

"...the early applications of scientific management were not as successful in services as in manufacturing. Today, however, a number of service industries, from the customer contact factories of the call centers to the managed care organizations in the healthcare services, are well positioned to apply the principles of scientific management (Head, 2003). The main difference now, of course, is the power of modern information technology. ...The factor that limits the extent of service rationalization is the variation inherent in the human interactions, a hallmark of the service processes." (p. 382)

So in their opinion "Fordism" had been made possible in the service industries due to the IT-development, on the other hand, development is still limited by the need for human interactions.

### **1.1.1.2. Lean in logistics**

Hesse and Rodrigue, 2004, mean it is Taylor's "Fordism" that is the model for modern logistics principles (p. 174). This is in a sense natural since in the past materials' management and manufacturing mainly took place in local factories and regionally (Harrison and van Hoek, 2008), whereas in recent decades global production and distribution has increased the importance of geographical and temporal aspects of logistics in international transport in coordinating supply networks (Hesse and Rodrigue, 2004).

Goods transport services can of course be very varied, some are quite standardized, while others are totally customized. When volumes get big enough a certain amount of standardization can be done. With a number of customers and a large variation of shipments (sizes of shipments, different destinations, different products) one could safely say that most industrial shipments have a fairly high degree of customization. Some of the operative, face-to-face interaction, though, is automated by e.g. barcodes, EDI or Internet. As can be seen from Figure 1 the other trade-off of business opportunities decreases the more the degree of automation increases. This means that there is a risk that too much automation can lead to that companies get more distanced

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<sup>8</sup> Japanese for "mistake proofing" according to Wikipedia.

from the customers, and thus miss chances for more business and possibly also pick up less cues about the customers' opinions of the performance.

### **1.1.2. The need to be flexible**

At the other end of the spectrum is the increasing demand for higher quality and time-dependent service, which could be one way of improving or keeping competitive advantage, e.g. since it can cause delays, loss and damages, and extra process costs to customers (Morash and Clinton, 1997:7). However, according to Mentzer, deWitt *et al.*, 2001, it is primarily a matter of more skill and flexibility, at the same time as it is a requirement:

“...companies in particular and supply chains in general compete more today on the basis of time and quality. Getting a defect-free product to the customer faster and more reliably than the competition is no longer seen as a competitive advantage, but simply a requirement to be in the market. Customers are demanding products consistently delivered faster, exactly on time, and with no damage. Each of these necessitates closer coordination with suppliers and distributors. This global orientation and increased performance-based competition, combined with rapidly changing technology and economic conditions, all contribute to marketplace uncertainty. This uncertainty requires greater flexibility on the part of individual companies and supply chains, which in turn demands more flexibility in supply chain relationships.” (p. 2)

So how can these two extremes, the lean view of maximising the utilization of resources and standardization, i.e. a minimum of flexibility, and the agile view of customization and maximum flexibility, be reconciled?

## **1.2. The research question**

From the above can be seen an apparent contradiction in the development of management in some industry sectors, such as goods transport services, where demand, on the one hand, increases pressure for more flexibility and time-constrained service, and on the other, increases pressure for leaner operations and lower costs.

Short term a service company in a competitive market could be up against such dilemmas. Long term such a company (or any company) also has to tackle disturbances and change. To do that resilience is needed, i.e. capacity to respond and to adapt to major changes.

Lean thinking seems to be a major driver in the development of the transport industry, e.g. the concentration of fewer and bigger actors, both on the forwarding business level, and on the haulier business level<sup>9</sup>.

What we are looking at is an allocation problem of matching service capacity with demand. Service demand is in general often hard to predict, reasons for that will be discussed in chapter 8 and 9. What long-term consequences have for example a lean strategy of maximising the use of capacity of production resources (people and technical resources)? How does the short-term matching of demand and supply capacity affect the long-term development of resilience so that the company does not lose its competitive advantage over time?

A relevant research question for this thesis is thus:

**In what way does high capacity utilization affect the development of long-term resilience and competitive advantage of a service company?**

To answer this question I use and discuss primary data from two studies I have performed or been involved in, and literature. These studies were focused on Transport Buyers' view on Transport Providers' performance and capabilities<sup>10</sup>.

To "operationalize" the research question, which covers a lot of ground, I also want to formulate four sub-questions:

- How do Transport Buyers' pressures affect the quality of service Providers' performance?
- How can constraints of the service Providers' capabilities / resources explain performance quality problems?

These two questions will be answered in the empirical section through the analysis of data. The following two I reserve for the discussion:

- Why are failure rates so high for Transport Providers?
- Why are Buyers not satisfied with Providers' capabilities?

---

<sup>9</sup> Bigger forwarders often subcontract hauliers to perform the actual transport, in other words the forwarder sells the door-to-door transport to the Transport Buyer, then hauliers carry out the actual shipment. More about this in section 8.2. In this study it is the company that does the business transaction with the Transport Buyer that is called "Transport Provider".

<sup>10</sup> Definitions of Transport Buyer and Transport Provider is in Appendix 1.



### 1.3. The purpose of the study

As implied above, lean thinking has had a momentous influence on how companies are managed, and short-term acting. However, despite its underlying sound principle of not wasting resources, there are signs that bottlenecks easily form if there is too much “leaning”, which can have long-term consequences, such as quality problems, and deteriorating flexibility e.g. when disruptions occur (Zsidisin *et al.*, 2005).

One reason for the concern with this development and influence of lean thinking and application in supply chain networks has been, according to Hines *et al.*, 2004, the almost complete lack of strategic perspective in the discussion (p. 998ff). Focus for lean programmes and management principles’ discussion have been on the application of a number of tools and techniques in shop-floor situations (*ibid* p. 1000), not on the strategic implications for the companies in the supply network.

Another aspect, argued by e.g. Leitch, 2001; Anderson *et al.*, 2005, is that most research of lean principles and matching problems has been done on manufacturing companies with “push”-strategies, and same management principles are recommended for and applied in the service sector, even though their situation and “operational logic” usually is totally different.

Also in capacity research on services, especially with the effects on quality, not much research has been done (e.g. Armistead and Clark, 1994; Akkermans and Vos, 2003; Chase and Apte, 2007).

Constraints, as mentioned above, can be both good and bad. By looking at the bad, the failures, one can often learn something about the good. My purpose with this study is thus to illustrate and discuss unwanted or unintended constraints in a service industry in the light of a dominating and somewhat misapplied management trend that is likely to affect the long-term development of capabilities, resilience, and competitiveness negatively.

More specifically, the purpose of this thesis is

- 1) to illustrate and discuss the consequences of operationally constrained capacity, commonly called “bottlenecks”, in a service industry,
- 2) to discuss the relationship between the utilization of capacity and the quality of the service performance,

- 3) to discuss a plausible relationship between constraints and resilience in the context of complex service operations, such as transport services.

## 1.4. Some limits

Much of the data is from a cross-sectional study of Transport Buyers' attitudes. This obviously limits the interpretation of the data compared to a longitudinal study, where changes can be observed directly in the data, however extensive studies like the present can also be difficult to repeat, since they are time consuming for the respondents.

Another limitation is the selection of respondents. Primarily, respondents were the ones responsible for the purchasing of the transport solution, such as logistics, transport, distribution, or procurement chiefs. Most of these people were in some operative management position. Of course sometimes, e.g. in bigger international companies, the transport solution might be influenced or decided also by others, e.g. the leadership group, and with different criteria, e.g. financial indicators, like cost, ROI, etc., however in this study that perspective was not possible to include.

There are obviously always limits to how much data can be retrieved, and what is necessary. The data for example contain some important aspects of flexibility, e.g. quality fluctuations, volume fluctuations, time flexibility. However, flexibility is a big subject, and there has been no attempt or possibility to cover everything, e.g. concerning employees' skill, their availability, and information quality. The same goes for collaboration in the dyad. It is also covered by two questions, and obviously there are nuances that will not be covered.

Another limitation is about the interpretation of the data. The findings only represent the Transport Buyers' perceptions and opinions of the goods transport industry. The bottlenecks found affecting certain industries could be located within the transport industry, but they could also partly be situated in the Transport Buying industry (or with the Receiver of the goods), since there are interactions involved. It is not possible to establish the exact location of the bottleneck since several actors are involved. That is a question for further research.

Not all categories of services are the same, as will be shown. However, in chapter 8 and 9 my intention is to lift the discussion from debating specific

findings in the transport industry (which is used to show that the problem can be detected, a testing of the Theory of Constraints), to discussing the *phenomena* constraints and resilience in a broader context of service industries. This does not mean that all the conclusions are applicable to all kinds of service industries. The conceptual constraint – resilience framework modelled in chapter 9 is also based on sources in the literature (discussed in chapter 8 and 9), and has to be tested empirically for different types of industries.

## 1.5. Thesis structure

This study is divided into **four parts**:

### **PART 1 Background**

*The problem is introduced in the context of the dominating management practice. The theoretical frame and the method for the study are presented.*

- In **chapter 1** the subject of what the link is between constraints and resilience, and how this affects a company's long-term development and survival, is introduced. In this thesis the goods transport service industry is the research area, and the Transport Buyers' assessments of the Transport Providers' capabilities the object of the study.
- In **chapter 2** relevant theories and concepts are presented. I start off with contextual theories of competitive advantage and service categories. The main focus of this chapter is on how capacity is used, its limitations, and a short introduction of the resilience concept.
- In **chapter 3** the method I have been using is described in detail: Interviews and an extensive survey to goods' transport service Buyers.

## PART 2 Observations

*In this part the results of the data analysis are presented: factors from the factor analysis, and an effect analysis to find signs of constraints.*

- **Chapter 5 and 6** present the **main findings** of the data analysis.
- In **chapters 4 - 6** I present some contextual data, then the factors from the “Principal Component Analysis”. The analysis of constraints is done in two steps:

1) 31 questions to the transport Buyers are reduced to nine factors.

In section 5.3. these factors are reduced further to five “*grouped factors*” representing *capabilities* (Shipping Capacity, Ability to solve problems, Information & Communication System, On-time delivery, and Financial factor) sorted into three main categories (people-focused, technical, and financial). There is also a factor representing the Transport Buyer’s Overall Satisfaction. Levels of actual error rates (customer statistics of shipments “not on time” and damages) are also analysed.

- 2) The grouped factors, pressures, and performance data are analysed *together* in an effect analysis (partial least square) to find constraints. In **chapter 6** the main findings from that analysis is presented.

These findings are the signs of failures and bottlenecks (i.e. “bad” constraints).

## PART 3 Discussion

*The purpose of the discussion is to answer the research question in the light of the assumptions. The discussion is lifted by Allison’s decision perspective theory to focus on the relationship between constraints and resilience as a resource allocation problem affecting the capability to process information and to communicate. A conceptual framework is proposed. This explains the relationship between constraints and resilience as a learning and adaption process to change.*

- In **chapter 7** the research model is derived. This is developed further in chapter 9 into a constraints-resilience model.
- In **chapter 8** the stage is set by describing the Buyer’s and the Provider’s perspectives and their interaction. The matching of demand

and service capacity is a crucial process in all enterprises, and especially in service industries, since they operate with special logic.

- In **chapter 9** some important concepts, which affect the quality of information (i.e. the level of uncertainty) are discussed: the role of information, communication, decision rules. Findings are interpreted and discussed in the context of information quality and problem-solving ability.

A conceptual framework of constraints – resilience is derived from the findings and literature. The forming of resilience is modelled as a long-term learning- and adaptionprocess integrated in the resource-generating production process. Four important principles and prerequisites of the learning process are discussed.

This explains the relationship between information quality, constraints, and resilience. It also explains how constraints, and resilience are formed — maybe even more important, how resilience can be destroyed. This is one of the contributions in this research.

## **PART 4 Conclusions**

*This part concludes the study and initiates new.*

*The main conclusions in chapter 10 is that bottlenecks are primarily located in the Information & Communication System, which in accordance with the Theory of Constraints, affects the Ability to solve problems, On-time delivery, and the Transport Buyers' Overall Satisfaction.*

- **Chapter 10 and 11:**

The main conclusion from the findings is that it is primarily the ability to solve problems, probably in combination with unsatisfactory availability of relevant information and / or communication that lies behind many performance problems. This indicates a “blockage” or bottleneck in the communication or information flow to the decision-makers, and reveals that there is a lack in understanding how the system operates or functions.

Reserve capacity is not waste, but a Quality Protecting Zone, which aims to constrain the company from eroding the performance quality, and it is a prerequisite for the forming of resilience.

The importance of this finding, consequences, and implications for practitioners and for future research is discussed. Especially the constraints – resilience framework, the CORE- learning model, needs to be tested empirically. A number of possible research tracks are suggested.

- A *summary* of this thesis is available on request separately in Saxin, 2013.

## 2. Capacity and its use

In this chapter I will describe the main theoretical underpinnings and perspectives on the relationship between the utilization of capacity and quality in services.

My intention with this research is to contribute to the understanding of the relationship and interactions between constraints, performance and quality in complex service organizations in supply networks. Much operative research has focused on increasing productivity and reducing waste and lead-time in manufacturing supply chains. But does that lead to resilience, competitiveness and long-term survival?

Services are often analysed using the same logic as goods flow chains. There is research, though, showing that their dynamics are different (e.g. Akkermans and Vos, 2003; Anderson *et al.*, 2005). In both cases, however, there are clear effects on the quality of the operations and in fact often also on the overall productivity. The Theory of Constraints is addressing especially the latter problem: focus on productivity often leads to local optimisation (sub optimisation) of performance, but losses in other parts of the chain (Goldratt and Fox, 1986; Goldratt, 1990; Sterman, 2000). But maybe more serious and subtle is that focus on cost and productivity also can lead to not only short-term improvements but also long-term erosion of quality, capabilities, and resilience (e.g. Oliva, 2001; Repenning and Sterman, 2002; Weick and Sutcliffe, 2007).

Goldratt, 1990, based much of his theory on the Toyota Production System (TPS) form of lean management, developed by among others Taiichi Ohno (Goldratt and Fox, 1986; Stratton and Warburton, 2006; Holweg, 2007). Ohno in turn was heavily influenced by Deming's quality thinking (Stratton and Warburton, 2006:669). The bad effects of (unintended) constraints on the productivity, or throughput, and indirectly on a company's ability to compete, are the focus of the Theory of Constraints. That the effect of constraints in product supply chains could be inventories is easy to see, but in services inventories are not present, except as "Work-in-process" and queues of customers. Sometimes this is referred to as backlogs and workload (or work pressure). The choice of literature is therefore in the area of the interaction and operative application of resources, above all capacity utilization, and the effect on service quality. Both in services and manufacturing human capacity, in the form of work-hours and skills, are inputs. Research show that especially in service processes the capacity is sensitive to constraints, and this

is connected to the workload. Research covering workload or work pressure, and effects on service quality as well as long-term capability are therefore included in the theoretical frame.

The data in this study is from the transport service sector, thus from a sector that is both capital and labour intensive. Services can, however, differ widely, as can manufacturing, depending on the industry. Thus selling insurance is obviously quite a different process from doing maintenance in an oil refinery, or transporting goods. However, with a systems' perspective it is easier to analyse the connection between the structure and the behaviour of the system, thus drawing more general conclusions. Service categories also change over time, e.g. from having been customized to become more or less standardized and automated (e.g. Schmenner, 2004; Chase and Apte, 2007). An example of this is bank service, which has gone from over-the-counter service to self-service in automats or internet-payments. Also in goods transport the same development is obvious, e.g. track-and-trace information can be retrieved directly by the customer via internet instead of phoning the transport company, the customer packs and ships a whole container instead of a number of separate pallets at different occasions. There is also the opposite development with just-in-time (JIT) shipments, instead of shipping a whole container, the customers want frequent deliveries of small quantities and third party logistics (3 PL) arrangements where the Transport Provider provides additional services. The point here is that the strategic choice of operative structure, how services are to be carried out, also affects how capabilities develop over longer periods of time.

## **2.1. Competitive advantage**

Pressures from customers and stakeholders arise due to competition. Porter, 1980, emphasised that it is the competitive forces on an industry level and the strategies and actions planned by managers that decide market positions of companies (Teece, Pisano *et al.*, 1997:511). This is a theory of competing or rivalling for resources by outfoxing opponents. The market strategies to create competitive advantage are either to make things or service the same as others, but as cheaply as possible, i.e. to have a cost advantage, or else do things that differ from others, i.e. differentiation.

Another view on how to achieve competitive advantage is the resource-based, which is a firm-level strategic theory, that it is the firm's available resources or assets coupled with its capability that is the foundation for growth (Hunt



and Morgan, 1996; Teece *et al.*, 1997; Penrose, 2003). Thus the essence of a resource-based view is that competitive strength comes from within the companies, how resources are used and combined, and how knowledge and skills are formed and developed. This model is more focused on creating advantage by operative competence and strategic cooperation in ways that build products and services so they have “unique properties”, i.e. they will be difficult to copy.

According to Teece *et al.*, 1997:516:

“End products are the final goods and services produced by the firm based on utilizing the competences that it possesses. The performance (price, quality, etc.) of a firm’s products relative to its competitors at any point in time will depend upon its competences (which over time depend on its capabilities).”

Capabilities are, according to Day, 1994:38:

“...complex bundles of skills and accumulated knowledge, exercised through organizational processes, that enable firms to coordinate activities and make use of their assets”

So companies need to have and develop certain strengths and be aware of or eliminate weaknesses. In Porter’s (1991) competitive forces’ view some assets are to be important, but “secondary” to managers’ strategic skills and abilities to position their companies on the market. In that view resources are “homogeneous”, i.e. not changing, but are interchangeable<sup>11</sup>, whereas in the resource-based view they are considered “heterogeneous”, they have different value depending on how they are e.g. combined.

Gadde, Håkansson *et al.*, 2002, (p. 85):

“Therefore, business relationships promote innovation, as does the interaction of different types of resource elements (Gadde and Håkansson, 2001). Accordingly, resources can be regarded as results of economic processes and not just as conditions for them. This view is in contrast with classical microeconomic models in which resources are perceived as givens. In our view there is much to be gained from a perspective on logistics where it is considered that resources might be provided with new economic features. Thus, we have to start from the assumption that the economic processes in which they are involved affect resources.”

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<sup>11</sup> Like spare parts.

So the performance and the capability of a firm are considered to be built up interactively over time as skill and knowledge increase the competence. These are the active, added resources of a company. As skill and knowledge increase, capabilities are sustained or improved. If they are not, then capabilities will erode, for example by neglecting maintenance, training, and / or development.

But capability is not just about handling the present situation, but creating some kind of sustainability and future of a firm. In the words of Mentzer, Min *et al.*, 2004, for logistics operations:

“Schumpeter (1950) theorized that firms are seekers of new ways of competing and, thus, should focus on market dynamics. Schumpeter further argued that competition based upon innovation is more effective than price-based competition. In logistics, for example, postponement (the extent to which production and distribution are delayed to add options or differentiate the product as close as possible to when customer purchases the product) is an innovative approach in which firms achieve not only cost reduction but also product customization (Waller *et al.*, 2000). From the Schumpeterian view, distinctive logistics capabilities based upon organizational learning emerge as valuable factors in the development of customer-oriented corporate strategies aimed at obtaining sustainable competitive advantage through creating customer value.”

## 2.2. Categories of service

Central in services is what degree of contact there is between personnel and customer in carrying out the service (Chase, 1978; Lovelock, 1983). As described above, Chase's classification system (Jacobs and Chase, 2008:110, see Figure 1 above), describe the balance between standardization and customization. It obviously depends on the nature of services if automation is going to be possible, but often some kind of mixture is present, i.e. the customers do a part of the work of the service delivery themselves. The factor costs (wage level for the employees and the cost of automation respectively) are obvious drivers, as well as the prospects of increasing productivity, and increasing capacity e.g. by being more available to customers (Schmenner, 2004).

The goal for the service company is to simplify operations by higher degree of standardization. This strategy has a productivity-focus, whereas more customization requires more human involvement and more time consumption

and tying up of resources. On the other hand, as Figure 1 shows, more personal customer contact also gives better chances for sales and building relationships.

For services (as well as in manufacturing) there is, according to Schmenner, 2004, a clear trend towards increasing standardization with movement from the “Professional service” corner towards the “Service factory” corner, with lower labour intensity, lower throughput time, and less customer contact. Schmenner, 1986, places “trucking” fairly far up in the “service factory” area, with little customer contact, and fairly low labour intensity. In the revised and developed diagram with more of a process view<sup>12</sup> (ibid. p. 342), trucking is split up in “ground service trucking”, placed in the “Mass service” category (medium or high lead-time, i.e. slower), and “Express service trucking” (low lead-time) in the “Service factory” category. The Express services are generally speaking more capital intensive than Ground services in trucking (p. 341).

Armistead and Clark, 1994, describe operational focus by a model based on previous research, Figure 2. Here customer contact and degree of standardization illustrated in Figure 1, is combined with the dimension of value creation. Where in the service process is the value created for the customer (seen from the customer’s perspective)?

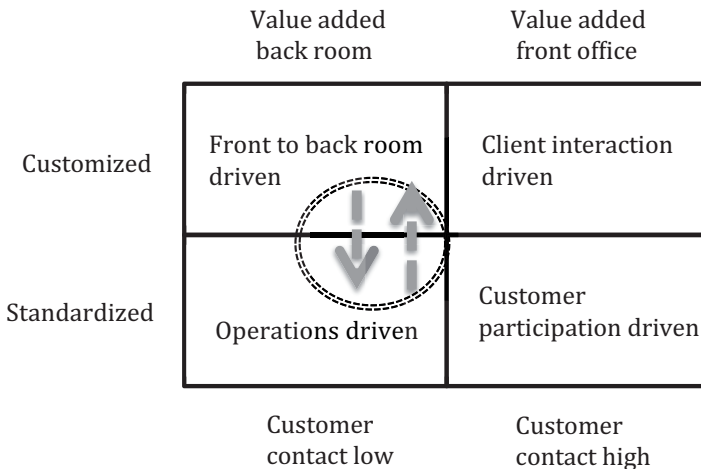


Figure 2: Circled is the operational domain for transport service delivery based on the degree of interaction with the customers.<sup>13</sup>

<sup>12</sup> Relative throughput time.

<sup>13</sup> After Armistead and Clark, 1994:13.

Simple transport services that are highly standardized (e.g. transport from A to B, time table) are thus largely operations driven. This could maybe be described as “mass service”. However, if the operational focus is more customized, e.g. by time constraints, or some kind of flexible arrangement, it becomes more front to back room driven. This means that the higher logistical content of the service, the more complex and “niched” a service is, the more crucial is the interaction with the customer, and the more skill is required by the staff. The “front office” (staff in direct contact with the customer) e.g. are important to manage the customer’s expectation (Armistead and Clark, 1994:14), but they also need to be updated with the status of the “back room” (which the customer does not see).

## 2.3. Resources and activities

Mentzer et al., 2001 define a supply chain the following way (p. 4):

“... a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.”

In this thesis I focus the discussion to apply to companies in interdependent arrangements, as suppliers and customers, but the context is a supply network. As Lambert, Cooper *et al.*, 1998, point out, not all supply chains are strictly separated. There can be links to “non-members” in the supply chain, i.e. influence from one supply chain to another, e.g. a supplier can also sell to customers that are competitors in different supply chains. They describe this as a network structure in supply chains. The activities of transport services (the shipments from suppliers to their customers) tie different actors and resources together in different supply chains; a supply chain network perspective is therefore appropriate to describe such business relationships. A point of significance in this context is that the network structure can thus affect e.g. exchange of information. Especially since the Transport Provider could serve competitors it could result in communication constraints in these supply chains.

Actors use resources in interactions, and these activities form the processes and performances of production or service. The view on resources and activities in logistics research has shifted over the years (Jahre, Gadde *et al.*, 2006), from resources considered to be the foundations of the activities within a firm (*ibid* p. 34), to almost a total focus on the activity dimensions, invol-

ing actors in the whole supply chain (ibid. p. 39f). Activity focus is especially the case of the process-oriented view of lean production. In that view “the main task of resourcing is the more or less predetermined utilization of a resource in the context of a particular supply chain.” (ibid. p. 40), i.e. resources are “givens” or “homogeneous”.

Jahre *et al.*, 2006, argue that resources can be coordinated in different ways, and thus the use of them can yield different results (p. 38f). They mean that a resource-focused view is important because it can provide opportunities of joint benefits e.g. by combining resources in innovative or new ways (p. 44), be “facilities of value rather than facilitators of operations” (ibid. p. 36).

This has been shown also empirically for companies of various sizes (Jahre *et al.*, 2006; Gadde and Håkansson, 2008; Skarp and Gadde, 2008; Jansson, 2012).

From a resource-based point of view there are really only a few generic components that are needed to describe a business. For example Polesie, 1995, uses a square-model in financial analysis of a company’s resource side, its financing, and its production side, how the money is used. Jansson and Polesie, 2011, and Jansson, 2012, also show that even three dimensions can give a good understanding of the basic resource groups, their flows and relationships in a business. These dimensions are labelled subjects, objects, and finance. Objects can be network relationships, business units, factories, machines, trucks, and computers. Subjects are people. In this thesis I will make this distinction of “resources”, i.e. the objects or the technical and network facilities represent “shipping capacity”, and the subjects are the people-dependent factors. There are also different understandings that can be enhanced by applying different perspectives, such as political or informational dimensions (Allison, 1971).

## ***A lean view on the use of capacity***

In lean thinking excess inventory buffers are considered waste and are therefore targeted, and that is no difference to the Theory of Constraints view (e.g. Stratton and Warburton, 2003; Hines *et al.*, 2004). Inventory buffers are, though, sometimes necessary for service level reasons, especially when demand fluctuates. According to Stratton and Warburton, 2003:184-185 there are only three ways to protect a flow in a supply chain from the impacts

of demand fluctuation: level scheduling<sup>14</sup>, protective inventory and protective capacity. The last option, they mean, has traditionally been avoided in volume manufacturing such as lean.

According to Mason, Lalwani *et al.*, 2007:193:

“Where spare capacity in those assets exists on a value stream the ideal from a lean perspective would be to stabilise demand and right size the assets accordingly (Womack and Jones, 1996)”

In other words capacity is to be trimmed or cut down to fit the flow, with level scheduling. In lean, idle capacity is considered waste according to Moore and Scheinkopf, 1998:28. They point out the underlying lean philosophy of “everything-works-or-nothing-works” (quoted from Womack and Jones, 1996), which simply means that everything and everyone works, however it requires e.g. cross-trained workers, machinery that is 100 % available, and accuracy, etc. (Moore and Scheinkopf, 1998:28). According to this cost-focused view “less is more” (Jahre *et al.*, 2006:36), i.e. the more resources (including people) are utilized, the better.

This view has led to that companies in reality slim not only excess capacity but also reserve capacity, e.g. due to financial constraints (Oliva and Sterman, 2010:350).

## 2.4. The Theory of Constraints

A constraint should in this thesis be interpreted as a limiting consequence of an unintended or intended action<sup>15</sup>. The limitation can be beneficial and developing (such as giving a direction, or enabling focusing on skill improvement in a certain speciality or niche), or it can be potentially harmful (bottleneck or obstruction), which also appears to be the meaning of in the Theory of Constraints, as shall be shown.

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<sup>14</sup> Level scheduling or “uniform plant loading” (Japanese heijunka) is to try to stabilise production planning and revising plans close to production, so that it will be evenly spread during a certain time period, see e.g. Harrison and van Hoek, 2008; Jacobs and Chase, 2008.

<sup>15</sup> An unintended action is when an action that is supposed to give certain intended effect also have counteracting (unintended, not foreseen) effects. An intended action could also cause a constraint, e.g. if someone is intentionally blocking or sabotaging a certain decision with the intention to harm the organization.

The essence of the Theory of Constraints is that something limits the flow (“Throughput”) of the system in relationship to its goal (Goldratt, 1990), i.e. some kind of “bottleneck” is restricting or even hurting the flow. So the constraint is a limitation of the capacity in a system. However, Goldratt starts out his book (Goldratt, 1990) saying: “The message of this book is not bottlenecks or cutting batches” (p. 3). The (implicit) reason for this statement is thus most likely that people, including professors in business schools, company leaders, managers, and business consultants think the Theory of Constraints is about increasing capacity (which often means hiring more labour) by increasing financial investment and cost. Goldratt’s main message is that it is not always the human and technical capacity, such as the number of people (“work-hours”) and the production capacity of machines that limit the throughput (i.e. the flow or the product volume per time unit) but other things in the organization, such as emotional resistance to change, bad managerial models and policies. Therefore, he gives his definition of a system’s constraint as (p. 4):

“...anything that limits a system from achieving a higher performance versus its goal”

In other words, what Goldratt is saying is that a constraint definitely *is* a bottleneck of a flow. However it is not always caused by a lack of technical resources or human capacity (labour-hours). Thus it does not automatically mean increased cost to do something about improving operations, so that the Throughput and (thereby the productivity) will increase. However, it practically always means that people in the organization need more insight and knowledge on how the system actually works. Goldratt seems to be inspired by some or all of Deming’s 14 points (Deming, 1986; Bergman and Klefsjö, 1990; Stratton and Warburton, 2006), and the so-called PDCA cycle (problem solving cycle, see e.g. Bergman and Klefsjö, 1990) and the TPS lean principles (see e.g. Jacobs and Chase, 2008, ch. 9).

Goldratt uses cost accounting terminology in discussing efficiency and flow (Goldratt and Fox, 1986; Goldratt, 1990), however the theory is more about logistics and operative management. He defines the term “Throughput” as “sales” (i.e. volume of sold products per time unit, expressed in monetary units)<sup>16</sup>, Inventory as “assets” (means both Work-in-process, stocks of raw

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<sup>16</sup> This definition means that “Throughput” in Goldratt’s view is to be understood as “actual demand” (i.e. what has been ordered and delivered and payment has been made), since he also assumes “kanban” (make-to-order). In reality this definition can cause problems, since customers

materials or components, finished goods, and equipment, buildings etc. needed for the production processes), and Operative Expense (salaries and other costs for sold products). Goldratt is highly critical of classical Cost Accounting, and also means that the concept “cost” is ambiguous and being used to mean different things: purchasing price, operative expense, and product cost (Goldratt, 1990:49). As an example of the influence from cost accounting on the operative supply and production design decision he uses the batch size problem (ibid). Batch size, as order quantity, is in operative management often calculated as a trade-off between storage cost and set-up cost<sup>17</sup>. Some kind of internal cost distribution model is used to calculate the cost of work time, etc.<sup>18</sup>. Goldratt means this optimisation is not based on how the system actually works operationally, and means furthermore that this is a cause for excess Inventory and thereby slowing down Throughput, in other words it actually decreases the productivity of the whole system. Goldratt, 1990, qualifies this (p. 49f): *If there is a bottleneck situation “...in such a situation, the impact of doing an additional setup would not be an increase in Operating Expense, but rather a more devastating effect, a decrease in Throughput.”*

Taking time in that situation would mean stopping up the flow while setting up e.g. a machine an extra time. The constraint decides the rate of production (“drum”<sup>19</sup>), and anything that disturbs the flow of course slows the flow even more. This means that, as delay (or lead-time) increases<sup>20</sup>, thus throughput decreases. However, if there is a kanban<sup>21</sup>-system, it is not inventory that piles up but the backlog of orders.

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sometimes order but then cancel. Notice that “throughput” in an operative sense and in this thesis is to be understood as output from a system or a process (whether it is a phantom order or not). If it is a “push” system, which produces to plan, readymade products are stored in a finished goods inventory, waiting for the demand.

<sup>17</sup> Set-up and break-down time that it takes to switch when a variety of products are going to be produced in the same machine. In transport this is equivalent to getting loading equipment changed, e.g. different types of trailers.

<sup>18</sup> For example calculated with ABC (activity-based costing) or similar cost distribution model.

<sup>19</sup> Goldratt calls an analogy or metaphor of marching soldiers (of different abilities) to illustrate the underlying logic of the TPS, and calls the technique drum-buffer-rope. The constraint represents the “drum” which indicates the pace for which the material or components were to be introduced (expedited) into production. A “rope” ties the “drum” to the entering station in a manufacturing chain. A “rope” is in other words an information feedback or communication, and the drum + rope system is a kanban-system. The buffer is extra capacity that can be placed in front of the constraint to eliminate it.

<sup>20</sup> By Little’s law, see section 2.5.

<sup>21</sup> See footnote 19.



And, Goldratt continues, *“let’s assume...none of the resources involved in the setup is a bottleneck. In such a case, the impact of doing an additional setup on Operating Expense is basically zero.”*

The logic of this is that the resources are there anyway (unless the setup takes a long time so that a bottleneck is formed meanwhile).

The main purposes of the Theory of Constraints are thus to

1. Improve the total flow through the system (“Throughput”), not just for local processes, by finding and eliminating bottlenecks
2. Promote and encourage learning and knowledge formation
3. Develop and support a culture of continuous improvement (i.e. a profound ability to solve problems and develop the business)

So Throughput is the primary according to the Theory of Constraints. Throughput is limited and also decided, actually dictated, by the system’s constraints. It is therefore the Throughput that primarily should be balanced, not the capacity (Goldratt and Fox, 1986). What Goldratt means is that it is not the capacity in the production chain that should be trimmed (i.e. that the reserve capacity would be taken away), but the flow that is to be adjusted. If there is a constraint, it is that constraint that should be eliminated instead, i.e. be given extra capacity. The obstacle is to be removed.

Goldratt thus has a holistic approach and advocates a global perspective in finding and dealing with constraints in the flow (Goldratt and Cox, 1989).

Since it is the constraint that “dictates” the rate of the flow through the entire system, there is no point, according to Goldratt, in optimising non-constraints, which unfortunately sometimes happens. On the contrary, increasing capacity utilization at non-constraints only increases Work-in-process (inventory), which clutters the whole system even more i.e. it creates waste, increases lead-time, and lowers throughput<sup>22</sup>. On the other hand, to cut down “slack” capacity of non-constraints without trying to find, analyse and eliminate the real constraints could be a recipe for stagnation or even a “death-spiral” (Goldratt, 1990; Oliva and Sterman, 2010) of the company. Also that is unfortunately common management philosophy (ibid).

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<sup>22</sup> I here use the term “throughput” from an operative, logistical flow perspective, in the systemic way, according to Little’s law, see e.g. Sterman, 2000.

Goldratt's Theory of Constraints was mainly focused on manufacturing when it started off in the 1980's. Thus many of the processes and applications are for the shop-floor and within a company. This is in line with lean management. Also the "Japanese" form, TPS, was originally mostly applicable to the shop floor (Hines *et al.*, 2004). The application to supply chains has since then been somewhat developed.

The constraint is in other words a balancing or goal-seeking process that can explain the operative inertia in such a system (Sterman, 2000). Sometimes an upper limit of production is a goal, however, what Goldratt means is that there can be inefficiencies in an organization other than the production resources per se, which affect the Throughput.

## 2.5. Capacity and delays

What have delays got to do with capacity? According to Sterman, 2000. "A delay is a process whose output lags behind its input in some fashion" (p. 411). A system in its simplest form, including a production system, is characterised by a flow in transit and at least one accumulation, or a stock, which is the difference between the inflow and the outflow to a delay (p. 421). The reason for this is that things takes time, like production, it takes time to get information, measure, assess, make decisions, get production resources, and so on (p. 411). There are delays in material flows as well as in information flows (pp. 411-412). When something changes we normally do not act immediately. "There is a delay between the receipt of new information and the updating of your beliefs" (p. 412), which e.g. includes testing and assessment of data, reflections, discussions, etc. (cf. p. 426).

In a production flow, the accumulation is in other words a stock, e.g. an inventory, or products going through production processes (work in-process). It is the complexity of the process and the capacity of the outflow and the inflow, which decides how big the accumulation is going to be. This gives system inertia, normally expressed in delay or throughput lead-time. All systems strive to be in balance<sup>23</sup>, i.e. to have input equalling output (Sterman, 2000). Inertia is good, because it gives the system memory, thus makes it predictable and reliable, since it counteracts change. On the other hand, there are situations when inertia is considered bad, when instead responsive-

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<sup>23</sup> In some disciplines called "homeostasis".

ness, flexibility or fast response is needed. Constrained systems have more inertia than unconstrained, as shown by Little's law.

Little's law<sup>24</sup> explains why the Work-in-process (i.e. a queue) grows when a capacity ceiling is reached.

Little's law states:

$$\text{Work-in-process} = \text{Delay} \times \text{Throughput}^{25}$$

*Work-in-process* = i.e. the total accumulation (in transit) in the system

*Delay* = Time lag or lead-time to pass the system (e.g. cycle time)

*Throughput* = Throughput / time-unit, outflow-rate of a system in balance

So Work-in-process or a queue is really "inventory" (e.g. of unfinished products in the process of being refined; or a queue of customers) "in the pipeline". When getting near to the capacity ceiling this inventory grows, which increases lead times and slows throughput, in other words it increases inertia in the system. This is maybe not obvious at first but can be shown by e.g. queuing models (Hutchinson and Liao, 2009). Figure 3 shows the effect on Work-in-process of increasing capacity utilization. Thus, an inventory that is too big is generally "damaging", according to the Theory of Constraints Goldratt, 1990, since it slows down the throughput (total lead-time increases).

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<sup>24</sup> Really that the outflow of a stock equals its inflow, when the system is in balance. Outflow is the same as the throughput. This phenomenon was first proved by John Little, once professor of operations research at MIT (Sternan, 2000:423).

<sup>25</sup> Delay times Throughput.

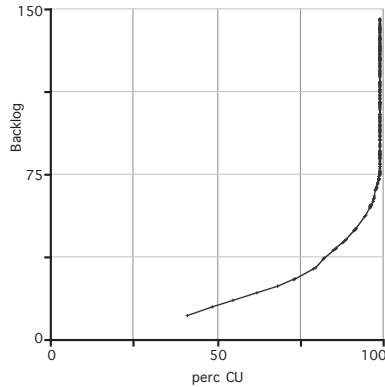


Figure 3: Constraining effect on backlog (work-in process) of increasing capacity utilization.<sup>26</sup>

### ***2.5.1. Capacity and performance***

Oliva, 2001:28, states that

“the major recurring problems observed in service industry – erosion of service quality, high turnover, and low profitability – can be explained by the organization’s response to changes in work pressure.”

Work pressure is described by Oliva and Sterman, 2001:898, as the “relative workload”.

Oliva, 2001:26f. describes work pressure for service personnel as how they perceive “the difference between the amount of work that can feasibly be done and the amount of work that needs to be performed”.

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<sup>26</sup> After Hutchinson and Liao, 2009.

Oliva and Sterman, 2001:898 give the following definition of work pressure ( $Wp$ ):

$$Wp = \frac{(RC - NC)}{NC} = \frac{RC}{NC} - 1$$

NC = Normal (effective) capacity

RC = Required capacity (necessary to deal with the workload in order to keep lead time)

Required capacity (p. 896):

$$RC = \frac{B}{\lambda} * T^*$$

B = Backlog of orders

$\lambda$  = Desired delivery delay = management's goal for delivery delay

$T^*$  = The standard time to be allocated to each customer

Akkermans and Vos, 2003 define workload  $W^{27}$  as:

$$W = \frac{B}{NLT} = \frac{RC}{NC}$$

where

$$NLT = \frac{\lambda}{T^*} = \text{Normal Lead time}$$

Under Little's law we can thus formulate the order backlog (B)

$$B = W * NC * NLT = RC * \frac{\lambda}{T^*}$$

Throughput (TH) is in other words

$$TH = W * NC = RC$$

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<sup>27</sup> In other words  $Wp = W - 1$

## 2.5.2. “Carrying capacity”

Carrying capacity is a concept that is used in ecological contexts (e.g. Catton, 1984), but is applicable to all systems, including companies and other organizations, according to Sterman, 2000. In the natural system (e.g. an ecosystem) it is the amount of available and resources necessary to keep people and animals, or an eco-system, alive. An example of that can be the spreading of a desert when dry lands are over-cultivated or overgrazed (too many domestic animals) (e.g. Dörner, 1996)<sup>28</sup>.

A limited resource can thus form a bottleneck. According to the Theory of Constraints all growing systems will sooner or later develop constraints (e.g. Goldratt and Fox, 1986). This is also supported by Systems thinking and described by the Limits-to-Growth model (Forrester, 1994; Sterman, 2000). Growth can only be sustained as long as the supporting capacity (“carrying capacity”) is not exceeded. When that happens the system “hits the roof”, and the growth stops (e.g. Sterman, 2000). In cases when the carrying capacity is eroded, which can happen e.g. when natural resources dwindle or when a company’s financial situation drastically worsens, the system could even collapse (ibid p. 123 f.). This happens e.g. when a business goes bankrupt. It can also be the case when a project or a business has been underinvested<sup>29</sup>.

But normally the limits-to-growth model produces an S-shaped growth-curve (ibid:118). The S-shaped growth means that the growth starts with an exponential behaviour, then, at some point, unplanned side-effects set in and slow down the growth, or rather “balances” the performance around a value, however higher than the original. The unplanned side effect is for example what Goldratt describes as a *constraint* or a *bottleneck* (e.g. Goldratt and Fox, 1986). So the nature of the constraint is that it limits the growth, i.e. first slows it down until it balances around a target value<sup>30</sup>. The constraint is in other words a balancing or goal-seeking process that stabilises a

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<sup>28</sup> Similar situation could be the case for the sustainability of a city. For example the Indian city Agra, just south of Delhi, with clean freshwater becoming scarce due to heavy water pollution upstream (Ghosh, 2011).

<sup>29</sup> Senge, 1990, p. 128f, based on a study by John Sterman, gives the example of the pioneering low-price People Express Airline that started in 1980 in eastern USA. The company was a success and grew fast. It invested a lot in aircraft capacity, but, under increasing price competition, neglected to do so in service capacity. However, according to that analysis, it was not for lack of number of service personnel but primarily the training of skills and organizational infrastructure that failed and affected the morale and the quality of service. Due to big losses that followed as people abandoned the company, it was taken over by another airline in 1986.

<sup>30</sup> Not necessarily the target value that was intended, but the balancing level of the system. What this is depends on among other things the inertia of the system.

system at a certain level, and it is very difficult to achieve any more growth after that, unless more resources are added, or obstacles are removed.

As Sterman, 2000 explains, the S-shaped growth-model can also oscillate or fluctuate around the carrying capacity. This happens when the balancing process (i.e. the negative, controlling, feedback in the process) contains a delay (ibid. p. 23). This indicates that there sometimes is “a margin” around the balancing level, i.e. the increasing phase in the oscillation has a maximum, but the decreasing phase also has a minimum below the balancing level. However, the maximum of the oscillation is not a higher level of the system that can be exploited at an extended period of time.

The concept “excess capacity” in this thesis refers to situations when work-pressure is  $<1$ , i.e. when normal capacity is not fully used, however in literature it can sometimes also refer to “reserve capacity”.

Example of when excess capacity means “slack” (i.e. less than “normal” production capacity is engaged):

- too much capacity because of misjudgement of demand when starting a business (Sasser, 1976:176)
- too much capacity because customers have left (consequence of quality erosion), etc. Oliva, 2001, or slack in the business cycle

Example of when excess capacity means “protective” (i.e. more than “normal” production capacity is engaged):

- protective capacity, a buffer to absorb variability and disruptions (e.g. Banker, Datar *et al.*, 1988; Leitch, 2001).

Note that e.g. Banker *et al.*, 1988; Leitch, 2001 use the concept “excess capacity” also to include “reserve capacity”. Their meaning of “excess” is “unused”, however in relationship to “available capacity”<sup>31</sup>. This is clear since they explain that too little excess capacity sometimes causes constraints.

Oliva and Sterman, 2010, use the concept “reserve capacity”. “Reserve capacity”, or sometimes “protective capacity” (e.g. Stratton and Warburton, 2003) is to protect a resource when work pressure is higher than normal (at

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<sup>31</sup> Leitch, 2001:174: “The difference between the capacity available and the resources used is the unused capacity or excess capacity”, calculated as a quota:  $1/(1+\text{excess capacity})$ . For example  $1/(1+0.20) = 0.8333$  capacity utilization for 20 % excess capacity.

least over an extended period), e.g. backlogs build up, and overtime is used to normalise the situation<sup>32</sup>.

I use the concept “reserve capacity”, i.e. as protective capacity, unless otherwise stated, in accordance with the third meaning. The focus is on the capability constraints of the Transport Provider (as seen from the Buyer’s horizon), i.e. the constraints that (usually not intentionally) limit the Transport Provider to perform according to the agreement made with the Buyer.

## 2.6. Resilience to increase response capacity

Growing interconnectedness and interdependencies, despite their benefits in business development, also mean increasing complexity in systems (Craighead, Blackhurst *et al.*, 2007)<sup>33</sup>, and thus increased vulnerability (Pettit, Fiksel *et al.*, 2010).

Pettit *et al.*, 2010, discuss a company’s ability to handle supply chain disruptions in view of ever-increasing interconnectedness and globalization. There is a growing awareness that such circumstances of business cooperation and competition also can increase vulnerabilities.

Often vulnerabilities are disclosed through unexpected events, like the tsunami and earthquakes in Fukushima, Japan, 2011, but sometimes they are consequences of designed structures and deliberate strategies, e.g. by increasing dependencies of relationships and time, complexity, chosen strategies, or neglected precautions, such as contingency systems (e.g. Svensson, 2002; Kleindorfer and Saad, 2005; Peck, 2005). When it comes to more or less “deliberate” choices, such as “no contingency system”, or “no quality monitoring”, too much “leaning” (e.g. Christopher and Peck, 2004; Kleindorfer and Saad, 2005; Zsidisin *et al.*, 2005), in order to increase productivity, it

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<sup>32</sup> All this confusion stem from the view of “waste” and what is compared. If a “normal capacity” and a “required capacity” is defined then a normalised measure can be constructed. Sometimes also maximum, or “heroic”, utilization of capacity used as comparison (cf. Sterman, 2000:555).

<sup>33</sup> Craighead *et al.*, 2007, define “complexity” as “the sum of two components—the total number of nodes (Nnodes) and the total number of forward (Nforward), backward (Nbackward), and within-tier materials flows (Nwithin-tier) within a given supply chain.” (p. 140). This means if there are only two nodes, e.g. between a supplier and a customer there can be (at least) two in-between flows (one delivery and one return if necessary) plus at least four within flows (if process allows correction). That adds up to 8. If the customer adds another supplier then the number will be at least 13. In other words there is (at least theoretically) a geometric growth in information.



could even be a *calculated* risk, or possibly overconfidence based on misjudgement (Sterman, 1989b; Dörner, 1996).

Pettit *et al.*, 2010, postulate that “Forces of change create supply chain vulnerabilities” (p. 6). Forces of change are understood as “internal or external disturbances”, and they identify seven major factors causing vulnerabilities, among them external pressures, (such as price pressure, corporate responsibility) resource limits (capacity limits, utilities availability, lack of workforce) (p. 18). Pressures and constraints are thus described as antecedents to vulnerabilities.

Vulnerabilities often cannot be totally avoided though. Long term it is a matter of developing resilience, i.e. a way to handle and balance vulnerability and capability, so that performance and quality is not compromised or eroded, and that new opportunities are not missed and the business can develop. Resilience is a property of “bouncing back” in the face of adversity, different types of flexibility as opposed to rigidity, but also has a dimension of learning and creative problem solving.

Originally an ecological concept (introduced by C.S. Holling in 1973, Gunderson, 2000), but little research has been done in management about resilience (Christopher and Peck, 2004). For example Bhamra, Dani *et al.*, 2011, show that there have been several publications since then that have used the concept also from organizational and supply chain perspective.

Christopher and Peck, 2004, distinguish between robustness and resilience, where robustness is understood as a built in capacity to deal with disruptions whereas resilience is defined as (p. 2):

“the ability of a system to return to its original state or move to a new, more desirable state after being disturbed.”

Conceptually there is room for clarification. In ecological and engineering contexts the concept used is rather “resistance”, i.e. how well a system can resist external pressure without being disturbed (Carpenter, Walker *et al.*, 2001; Fiksel, 2003), in other words resistance creates robustness of a system. Resistance is in organizations achieved by standardisation and management control (cf Fiksel, 2003; Pettit *et al.*, 2010), whereas complexity requires diversity (requisite variety, Ashby, 2011 (1968)). Fiksel, 2003, argues that systems (here meaning organizations) should rather be designed so that robustness would be achieved by resilience rather than resistance (p. 5338).

Fiksel (ref. in Pettit *et al.*, 2010:1) defines resilience as:

“the capacity for an enterprise to survive, adapt, and grow in the face of turbulent change”

Ponomarov and Holcomb, 2009, conceptually model supply chain resilience as three progressive phases of readiness, response, and recovery, made possible if certain dynamic logistic capabilities are present.

Resilience is thus a number of different capabilities that over time builds up an organization’s strength and ability to adapt to disruption, to better handle risk, therefore to increase chances of continuity, i.e. to survive and develop<sup>34</sup>. Resilience in the organizational world is in other words connected to people’s skill and abilities to deal with unexpected disruptions and recovery in complex contexts.

## 2.7. Empirical research on resilience and business continuity

The phenomenon of resilience for business organizations was however described and discussed before the concept resilience was commonly used. An early attempt was work going on in the Royal Dutch / Shell Group (de Geus, 1997). Four factors important for long-term resilience were identified in 27 companies: sensitive to their environment, cohesion (i.e., tolerance of diversity, conservative financing.

Also Polesie published a book on the subject based on longitudinal observations of 18 companies, of which several in the transport industry (Polesie, 1991). That book has the focus on the importance of organizational identity and its interaction with finance to enable continuity.

A newer publication with a resource-based focus uses several longitudinal studies of well-known companies to illustrate and discuss the resilience concept in an organizational perspective (Tengblad, Oudhuis *et al.*, forthcoming).

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<sup>34</sup> According to Pettit *et al.*, 2010 resilience of a supply chain increases as capabilities increase. They identify 14 capability factors and 71 sub-factors to increase capabilities, among them reserve capacity, redundancy, backup energy sources and communications, visibility, adaptability, efficiency, recovery, learning from experience, creative problem solving (p. 12).

Shifting perspective from production logic to the customer-oriented service logic is another aspect of resilience development. Enquist (Enquist, 2003) and Enquist, 2003; Enquist and Johnson, forthcoming, discuss the importance of communication and dialogue to develop value in public transport systems in Sweden, based on a model for dialogue in interest-networks, and service logic.

Holmén, 2007, uses the case of how a car manufacturer starts financial services for customers, and describes the long adaption process to implement a service logic from a dominating industry ideology, and how that changes the way the industry company later profiles itself. Inertia in learning processes is an interesting phenomenon involving the communication and information exchange, relationships, as well as the coherence (sense making) process.

Carlsson-Wall, 2011, exemplifies by three industrial case studies how difficult problem solving can be in product development project contexts due to communication problems. He describes how complexities, goal conflicts, negotiations, unexpected disruptions, and time pressure affect communication and information quality in cost-driven development. This illustrates the difficulties of cooperation in networks, of how not knowing the customers' "hang-ups" and opinions well enough, generate uncertainties in the information. This situation is transferable also to other complex situations, such as goods transport services, where the matching of the customer's needs and wishes with the supplier's capabilities and capacity can lead to problems, because what the Buyer means, is not understood the same way by the Provider.

## 3. Method

This research is descriptive and exploratory.

In data collection I have used both qualitative and quantitative methods and data. This is in line with grounded theory (Glaser and Strauss, 1967) in the sense that data sources and observations of different kinds are used as support.

The Theory of Constraints (Goldratt, 1990) is used to communicate the phenomena of constraints. Goldratt challenges a dominant paradigm in management thinking, which gives leverage to the discussion, since it makes it possible to refocus the problems.

Allison (1971) used more than one perspective to illustrate the reasons for the Cuban missile crisis, showing that different conceptual models can give different explanations depending on the perspective and “mental model”<sup>35</sup> of the actor, and at the same time increase the understanding of a certain phenomena or problem. The aim is to reduce complexity to understandable models or theories.

This is also in line with systems dynamics perspective which has a well developed coding system based on operative logics for flows, resource accumulations, information feedback, external influences, and boundaries (e.g. Forrester, 1958; Wolstenholme, 1990; Sterman, 2000). It also uses conceptual models that can be used to map complex systems and to simulate the behaviour of them.

### 3.1. Selection of transport companies

Goods transport service is a type of service supply chain that has similarities to hybrid supply chains (Anderson *et al.*, 2005). The transport service is though a pure service, and as such has the same logic (“pull” strategy, the transport cannot be produced in advance). However, at the same time it is involved in flows of goods. From that point of view a transport is a sort of “conveyor belt” between two geographical locations, and often in partnership with the Transport Buyer. It is, however, still “pull” logic in this performance, since there is no “product” but a service, which is the actual transport (not the goods that are transported), therefore the operations are constrained

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<sup>35</sup> See footnote 134

by the operator's performance capacity. Both Akkermans and Vos, 2003; Anderson *et al.*, 2005, clearly show that it is the capacity that takes over the role of protecting the chain from fluctuations in service chains<sup>36</sup>. Goods transport services also have a mixture of technical capacity (load capacity, terminals, computer systems, communication equipment, etc.) and human capacity, with a high degree of automation and under high competitive pressure, still, or maybe because of that, in need of developing skills and capabilities.

The other reason for choosing goods transport services is that it is a category of service where the customers' demand for quality and flexibility has increased, at the same time as complexity of the services also have increased. This change has only been possible through the technical and organizational development that has occurred in recent years, coupled with deregulation and globalization. But what got my attention were the relatively big adjustment problems that could be noticed, which above all can be detected as it also showed comparatively low satisfaction with some capability attributes of the Transport Providers.

## 3.2. The research process

The major part of the data was collected several years ago for a similar purpose in a project I was involved in. Since part of that very extensive data also was relevant for this thesis, I have used it as my main data set.

The data was primarily collected 2001-2004, and some complements in 2011.

The purpose of the original study was to study service quality and for that to collect flow data and attitudinal data from Transport Buyers of what service attributes they desired, and assess how their present Transport Providers performed (according to them).

In the data analysis I had observed the high failure rates and the exceptional time pressures in some industries in the data. Even though the "raw findings" were brought out and presented to industrial professionals and academics, there was never a deep discussion about the causes. The questions not discussed then were what the nature of these problems was, and if and how it

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<sup>36</sup> Even though they do not as such study transport, however the basic logic is the same.

could have any significance for the development of transport industry, from the point of view of the individual Transport Provider.

Since I started this thesis end of 2010 the theory of constraints was brought into the picture by Thomas Polesie. Question was raised whether the failures had to do with constraints and what kind of constraints. Could constraints be observed in the data? A number of discussions were held about constraints, which contributed to the development of the research model.

The interviews with Transport Buyers made in 2001-02 gave a lot of support for dissatisfaction with how transport services were performed. These data-sets were appropriate for the phenomena in question to be studied.

The research process has been iterative. It started with a question or hypothesis, the theoretical connection. In my case the stages from a research question to operationalization of this was done already a decade ago. This lead to, as described above, findings that raised further questions of how the services really worked, and why. Since then we have had many dialogues and discussions, which have lead to the development of concepts and the research model.

This process is in accordance with grounded theory (Glaser and Strauss, 1967), data from a number of sources can be used.

Interviews of Transport Buyers and Providers were performed late 2001 and early 2002. Meanwhile the project research group I was a member of prepared a bigger survey to Transport Buyers, with the purpose to find out their desired services. Below I will describe more in detail these processes and discuss validity and reliability.

The age of data is not a problem, since it is the phenomenon of constraints that is studied. However, it is justified to question whether the findings would be valid if the survey was repeated today. According to Ahldén, 2011, much would be the same, however there are some differences. For example the problems to get personnel are less today (more mobility in EU). Smaller Transport Providers have learnt to cooperate better, thus could add more competitive pressure. Smaller shipments are more prevalent today than 10 years ago.

Lean thinking is also even more established and accepted today, and “agility” is a fashion word in the logistics sector, however its application is more questionable. Both these concepts put more strain on available capacity.

This sounds to me like more time pressure, not less, which means the competitive situation could be even more sharpened, in other words there are no signs that planning, coordination, and time management would be less complex today than a decade ago. On the other hand more cooperation could of course also work in the opposite direction with better use of industry resources. Information & Communication Systems have developed technically and somewhat improved, however that in itself is no guarantee they have improved performance. My point is that there are no signs that the phenomena of constraints would be less relevant today than a decade ago.

I will first describe the process of generating the data sets used in this thesis.

### **3.2.1. Data**

Several project group meetings and discussions were therefore held before putting the rather detailed and elaborate questionnaire together. Meetings were also held with a project reference group to get the industry input. This led to that the data need could be specified.

Before the main study I also performed an interview study with Transport Buyers to explore and test some of the questions that had occurred in the discussions, partly as a validation.

I also performed some interviews with Transport Providers.

The data needed were context data, which described the flow (weight or volume of outgoing goods flow) in different dimensions, such as geographically (from-to), time-constraints (delivery-times, time windows, etc.), and failures. The main objective with the survey was to get information about the Buyer's criteria used in choosing a transport solution and specifically in choosing a Transport Provider. 33 attitudinal questions covering different operative and strategically important capability-aspects of the Transport Provider were constructed, such as geographical coverage, handling, on-time reliability, trust, quality fluctuation, accessibility, communication, routines, contingency, price, physical transport capacity, environmental aspects<sup>37</sup>. Two scales were constructed for the same capabilities, one describing how important the item was to the Transport Buyer, and the other how the Buyer assessed that the Transport Provider performed for the same item.

Another question describing the pressures in the choice of transport solution was also included<sup>38</sup>.

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<sup>37</sup> See question 24 in the questionnaire, Appendix 3.

<sup>38</sup> See question 9 in the questionnaire, Appendix 3.

### 3.2.2. Interviews with Transport Buyers

The purpose of this pre-study was exploratory, i.e. to get information of the current situation (2001 to early 2002) about industrial Transport Buyers' view on what factors influenced their choice of transport solution. As mentioned above, it was also a matter of testing and validating certain assumptions and questions that had come to light in the project group discussions.

This qualitative study was carried out as telephone-interviews, which lasted 15 – 30 minutes each. The interviews were performed at an appointed time, i.e. the interviewee was first contacted by phone, and a convenient occasion for the interview was then decided. The purpose of that was to avoid that the interviewee was under undue time-pressure to answer the questions. Telephone interviews were chosen because they were the most practical form for the interviewees rather than booking a company visit, which would consume more of their time.

The interviewees were mostly logistics or transport chiefs or chief Transport Buyers in the twenty medium- or large-sized manufacturing and wholesaling companies. Twenty-four persons in all were interviewed.

Thirteen of these companies were manufacturers and seven wholesalers, Table 1:

Table 1: Companies chosen in interview-study

<b>Industries</b>	<b>Nr of companies interviewed</b>	<b>Turnover range, million SEK per year, approx.</b>
Food & Beverage, manufacturer	1	600
Building & Construction, manufacturer	1	1 400
Steel & Metal, manufacturer	3	100 - 700
Industrial machines and tools, manufacturer	3	300 – 5 000
Electronics or electric appliances, manufacturer	4	250 – 8 500
Vehicle components industry	1	160
Food & Beverage wholesaler	3	17000-40000
Electronics & Household prod., wholesaler	1	1 600
Building & Construction, DIY* wholesaler	1	2 000
Industrial supply, wholesaler	2	800

\* DIY = Do-It-Yourself



These cases were chosen in a non-randomised manner from a business database that contains all registered limited companies in Sweden (AffärsData, 2002). The criteria were that they were to represent a spread of different trades of manufacturers and wholesalers. They were also to have a substantial turnover and represent medium- and large-sized companies, since they were believed to have bigger goods flows. Companies that were believed to have widespread distribution I considered interesting to study. This study was carried out October 2001 (3 companies) and in February 2002 (17 companies).

The interview was semi-structured and followed a question guide (Appendix 2). I introduced it with an explanation of the purpose of the study, i.e. to find out what their most important factors and criteria were in choosing a transport solution regarding quality, price and environment.

The respondents, answered in their own words (not multiple-choice questions). The aim for that was to get their spontaneous answers, not pre-fabricated choices.

I was not able to record the phone calls, but I took careful notes during the phone calls on the standardized form I had prepared. The notes from the telephone interviews were secured with complementary comments and supplementary documentation directly or shortly after the phone calls. The results were coded and tabulated, then summarised in an internal report to the project group (Saxin, 2002a).

### ***3.2.3. Interviews with Transport Providers***

I performed also a few exploratory interviews also with forwarders and hauliers in the Schenker-, and Danzas-sphere, and Euroute. These were company visits. Interview questions had been prepared in advance. Notes were taken and written out afterwards (Saxin, 2002b).

### ***3.2.4. The survey***

The purpose of the pre-study was to get some insight in how major Transport Buyers were thinking and what they considered important criteria in choosing a transport solution. It confirmed some views and clarified others regarding the Transport Buyers' views on time, quality, environmental matters, and price of transport. With this exploratory qualitatively designed study,

the other pre-study on the Transport Providers and another pre-study<sup>39</sup>, the research questions for the main study were specified.

A number of meetings were then held by the project group to design the extensive survey including questionnaire<sup>40</sup>. A number of meetings were also with a reference group with representatives from industry.

Since the study objects (the companies) were rather inhomogeneous, it was decided that the design of the survey would be a stratified random sample. The stratification criteria were *type (manufacturer or wholesaler) and size (number of employees) of company*.

The survey was carried out mainly the second quarter of 2003, but with some follow-ups the following months.

### **3.2.4.1. Response rates**

The final average response rate was 49%, Figure 4, but if this figure is adjusted by excluding the small manufacturing and wholesale companies, then the final response rate was 56% (63% for manufacturing companies and 45% for wholesale companies)<sup>41</sup>. These three groups of companies have the largest volumes of goods transported and therefore the major efforts to get the surveys sent back were made in these groups i.e. highest number of contacts by telephone and mail. The reward for this work is shown in the high response rates for these groups. 64% is undoubtedly a very high response rate for a survey like this.

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<sup>39</sup> See Lammgård, 2007.

<sup>40</sup> In Appendix 3 question 9 and 24 of the questionnaire are shown.

<sup>41</sup> Important is the fact that the largest companies in the two groups got a 63% response rate.

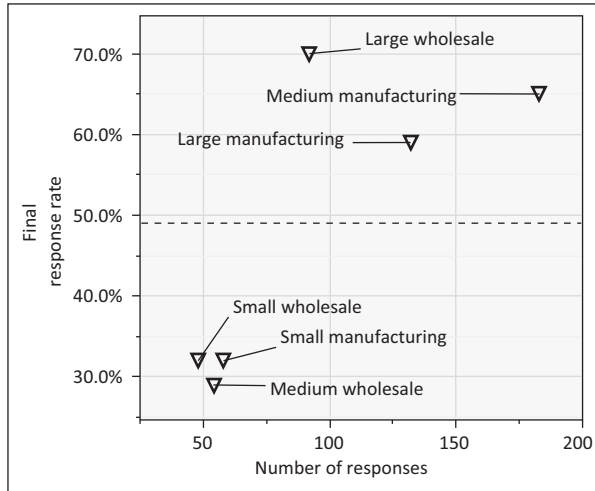


Figure 4: Final response rate and number of responses, the different types of companies, n= 567

### 3.2.4.2. Non-response analysis

Non-response testing was also performed. Lack of time and / or lack of statistics was in general the most common reason for not answering the survey. This was especially the case for the smaller companies and therefore response rate was also lowest, around 32%. A probable explanation is that these companies have low transport volumes and therefore do not use resources to collect and analyse flow data.

## 3.3. Validity and reliability

Lundahl and Skärvad, 1982:67, define validity as “the absence of systematic measuring errors”. They make a distinction between internal and external validity.

Internal validity exists when the measuring instrument, e.g. the survey questionnaire or the interview, measures what it is supposed to measure (ibid). This means there is high agreement between the theoretical and operational definition (ibid), in other words the interface between theory (hypothesis,

model) and the operationalization (the interview guide or the survey questionnaire, etc.). Sometimes coverage can be too much<sup>42</sup>, too narrow<sup>43</sup>, or skewed<sup>44</sup> (ibid. p. 68).

External validity is a concept covering the application of the measuring instrument, i.e. so that the results can be generalised from one population to another (Churchill and Iacobucci, 2002) due to the fact that the right people are interviewed, or the right objects are studied. This has to do with identifying and selecting the relevant people or the study objects with which the phenomenon or behaviour of interest is connected. A survey or an interview can have low external validity e.g. because people do not fully understand the question or the context (but they pretend that they do), they lie or deceive, or they remember wrongly (cf. Lundahl and Skärvad, 1982).

Reliability has to do with how the measuring has been performed, i.e. to what degree random errors are absent (Lundahl and Skärvad, 1982:69), i.e. that random events (that has nothing to do with the phenomenon studied) interferes with the measuring, or that the researcher somehow “fakes” the results (ibid). An example of the first situation could be that an interview is performed in a place where there are loud disturbing noises from the surroundings, or that the interviewee is constantly interrupted by phonecalls or by people urgently wanting attention. The second situation could be a researcher who has interviewed a number of people and feels he “knows” what the rest will answer and fills in the forms himself “for them” (examples from Lundahl and Skärvad, 1982).

### **3.3.1. The interviews**

Possible errors in my telephone interviews with Transport Buyers:

I had prepared the interview guide with support from group discussions, as described above. Since this was a pre-study the purpose was exploratory to see how e.g. transport chiefs of bigger Transport Buyers respond and describe their transport situation, this was an occasion to increase validity.

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<sup>42</sup> That is, the measuring instrument covers the relevant phenomenon, and also other phenomena in its context.

<sup>43</sup> That is, the measuring instrument only measures a part of the relevant phenomena. This obviously can lead to bias in the interpretation.

<sup>44</sup> That is, the measuring instrument does not “hit the target”, but measures maybe part of the phenomenon and variables that are not really relevant. This obviously can obscure, skew, or shift the focus of the phenomenon studied to something else.

External validity: The fact that a non-randomised manner was used to select the companies does of course not make the results generalizable. Yin (1994) means, however, that case studies can be generalizable in an analytical manner, by forming theory from them. Big companies in themselves are representative and influential of (and many times dominate) their industries. By choosing well-known companies in various trades and with different types of goods the external validity is likely to be less biased than just relying on one's own past experience or contact with a certain company.

A weakness was that I did not send over the questions in advance, which in hindsight I should have done. Then the respondents would have had time to prepare for the interviews better. However, I did get the impression from the conversation that there was no hesitation in their answers, and since the answers were open it was obvious that they were well aware of the situation.

Reliability in the context of these telephone interviews depends on consistency and how comparable the situation is when asking questions, how the interview material is recorded and transcribed or supplemented, and how it is analysed. By using the semi-structured interview-guide, replicability increases considerably. However, there is no guarantee that interviews made on different occasions will be exact replicas. Also respondents have different backgrounds and experiences, and occasionally it took explanation or clarifications of questions that I perceived were not fully understood the way intended. That, however, by definition would increase both reliability and external validity. It could thus be argued that clarifications that have the aim to convey the intended meaning of the questions should increase the chances to get consistent answers. As can be noticed from the interview-guide (Appendix 2) the questions were operationally detailed, which Yin, 1994, means increases reliability.

As a point of improvement it would have been better also to have e.g. followed up with one or several group discussions with the same people (see e.g. Vennix and Gubbels, 1994), however it was not workable in this case. Another point would have been to record the interviews, but as explained above, I did not have access to that kind of recording equipment at the time.

Interviews with the Transport Providers were performed on site, and notes were written out afterwards.

## 3.3.2. The survey

### 3.3.2.1. Validity

Internal validity can be considered high. Triangulation was used in constructing questions for the questionnaire. Questions were generated then discussed in the project research group for the senior researchers<sup>45</sup> input. There was also a reference group of representatives from industry and academia. Several seminar style meetings were held with progression reports and input from members. The exploratory pre-studies mentioned above were also performed to get the perspective of industrial Transport Buyers and Providers.

Scales were also discussed in the project group. The attitude question consisted of 33 items or sub-questions. These questions were carefully formulated and two scales for importance and performances respectively were constructed.

A semantic differential scale was chosen for these attitudinal factors, since evaluation was the purpose (Churchill and Iacobucci, 2002:382f.). Both scales have seven points (1 to 7) where 1 is very small / low and 7 is very large. The midpoint 4 thus means neither small / low nor large<sup>46</sup>. The reason for a seven-point scale and not a five-point is that it is slightly more nuanced, e.g. it is possible to distinguish if it is near high or low or indifferent. A nine-point scale obviously would give more nuances, however is harder for the respondent to weigh.

These scales were constructed as equal-appearing intervals (Churchill and Iacobucci, 2002:375ff) and summated scales (ibid:379) to enable the use of an interval scale.

For construction of scale describing pressures were used the constant sum method (Churchill and Iacobucci, 2002:393).

After several project group discussions, a pilot questionnaire was compiled. The pilot was tested by a group of practitioners and academics. We got some important feedback regarding the validity of the questions, and we adjusted the final version of the questionnaire.

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<sup>45</sup> With previous experience of such surveys.

<sup>46</sup> See question 24 in Appendix 3 about scale constructions.

With the above conceptual discussions and testing by both professionals in industry and researchers, the internal validity has to be considered very high. Especially the formulation of the questions to avoid ambiguity and bias, and to use concepts understood by practitioners in industry, considerable time and discussions were spent. However, there is always a possibility that people interpret concepts differently, especially when there is complexity involved (Churchill and Iacobucci, 2002:403). The most obvious difference could be differences between industries, e.g. careful handling might mean one thing if crystal glass is shipped, and another thing if it is tractors. Also it is likely that the transport chief in a local work unit has a different perspective than the chief procurement officer at head quarters in a bigger international company, however there is to my knowledge no way to eliminate that kind of bias. It is still the decision-makers opinions that are measured, even though individuals have different frames of reference. The important part in this is to find the actual decision-maker, and I believe that was done in most cases due to the telephone initiation of the survey.

The sampling was done on firm level from a frame of SCB's<sup>47</sup> database, containing all current firm registrations, which is updated regularly. It was SCB that performed the sampling. We used a stratified random sample to get better representation of bigger companies, which are few in number, but have the biggest flow of goods.

The sampling, dealing with framing and sampling problems, identification of respondents, and data collection have been described in detail and published in Lamngård, Saxin *et al.*, 2004. The identification of respondents was a meticulous (and very time-demanding) way to make sure the "right" person was identified. This was done by phoning the companies in the target population. This ensured higher quality in the answers than just sending the survey addressed to the company.

All phone calls were logged in detail.

Since the data contained quite exact classification of data, e.g. industry (SNI02-code), size, etc., it is possible to form categories in the analysis of the data, thus draw some conclusions about perceived problems, satisfaction, etc. from a statistical point of view. Problems in a certain industry could for example be connected to the type of goods being transported.

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<sup>47</sup> SCB = Statistiska Centralbyrån, Statistics Sweden, the official authority for statistics in Sweden

The problem is sometimes that the industry classification can change over the years, but the company might not make correction immediately of the registration to the authorities. Therefore, e.g. a company that has been a manufacturer and moves a part of the manufacturing abroad, might be more of a wholesaler in function, but could still be registered primarily as a manufacturer, until all production is moved. This obviously could affect the interpretation of the findings. However, since SCB's is the official statistical authority, the data is the best available.

Also in filling in the form there could be circumstances that affect the quality of the answers. Churchill and Iacobucci, 2002:404, exemplifies that e.g. the frame of mind or the circumstances the respondent is in when answering the questions, such as mood, health, can affect the quality of the answers. As described above, this could also affect the reliability of the survey results (interruptions, etc.).

### **3.3.2.2. Reliability**

The reliability of the survey is high since a questionnaire was used. Also an introductory letter was enclosed. The above described telephone-initiation method also contributed to finding the person responsible for the procurement of outgoing transport. However, as we could notice on the forms, sometimes someone else had filled in the form. Chances are that this delegation is done to someone with "less insight" in the strategic issues and criteria of choosing a Transport Provider, on the other hand it might not be. Risk is also, since the questionnaire contained quite a number of questions, that respondents rushed through the questions and that some answers were not well-reflected or based on guesses. Time-pressure and interruptions while filling in the questionnaire are, of course, also circumstances that can affect results.

## **3.4. Analysis of data**

### **3.4.1. Factor analysis**

Factor analysis is a collection of methods whose main purpose is to reduce and summarise data (Hair et al 1992:225). The reduction is if there are many overlapping questions, which are reduced to a few factors. In this interdependence technique all the variables are considered simultaneously (ibid).

In this study *Principal Component analysis* (PCA) is used.



The rotation-technique used is varimax rotation (ibid:235f.). See further details of tests and statistical strength in section 5.1. and Appendix 4.

Why is factor analysis used?

Asking a number of people many questions about their opinions about many different things gives a lot of complex data, i.e. uncertainty. This is because people normally have different preferences or opinions. Factor analysis measures the variance between all the variables, and is a technique that can be used in such a situation to reduce the uncertainty.

The purpose of the factor analysis is thus to condense a large number of variables (the questions or items<sup>48</sup>) into a smaller number of factors, which are easier to understand and analyse.

The reason for that is that questions often overlap each other if they e.g. intend to nuance an opinion from different angles. Each factor covers a specific common “topic” or phenomenon, e.g. the relationship between the Buyer and Seller, the service reliability, or the Information and Communication System.

In the survey 31 of the questions (describing attributes of the Transport Provider’s capabilities) were reduced to nine factors with PCA, see the two left columns in Figure 5. This is expounded on in sections 5.1. and 5.2.

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<sup>48</sup> Questions, here attributes of the Buyer’s assessments, are numbered as items. The numbers are referring to the order they appear in the survey questionnaire, see Appendix 4.

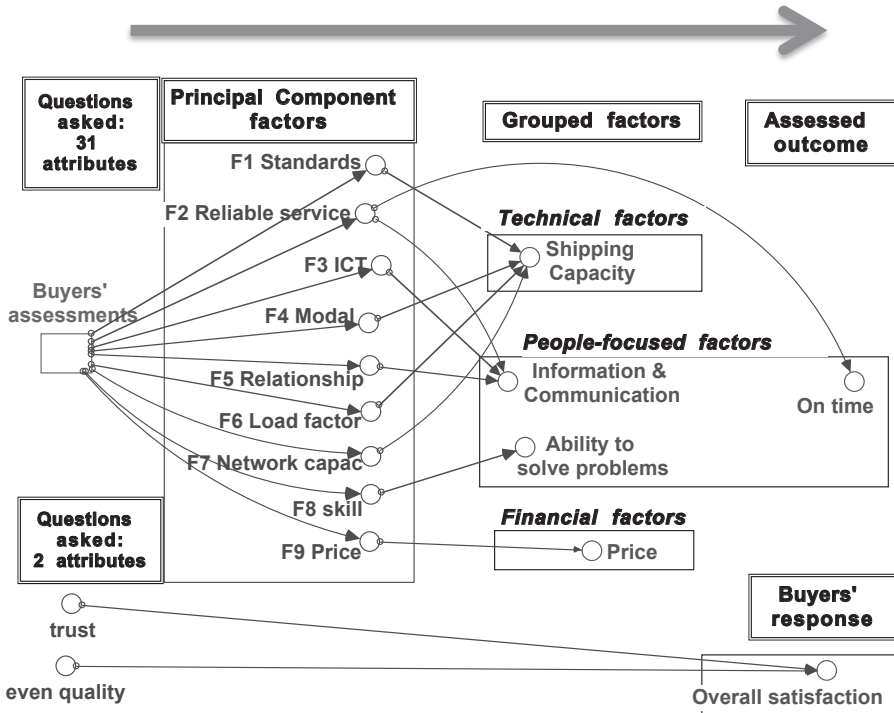


Figure 5: The sequence of data analysis<sup>49</sup>.

### 3.4.2. Partial least squares

The second reduction step of the data is illustrated in the two columns to the right in Figure 5. This grouping was done by sorting the dominating nature of the questions asked to the respondents into three major groups: technical, people-focused, and financial factors. There are five grouped factors defined to represent different resources or areas of capabilities. This is expounded on in section 5.3. Overall Satisfaction is the Buyer's overall assessment. This is explained in section 5.2.1. As "control variables" were also used actual quantitative data on On-time delivery (i.e. the failure rates) and the damage rates (in shares of the goods flow); these two are not shown in Figure 5. All these variables were used in the analysis of constraints. This is shown in chapter 6.

<sup>49</sup> The 31 items (questions asked to the Transport Buyers) were reduced to nine Principal Component factors in the factor analysis. These in turn were reduced to three factor groups (people-focused, technical, financial), consisting of five capability factors of the Transport Providers. The thick arrow shows the direction of the data aggregation. Thin arrows in this illustration show how the items and factors were reduced.

Partial least square regression (PLS), is a comparatively stable regression method for multivariate analysis that has some advantages over ordinary least square (OLS) and other regression methods (see Wold, Trygg *et al.*, 2001; SAS, Institute Inc, 2010, ch. 23). It is used to reduce a large number of variables to factors. One difference to OLS is that it works when there are many variables and correlations are high between the variables (SAS, Institute Inc, 2010:491).

The advantage is that it balances in explaining both the response variation and the predictor variation (*ibid.*). The multivariate PLS platform is a matrix where all the relevant input (X) variables and all the relevant output (Y) variables can be loaded into the same model. As X was for instance all the importance factors (the grouped capability factors in Figure 5) and the pressures loaded in, and as Y failure rates, damages, Overall Satisfaction and all the performance (grouped capability) factors. This gives the effects of the X-factors on the output-factors (Y), considering both the variance in X and in Y (*ibid.*).

As criteria of effects I distinguished primary and secondary. As a primary effect I defined a significant effect<sup>50</sup> that show an increase in the *measurable* dimensions (in this study: failure rate, damage %), and a negative satisfaction (i.e. dissatisfaction), and a negative effect on any of the perceived capabilities (Problem Solving ability, Information & Communication Systems, Shipping Capacity), or the *perceived* outputs On-Time delivery and / or Pricing.

As a secondary effect: as the primary effect but not giving a clear effect on both an output (measurable or perceived) and Overall Satisfaction.

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<sup>50</sup> According to Wold *et al.*, 2001 and others the VIP (variable importance plot) should be at least 0.80 and a clear coefficient. I have chosen the PLS-effect of  $\geq 0.10$  or  $\leq -0.10$ . See SAS, Institute Inc, 2010, ch. 23 for description of the method.



## PART 2

# Observations of Buyers and Sellers



## 4. The context

### 4.1. The survey

In this chapter I present some contextual data from the survey of Transport Buyers' opinions of conditions, pressures and selection criteria of Transport Providers<sup>51</sup>.

The general business climate 2002 and early 2003 was a medium, but distinct, upsurge from the recession years 1998-2000 where e.g. only about 40 % of the road hauliers had "normal" demand (i.e. full capacity deployed), in 2002 it was about 55 % (Konjunkturinstitutet, 2011). It also manifested itself in increasing difficulty in recruiting personnel, and other constraining factors, such as finance (ibid).

### 4.2. Industries

Two-thirds of the companies in this survey of Transport Buyers were manufacturing companies. This classification (a combination of SNI02-code<sup>52</sup>) has somewhat of a "value-chain" arrangement, where products further down in the list are in a more "refined" state or ready for consumption.

The following industrial categories are represented in Table 2. Numbers within parentheses are the industry codes used in this thesis<sup>53</sup>:

- 1) *Food & Beverage*: Food, beverages, and tobacco:
  - a Manufacturers (15), a large percentage of the manufacturers production is delivered to the wholesalers.
  - b. Wholesalers (512).
- 2) *Building and construction (B&C):*
  - a. Manufacturers (20) that produce building materials, such as wood, chipboard, fibreboard, stone, plaster board, stone wool, and glass products. Much of that is delivered directly to the

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<sup>51</sup> Some findings have been published in Saxin, Lammgård *et al.*, 2005; Flodén, 2007; Lammgård, 2007.

<sup>52</sup> SNI02 is a classification system of industries valid from 2002. The SNI code has since been changed.

<sup>53</sup> Below the industry code is slightly adjusted from SNI02. See Saxin, 2012, for a more complete list.

Building & Construction industry (B&C industry), but big quantities also to the wholesalers.

- b. Wholesalers (515) sell these products to e.g. building firms and consumers (via D.I.Y.-stores, postal order companies, etc.), but they also sell other manufactured products, such as ventilation systems, Steel & Metal constructions for building, sanitary porcelain, pipes, electrical materials for installation.
- 3) *Paper industry* (21). This includes pulp, cardboard, packaging, and paper for newspapers and finer paper for office or private use.
  - 4) Industrial manufacturers.
    - a. *Semi-manufactured products and simpler consumer products*. This is the large group of companies that manufactures anything from chemicals to plastic and rubber details or products (24), Steel & Metal parts (27), components and modules for further production. Most of this is shipped directly from the manufacturing industries to other producers, such as the Vehicle industry (34), B&C industry, Electronics & Household appliances industry (30), power industry. Some products like this are also supplied from wholesalers, as can be seen in the list, Table 2.
    - b. *Industrial production equipment*: Electrical machines, motors and electronics, tools, gauging equipment, etc. for primarily production purposes and integration in more complex products. Products like electrical motors could also be components in e.g. vehicles, compressors, pumps, power production equipment, and ventilation systems. Therefore these groups (“Machines & Tools” for industrial use (29) and “Electronics & Household appliances” industry (30)) contain sub-contractors or suppliers to the manufacturing industry, such as the Vehicle industry (34).
    - c. *Household consumption goods*: furniture and textiles, etc. (36), electronics, refrigerators (30).
    - d. *Vehicles* (34). Includes all types of vehicles: trucks, trains, wheel loaders, forest machines, and motorcars.
  - 5) Industrial wholesalers



- a. Business (e.g. office) and household products (514). As for other wholesalers, a lot of the products can be imports.
- b. Other industrial goods, including machines (518)
- c. Fuels and other chemicals (“Petrochemical” wholesale, 520). This refers to the wholesale distribution of primarily fuels to industry and consumers, such as petrol, oil products, and household chemicals.

Table 2 gives a summary of the industries represented in the study.

Table 2: Industries represented in the survey, numbers of companies.<sup>54</sup>

Company category	Industry	Adj. SNI02-code*	Estim. volumes	sample
			Million tonnes / year	n
Manufacturer	Food & Beverage	15	9.8	41
	Building & Construction (materials)	20	22.9	31
	Paper	21	22.9	42
	Plastics & Chemistry	24	7.0	48
	Steel & Metal	27	20.2	63
	Machines & Tools	29	2.0	64
	Electronics & Household appliances	30	0.1	13
	Vehicle	34	5.0	31
	Furniture & Textile	36	1.5	19
Wholesaler	Food & Beverage WHS	512	12.4	47
	Household appliances WHS	514	1.1	30
	Building & Construction WHS	515	3.9	16
	Industrial supply WHS	518	5.2	76
	Petrochemical WHS	520	6.1	9
	<b>Total</b>		120.0	530

\* Note that there has been slight adjustments of industry codes in this thesis compared to SNI02, see Saxin, 2012.

<sup>54</sup> Volume-equivalent weight is used by the transport industry in charging for the freight. Only for *low-density* freight it differs from real weight. Figures represent the total population (estimated statistically). WHS = wholesalers.

In this thesis the following groups will be analysed:

Industrial group	Clarification	Company type
Food & Beverage		Manufacturers
Food & Beverage		Wholesalers
B&C	Building & Construction	Manufacturers
B&C	Building & Construction	Wholesalers
Paper		Manufacturers and wholesalers
Industrial		Manufacturers
Industrial		Wholesalers

### 4.3. Size of companies

What is a small company or a medium-sized?

The survey of this study used the following criteria to decide company size: the number of employees, and the main category of business (manufacturer, or wholesaler).

Since manufacturing companies have more complex operations, they are, generally speaking, also more people-intense<sup>55</sup> than wholesalers, which only handle flows of goods. That is why manufacturers have been given more employees in each category. The following classification for company sizes is therefore valid in this study:

<p>A small manufacturer has 10-99 employees, whereas a small wholesaler has 5-19.</p> <p>A medium-sized manufacturer has 100-399 employees, whereas a wholesaler 20-99.</p> <p>A large-sized manufacturer has 400 or more employees, whereas a wholesaler has got 100 or more.</p>
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Two thirds of the companies in the survey were of the company size 100-999 employees, i.e. medium- to large-sized.

For all *manufacturers*, three quarters of the companies are also in the company size category 100-999 employees, and only about 16 % are small. Since

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<sup>55</sup> At least that was the case when the survey took place.

medium- and large-sized companies are the ones that have the biggest goods flows, they are good representatives of transport-intensive Transport Buyers. However, also small companies in some manufacturing industries could have considerable transport volumes, e.g. B&C manufacturers.

Almost half of the wholesale companies in the survey are large-sized (at least 100 employees), then approximately equally many medium- and small-sized companies.

Figure 6 illustrates the number of companies in the survey in each category (from left to right: large-medium-small) divided into manufacturers (bars to the left, n=373) and wholesalers (right, n=192).

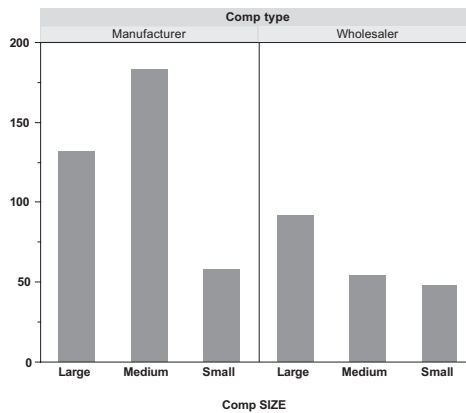


Figure 6: Company sizes, number of companies in the survey, large, medium, and small. Manufacturers (left) and wholesalers (right) respectively, n=567

#### 4.4. Flows: Volumes of goods

The flows measured were the outgoing goods from each work unit (“company”) that had been contacted. The criteria were that at least some part of it was transported at least 150 km, and that the goods had to be physically distributed with starting point in Sweden. This was to ensure that companies studied handled actual transport flows.

Manufacturer’s volume is about three quarters of the total flow. Large and medium sized manufacturers constitute almost 63% of the total, but even small manufacturers have sizeable freight flows.

Figure 7 shows the distribution (% of total) flow per industry groups (as defined above, section 4.2.). Biggest flow was found for Industrial manufacturers and wholesalers, which together answer for about two fifths of all outgoing flows. B&C has a little more than a fifth (mostly manufacturers), Food & Beverage, a little less than a fifth, and so does Paper industry.

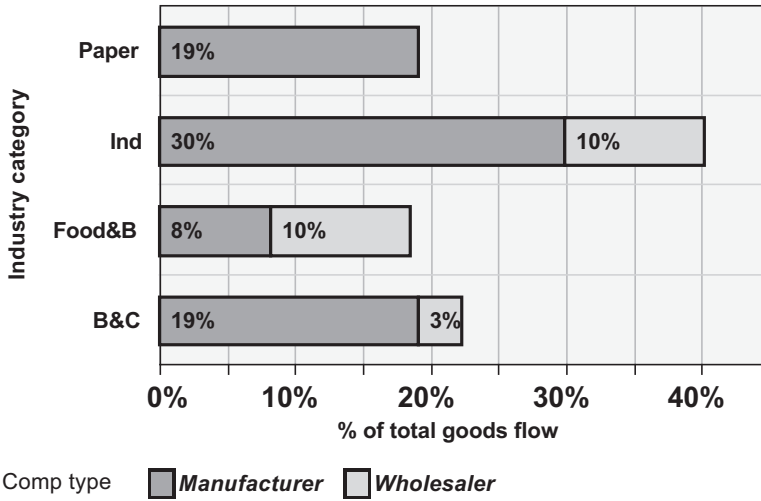


Figure 7: Goods flow per industry group, % of total, tot pop (n=530, N=7,075).

## 4.5. Transport Buyers' conditions

The Transport Buyer's conditions on the Transport Provider's performance are strongly influenced by the competitive pressures exerted by the Buyer's customers and the market situation. These "frame" or fundamental conditions can therefore be described as "pressures" or constraints of the transport, e.g. how fast the transport should be, within which time specifications delivery can take place, and to what price.

Sometimes transport lead-time has to be short. In other words transport has to be speedy. This could be for products with limited life-time, such as fresh fruit, vegetables, fish, newspapers, or fashion products and electronics, where the product life cycle is short, and deliveries have to be frequent and in small batches to minimize the risk of obsolescence and unsellable

inventory for the retailer or the distributor (Harrison and van Hoek, 2008; Simchi-Levi, Kaminsky *et al.*, 2008).

In such cases speed is exerting a higher pressure than price on the transport. We can therefore define this as the “*speed pressure*” of the transport solution, i.e. how much of the transport decision depends on speed factors?

In a similar way certain distribution strategies must be based on not only speed but often also on time precision. Time precision means delivery within a certain time window, e.g. 12 o'clock  $\pm$  1 hour. It could also mean pick up of the goods from the Buyer within a certain time window.

The corollary of this is that increased time restrictions are constraints in choosing transport solutions; it restricts the number of service Providers to those who have capacity available and capability to perform the transport on time. So “*time precision pressure*” is the ability to handle resource constraining conditions either by increasing the capacity, other capabilities, or the work pressure.

Price is normally increasing for a transport service that is performed faster than one of “standard delivery time”, and time precision justifies even higher prices due to the increased logistical complexity. Price is, of course, always an issue, but if speed to market is the underlying business logic of the distribution strategy, then speed takes precedence over price, in other words, the Buyers are prepared to pay more to get the products delivered faster. Price pressure is thus higher if price (or financial situation) is more of a critical factor, i.e. if the Buyer is more price sensitive, and does not want to pay extra for the delivery service. So the “*price pressure*” can be defined as high when a low price is more important than extra service, including special timing of the transport.

In the survey the respondent was asked to describe how much (weight, percentage) of each of the following pressures influenced the choice of transport solution: Time precision, Speed, Price and Emission Control<sup>56</sup>. In reality most companies have a “mix” of these four (and maybe others, but in this study only these four will be considered) depending on the competitive situation, the industry, size of company, and the customer. In this study only the first three will be used in the analysis and discussion to reduce complexity.

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<sup>56</sup> See question 9 in the survey, Appendix 3.

These variables will give the “strategic service focus” of the transport, i.e. what kind of service content the transport has, e.g. if the time factors dominate or the price (=less “frills”, or just an “a to b” transport). This is what the Buyers pay for. If they want fast transport then the strategic service focus is “Speed”, if they want delivery within a certain time window, then the strategic service focus is “Time Precision” (which can be both fast and with special coordination to pick up and deliver within a certain time margin, or it can be a normally paced transport + time window, however with the logistic complexity increased compared to the standard transport).

The levels (% per industry group) of these pressures are shown in Figure 8. As can be seen Price (the highest bars) is always, on average, an important factor for most industries, but especially for B&C, both manufacturer and wholesalers, paper, and industrial wholesalers. For individual companies this can vary though. High time-sensitivity is especially apparent for Food & Beverage, and Industrial Products, especially wholesalers, but also manufacturers. Price sensitivity normally increases for smaller companies.

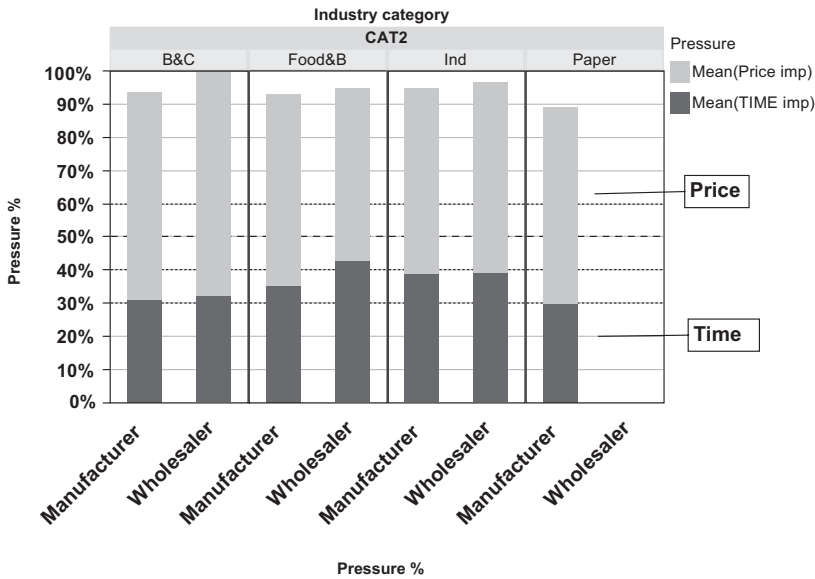


Figure 8: Price and time pressure shares (%), per industry group.<sup>57</sup>

<sup>57</sup> Price pressures are, on average, all over 50 %. NB! Individual companies may have big deviations from this. Time pressure here = speed + time precision pressure. (Weighed to represent the total population, n = 567, N = 7,832).

## 4.6. Transport Providers' time to prepare

Buyers affect the time pressure in the order fulfilment process also by how long in advance they notify the Transport Provider, i.e. how long they order before the actual delivery. This indicates how long the operative “planning horizon” is for the Transport Provider to allocate transport resources<sup>58</sup>. Table 3 shows the range of average number of hours the notification is done in each industrial group. As can be seen, notification is often given just a day before delivery takes place<sup>59</sup>.

Table 3: Notification time of Buyer when booking an order, hours (tot pop), approximate range, average hours per industry group, n=354.

CAT2	Comp type	Min hours	Max hours
Food&B	Manufacturer	10	25
Food&B	Wholesaler	15	22
B&C	Manufacturer	24	67
B&C	Wholesaler	7	19
Ind	Manufacturer	16	34
Ind	Wholesaler	7	30
Paper	Manufacturer	6	21

Figure 9 below shows the Transport Providers' average response time, i.e. the quota between the transport Lead-Time (LT) and the minimum Order Cycle Time (OCT min time)<sup>60</sup>. A higher quota means there is little time gap between order and delivery.

Whether delivery can be performed quickly could depend on the Transport Buyer's stock levels. The figure shown after the industry category is the mean percentage of goods delivered from stock. Paper industry and Food & Beverage manufacturers appear to have the speediest deliveries in relationship to the OCT. Wholesalers are in the middle, and Industrial and B&C manufacturers have a lower quota, in other words somewhat more allocation time.

<sup>58</sup> In contractual situations though the transport volumes could be known or scheduled over a longer period of time, however all fluctuations might not be foreseeable.

<sup>59</sup> Interpretation should be cautious though since not everyone answered this question.

<sup>60</sup> Order Cycle Time (OCT)= the time from the order until delivery arrives at the customer.

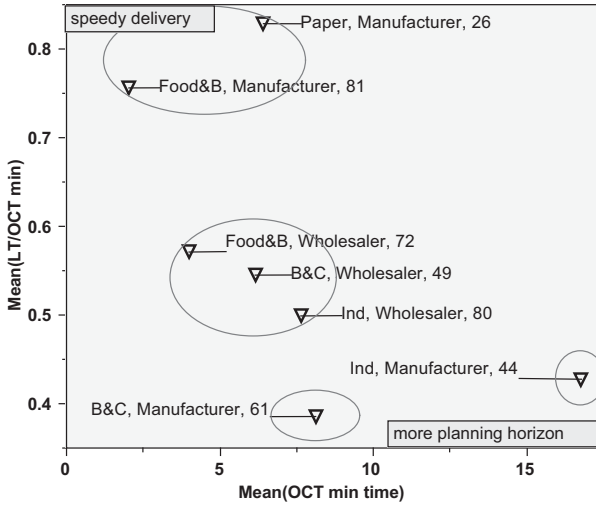


Figure 9: Order cycle minimum time, and transport lead-time share of minimum Order Cycle Time (OCT).<sup>61</sup>

Figure 10, below, shows how much (percentage) of the goods are delivered from stock. It is noticeable that stock levels are higher for manufacturers of Food & Beverage and B&C. For Industrial products it is the opposite, and the difference is statistically significant. The low stock levels for Paper industry and relatively low lead times, indicate a high time pressure at delivery point.

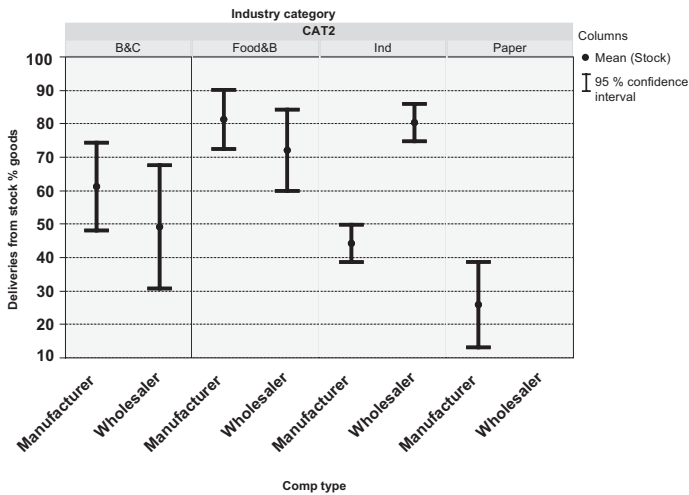


Figure 10: Percentage of goods delivered from stock.<sup>62</sup>

<sup>61</sup> The figure gives the average percentage of goods delivered from stock. Average lead time, weighed against the goods flow (volume equivalent weight). OCT min time is the average of the entire minimum Order Cycle Times.

<sup>62</sup> 95 % confidence interval indicated around the mean (the dot). n=522. Tot pop (N=7,305).



## 5. What is important for the Transport Buyer?

As a supplier of goods, the Transport Buyer has to be able to give its customer a certain level of service (e.g. delivery of specified quantities at specific times) at a certain price, therefore it has specific requirements of the Transport Provider's capabilities. The Buyer obviously tailors a delivery strategy that stays competitive. Therefore certain factors are more important to the individual company than others. If the Provider can fulfil the requirements they have agreed upon, the Buyer will be satisfied, if not — dissatisfied. In order to e.g. renew contracts, Buyers periodically assess their Transport Providers' performance, and the assessment is at least hypothetically compared to their own importance weights.

### 5.1. Some factors

To find out which factors are important to different industrial Transport Buyers we asked the respondents to assess how important certain attributes of a Transport Provider's performance are to their business in choosing a Transport Provider.

In all, 33 questions were asked, see question 24 in the questionnaire, Appendix 3.

These attributes covered more technical and operational aspects of the transport service, as well as the human aspects, such as communication, information retrieval, trust, quality, problem solving, and skill. The same questions were also asked regarding their main Transport Provider's perceived performance, see Appendix 3.

Two of these attributes, trust and quality stability, were chosen to represent the "Overall Satisfaction" with the Transport Provider's performance. The equivalent importance attributes formed "Overall importance", which in other words is the "input" variable<sup>63</sup> representing, attributes that make prediction and planning easier. Of the remaining 31 attributes nine factors were chosen,<sup>64</sup> see Table 4.

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<sup>63</sup> I.e. the independent variable (X).

<sup>64</sup> Principal Component analysis (PCA) of correlations was performed of the Transport Buyers' importance weights. The model explains 62% of the total variation (i.e. it reduces uncertainty in the statistical information with 62 %).

Codes in Table 4		
Code	Factor loading	Relationship (correlation) between item and factor
+++	0.70 - 0.88	Very strong positive association
++	0.50 - 0.69	Strong positive
+	0.40 - 0.49	More important positive
(+)	0.33 - 0.39	Significant positive
empty	< 0.33	Uncertain, not shown in the table

Compare Hair et.al., 1992, p. 239.

### ***How to read Table 4***

Factors (in the columns) are the resources or phenomena that describe the major capabilities of the Transport Provider.

The items (or attributes = the rows) are the different questions asked to assess about levels of different aspects of the Transport Provider's capability.

Each factor is formed when usually several items with high factor loadings "flock" on it. The factor loading (here shown by "pluses", see "codes" above) shows the strength of the association between each item and the factor, i.e. if the item and the factor vary in the same or the opposite direction. With positive associations, the "movements" are all in the same direction for each factor's items, however some items contribute more than others.

When the factor loading = 1.0 item and factor move in the same direction, which means total agreement, no uncertainty whatsoever.

-1.0 means they move in the opposite direction.

Values near zero (0) are therefore interpreted as if there most likely is no association, i.e. people asked are uncertain, or they don't really know. Random answers like that therefore cancel each other. Generally, the loading is tested at a certain significance level, for example 95 %, which means there is 5 % risk that what seems to be a connection could just be a coincidence, i.e. just a random event that "happened" to occur.

Table 4: The 31 attributes<sup>65</sup> reduced to nine factors (in the columns),  
Principal Component analysis.

Item #	Transport provider attribute	F1 Standards	F2 Reliability of Service	F3 ICT	F4 Modal	F5 Relationship	F6 Load Factor	F7 Network capability	F8 Skill	F9 Price
32	Environmental mgmt system	+++								
33	Environmentally efficient transport	+++								
30	Low emission standards	+++								
6	Quality certif. (e.g. ISO 9000)	+++								
29	Using other fuels than diesel	++								
10	Accessible for bookings		+++							
15	Transport on time		++							
11	Accessible for follow-up		++							
17	Routines. disruption report		++							
3	IT system, track & trace			+++						
2	IT system for ordering			+++						
4	Complementary logistics services			+						
31	Offers intermodal R/R				+++					
27	Offers Rail transport				+++					
23	Access to detachable load-carriers				++					
24	Different transport modes				+					
21	Has good reputation					+++				
20	Has worked for us before					+++				
18	Good manners					++				
26	Coordinated deliveries with other companies						+++			
28	High loading factor						++			
25	Can coordinate our in- and outbound transport						+			
12	Many scheduled dispatches							++		
13	Can adjust to large variations in volume							++		
14	Deliveries at short notice							++		
1	Geographic coverage							(+)		
5	Can handle our goods								++	
9	Customized transport								++	
7	Routines document handling								(+)	
8	Has safety routines								(+)	
22	One of the lowest prices									+++
	Uncertainty reduced (%)	11.4	10.4	7.6	7.2	5.8	5.7	5.3	5.3	3.6
	Total uncertainty reduced (%)	62.3								

<sup>65</sup> See Appendix 4 for exact factor loadings and other measurements.

Factor values were then constructed as summated scales both for the Transport Buyers' assessed importance weights and the performance values. Reliability tests of these summated scales were performed which gave high or very high Cronbach's (standardized) alpha.<sup>66</sup>

## 5.2. Description of the factors

The mean importance weights (bottom row of Table 4) show that the respondents classify the factors "F2 Reliability of Service", "F9 Price", "F8 Skill", and "F7 Network Capability" as the most important.

Factor "F2 Reliability of Service consists of four attributes to do with on-time delivery, and different aspects of communication with the Transport Provider. This will be described more in detail below. F7 Network Capability, a technical system factor, covers the distributional aspects of geographical coverage of the transport network, and the delivery operations: that the service Provider has enough capacity to cope with volume fluctuations, high frequency, and short notice transport. The factor "F8 Skill" is a "People"-factor. It is a crucial factor tying people, technology, standards, and operations together, so that at the same time efficiency and good service can be achieved, that damages, loss and failures to deliver the goods on time can be minimised.

Regarding the factor F9 Price, see section 5.2.10.

Relationship (F5) consists of three items: "...has good reputation", "... has worked for us before", and "...has pleasant manner..." (these will be described more below), i.e. how well-known, reputable, and approachable (thus communicative), are the Transport Provider and their personnel?

The last four factors are Technical, "F1 Standards", "F6 Load factor", "F3 ICT", and "F4 Modal". "F1 Standards" represents quality and environmental management systems, i.e. both quality certification, and technical systems that fulfil the requirements for Emission Control, to ensure environmentally acceptable transport<sup>67</sup>.

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<sup>66</sup> Cronbach's alpha gives the internal reliability, i.e. is a test that the variables are measuring the same thing. Should be at least 0.70, but in some cases could be lower. See Appendix 4.

<sup>67</sup> Some critics of ISO 9000 certification mean it has little to do with quality development since the system is product oriented, not process oriented, encouraging an old fashioned control view instead of continual improvements (Bergman and Klefsjö, 1990:269f).

“F6 Load factor” covers efficiency and utility of space in the vehicles and load-carriers, which in other words has an economical aspect to the transport.

The two lowest ranked factors are “F3 ICT”, and “F4 Modal. “F3 ICT” contains attributes to do with the IT-based communication standard, and any extra third party logistics services offered by the Transport Provider.

“F4 Modal” includes availability of different transport modes, including regular train, and intermodal road/rail transport, and access to detachable intermodal load-carrier units (e.g. containers). However, there can be big variations in importance weights especially between different industries and company sizes.

So what we see here, from this *explicit* ranking of importance, is that factors which concern the *core* operative service of the relationship, reliability and skill that the service will be performed as promised, that all customers can be reached, and that capacity is available for flexible performance, are weighed the most. These are often considered, on average, at least as important as price. That the remaining technical factors are described as “less important” does not mean they are considered unimportant; they might just be anticipated or expected as “basic requirements”. Such factors will not necessarily increase satisfaction as performance improves, however they will invoke dissatisfaction if performance worsens (e.g. Matzler and Sauerwein, 2002; Vargo, Nagao *et al.*, 2007).

In the following description of each factor, for the “items” referred to, see Table 4, and the full question in the questionnaire, see question 24 in Appendix 3. The factors are presented in the same order as they occur in the PCA (the factor order in Table 4), which is based on the explained variance.

### **5.2.1. Overall Satisfaction**

The most fundamental entities in a relationship are trust and reliability<sup>68</sup>. The inter-organizational relationship in question, between a Transport Buyer and a Transport Provider, is also the interface between the Buyer and

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<sup>68</sup> What I mean by reliability is that the agreement of service delivery is fulfilled, i.e. that service is performed within e.g. the time limits or in a manner that was agreed upon. Trust is a relationship concept that assumes (from the Buyer’s horizon) that the service Provider is not only reliable but also honest, and capable of, if necessary, taking initiative without a contract in order to benefit a good relationship. Notice that reliability in this context is a perception concept, and not necessarily the same as the statistical reliability.

its customers, thus extra sensitive. To anchor “trust” with an overall operative indicator, I chose to use “quality stability”, since the Buyer wants as little quality fluctuations as possible.

So Overall Satisfaction can be described as an overall indicator of trust and reliability in that the Transport Provider will perform in a predictable way, i.e. in a way that they have agreed upon, and that gives as little uncertainty as possible.

So the two items used for this overall or “summarising” indicator are:

- Item 16: Measures how the Transport Provider fulfils its commitment, i.e. the agreement with the customer. It also assumes (from the Buyer’s horizon) that the service Provider is reliable, honest and capable of e.g. taking initiative (also without a contract) to benefit a good relationship.
- Item 19: “The Transport Provider maintains an even quality level”, which is the assessment of quality fluctuations caused by disturbances or deficiencies of the performance and capabilities.

### **5.2.2. Standards**

I call this factor F1 Standards, see Table 4, because it contains industrial standards or guidelines for both quality and environment in the form of ISO-certifications or comparable. It is not difficult to see e.g. the connection of quality-certification such as the standard ISO-9000 compared to the performance of the production process. For the item especially important for the process quality the question was asked:

“The Transport Provider is quality certified e.g. ISO 9000”<sup>69</sup>. Why was this question chosen for the survey?

The attribute describes quality standards according to the international ISO 9000 or similar certification. The whole idea with quality-certification is to create awareness of quality levels, and to increase *predictability* by standardization. Quality that fluctuates is a big problem, not the least if flows are big. One purpose of a quality system such as ISO-9000 is to make it easier to compare suppliers when it comes to factors that are essential for a production (or service) to be reliable, i.e. to make sure that the supplier has

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<sup>69</sup> Item 6 of question 24 in the survey, see Appendix 3.

an organization that clearly defines production processes and responsibilities, how these are to be maintained. It also specifies how routines should be applied, contents of contracts, etc. (IVF, 1989, p 222-223).<sup>70</sup>

### **5.2.3. Reliability of Service**

The factor named “Reliability of Service” consists of four core service items,<sup>71</sup> see Table 4. Three of them cover communication to and from the customer, one the performance on time.

Communication:

- Item # 10 is measuring how accessible the personnel is in giving information and in assisting with bookings
- Item # 11 is measuring how accessible the personnel is in giving information when orders need to be followed up
- Item # 17 is a contingency or warning-variable that has to do with giving feedback when something goes wrong or disrupts the delivery. This obviously could include communicating with the Transport Buyer or its customer if necessary.

Core performance:

- Item # 15 measures how important it is to stick to agreed delivery times. From a business perspective time precision is often crucial to keep service levels up. The importance weight is in other words indicating the Buyer’s time sensitivity, and its performance assessment to what degree the Provider is able to deliver On Time.

It can be noticed that these items are connected to people, either accessibility to a person (to retrieve information, items 10, 11, 17), requesting skills or routines for special tasks (15, 17). Of course, there could also be technical or resource aspects to these, such as enough capacity to perform deliveries on time (15).

The first three items are communication with the intent for the Buyer to retrieve essential information. I call it communication because it could also give the Service Provider direction e.g. how to solve a problem.

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<sup>70</sup> See also comment in footnote 67.

<sup>71</sup> Reliability, see footnote 68.

The last item has to do with *trust*, and the *performance evaluation measure* with *reliability* more than any of the other factors<sup>72</sup>, and could therefore in that sense be considered a "skill-factor" as well as a factor representing the perceived performance or output of the service.

### **Ability to communicate**

To be able to plan, there has to be relevant information available. For shipments that might mean to get information about an express delivery, or about customs regulations and service levels to customers in remote geographical areas. Much information is available through technological means, such as Internet or EDI, timetables, price lists, etc., but sometimes communication has to be direct through a person, to avoid misunderstandings if nothing else. The attribute items 10, 11, and 17 described above are covering some of this, including the booking situation, the possible follow-up during or after the transport.

Many "lean" companies are so slimmed that barely anything must go wrong; otherwise there will be disrupted processes (e.g. Christopher and Peck, 2004; Zsidisin *et al.*, 2005). Therefore predictions have to be reliable. To be reliable especially means to be dependable, so that predictions can be trusted. But predictions are unfortunately not flawless, since the future is not known. In processes it is therefore sometimes necessary to have a working contingency system instead, or a "plan B", if and when something goes wrong that needs quick attention. A contingency system could be a feedback or communication system, which gives early warning when something unforeseen happens, so the problem can be tackled and managed, or at least mitigated.

### **Access to personal service**

Transport Buyers are many times pressed for time, since processes are increasingly time-compressed. One could assume that the Transport Providers try to routinize and standardize as much as possible of their operations, much the same way that banks are trying to automate services so that the customers themselves do the actual work (e.g. Schmenner, 2004). Examples for Transport Providers are e.g. self-booking by EDI and internet or in providing "track and trace" of the shipments. However, it seems from findings in this survey quite clearly that customers are very dependent on personal

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<sup>72</sup> Apart from "Overall Satisfaction", which is intended to measure the *overall* trust and quality of the Transport Provider's performance, see section 5.2.1.



assistance in situations like getting information, doing the booking, and following up orders<sup>73</sup>.

Why then is the personal contact so important to Transport Buyers? If people are easily accessible to answering questions, it saves time for the Buyer. Direct communication also reduces uncertainties regarding the transport situation very quickly. The same goes for item 11 (“...follow-up of transport”). This could concern questions when there are problems with the shipment, such as delays or damages. The bottom line is that personal contact is preferred when there are uncertainties in complex situations, and one can assume time-saving is a reason; another could be personal preferences if it is easier to communicate by personal contact, it reduces misunderstandings.

### **Routines and contingency systems**

Routines are standardized behaviour to deal with repeated tasks in an efficient and hopefully also effective manner. Item 17 above concerns routines that directly affect the quality of the delivery. “The Transport Provider has well functioning routines for reporting deviations” involves giving feedback, i.e. communicating, with the Transport Buyer when things go wrong. This way precautions can be taken to compensate for, or “fix”, disruptions or emergency situations in the delivery, in other words this is a part of a responsive contingency system. The idea of this is to deal with the unplanned so that failure can be avoided or at least mitigated, just like a “shock-absorber” of a car, which “deals with” potholes in a road.

This factor is therefore named “Reliability of Service” since it captures both the trust-aspects of the service relationship: that the service Providers are reliable and can live up to their commitments, and that they have the capacity to “fix things” when things go wrong. This is to keep quality fluctuations within the “tolerance zone” (Berry and Parasuraman, 1991; Strandvik, 1994). And, maybe above all, that communication and feedback is there when such disruptions occur.

### **5.2.4. Information and Communication Technology**

ICT stands for “Information and Communication Technology”, but the factor also contains an element of external problem solving (3PL). It consists of three items (item numbers from Table 4):

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<sup>73</sup> The importance weight average for item 10 is 6.26 (tot pop), which is among the four highest of all the 33 variables, however the performance is far below this expectation.

- Item # 2: Order booking system available
- Item # 3: Track and trace system available
- Item # 4: Complementary logistics services can be offered (3PL)

It was shown above that one of the biggest concerns of the Transport Buyer is to get personal service, e.g. to get information for booking transport, or follow up information. However, once a transport solution is well functioning it might be more practical to get access to the Transport Provider's system in a way that can be routinized. IT-based information and booking systems could, if the process is well known, be controlled by the customer himself and therefore important for various reasons, e.g. to save time, to have better control, or to get standardized information. This works today e.g. by EDI or by Internet-based databases. When the survey was made there was also access to these, but it can be assumed that considerable technical development has been in the meantime.

The importance weight for this variable (item 2) is 4.27, which shows this is considered to be of "medium" importance. To have control of the transport process through "track and trace" seems to be of more interest by the Buyers. This could have to do with e.g. the urgency to retrieve information when there are deviations from plan, i.e. when there is some delivery problem, however possibly this is also a sign that the personal communication is not so good.

This indicates three things:

- 1) The interest is high to be able to trace the goods through an IT-system.
- 2) There is a considerable variance, which means to some companies this is high priority, to others this is low priority.
- 3) Transport Providers are, on average, good at offering technical support for information search and on-line booking.

Comment on item 4: The outsourcing trend for logistics, so called third party logistics (3PL), is strong, at least if one looks at the logistics services (Weele, 2010:161). However in asking the Transport Buyers the question "...has a wide variety of complementary logistics services", it was somewhat surprising to find that this was one of the lowest weighted items of all of them. There is a considerable variance for different trades, especially con-

sidering the volume effect, i.e. the size of the flow. Bigger companies seem to consider 3PL somewhat more important than smaller ones.

### **5.2.5. Modal factor**

This factor consists of four items, of which three concern the choice of vehicles. A fourth item deals with access to detachable load-carriers, such as ISO-containers.

The modal choice depends to a large degree on if the chosen forwarder has access to different modes of transport. For bigger forwarders with a network organization it is normal that they can offer different modes: truck, train, ship, and airplane, or any combination of these. Buyers normally do not bother about the modal choice as such, so importance weight average is low.

However, the access to detachable load-carriers is sometimes of more concern, as can be seen in the findings for some industries (e.g. Paper industry, and Machines & Tools manufacturers).

### **5.2.6. Relationships**

Three items constitute this factor, see Table 4:

- Item # 18: If the personnel have good manners when they collect and deliver the goods, this can be important to the Transport Buyer.
- Item # 20 weighs to what degree the Transport Buyer feel they know a Transport Provider by own experience, before contracting them again (or for the first time). This obviously has to do with uncertainty and risk assessment, and being able to plan ("we know what we have, but not what we will get"). A new Transport Provider could be cheaper, but might not fulfil the service requirements that the Buyer expects.
- Item # 21: The same reason as a pleasant or friendly manner can be crucial, the reputation of the Transport Provider is very important. One reason for that is that a bad reputation could easily "rub off" or stain the Buyer's own reputation. Most of all, though, it could be considered to be a "trust-indicator" since reputation usually also includes the image that the company has in the market.

These items really have to do with communication.

At the collection it could e.g. be that special instructions about the goods have to be given. Or it could be to get feedback about a previous transport or any other problems that needs to be dealt with. This makes it important that the personnel are reliable, approachable and communicative. It could also be a way for the Buyer to assess the Transport Provider when it comes to skill and problem solving. Transport companies with well-trained and experienced staff are likely to handle both goods and disruptive situations better than inexperienced personnel.

Also in delivering the goods to the receiver it is obviously an advantage to have a pleasant and approachable manner for the same reasons as above. Sometimes this is also the only person-to-person contact the Transport Buyer has with its own customers, which means the driver actually is the “representative” of that company.

Networks of transport chains are often complex with many actors, and it is important to know that the relationship works. To work with known partners that have good performance records should be more important as companies’ vulnerability to disturbances increase. Findings in the survey indicate that relationships overall are lasting. However, especially bigger companies usually have many contracts and can therefore switch over more easily if there are relational problems.

### **5.2.7. Load factor**

The naming of this factor refers to what degree the physical loading space and capacity of the shipment equipment (vehicles, containers, etc) is used.

This factor consists of three items (see Table 4):

- Item # 25: To coordinate in- and outbound flows of a company increases dependencies on the Transport Provider and has consequences for coordination of both receiving and shipping goods. Looking at it this way, then this variable is also connected to skill, to be able to plan and coordinate. This item deals, in other words, with the productivity aspects of the transport, but is at the same time connected to the dispatch situation and frequency (planning and coordination), which obviously also has economic considerations.
- Item # 26: Sharing deliveries with other companies puts even higher demands on skills to plan and coordinate. Despite this, there might

be other reasons why companies do not want to freight goods mixed with other companies' goods.

- Item # 28: High loading factor is considered very important in some industries, e.g. food and paper industry. This is an efficiency aspect of the transport, a sign of high competitive price pressure.

All three of these items can be interpreted as *productivity* variables. As such they have a direct economic impact on performance (e.g. cost per delivery).

To co-deliver goods with different Transport Buyers in order to increase the loading factor obviously also increases the productivity, at least if the Buyers are located reasonably near each other. This is the economical and corporate reason to co-ordinate shipments. However, as I found in the interviews, there are reasons why Buyers do not want to mix their goods with other companies' goods (Saxin, 2002a). One might be for marketing reasons. Sometimes companies will not co-transport, simply out of competitive reasons (e.g. ICA does not co-transport with COOP or Axfood). Sometimes it is due to security reasons, goods might get damaged or stolen more easily, or even because it could be against the competitive legislation (cartel-like situations). One company I interviewed e.g. had to turn down an offer of co-transport of tyres with their food product due to the risk of not being able to substitute damaged goods and also due to increased theft risk since their own personnel would not be present at the loading.

### **5.2.8. Network Capability**

This factor consists of technical resources (capacity, geographical coverage), and people-focused resources (relationships). However, in the survey, the four questions that were asked were more focused on the technical system aspects, why it is not possible to single out the relationship factor here.

The factor thus consists of the following items (see Table 4):

- Item # 1: Geographical coverage, to have access to a network that can reach all required destinations. This normally means cooperation with global or international actors. This item is considered of very high importance.
- Item # 12: Frequency, "...has many scheduled dispatches". This means regular distribution after time-table or special arrangements.

- Item # 13: The ability to adjust to large volume variations means the company must have access to reserve capacity.
- Item # 14: The ability to deliver at short notice requires availability to reserve capacity. This type of flexibility is, in other words, also including ability to deliver apart from the scheduled shipments.

Network Capability has to do with the physical shipment capability of the Transport Providers, how they have enough spatial resources such as their own transport chains or a network that enable them to reach all required destinations. Another dimension is the shipping capacity, which includes access to reserve capacity.

The frequency (item 12) of scheduled delivery occasions is a fundamental, not to say crucial, and observable part of the service level. If the pick-up occasions are enough, the purchaser won't have to be worried about disruptions or long delays in the dispatch of the goods. What is "often enough" obviously varies depending on the type of industry, the volume of the flow, and other factors such as Price. Frequency, however, is important but less of a problem according to the respondents, since performance is almost adequate. The ability to absorb fluctuations is of a far bigger concern, according to the Buyers' responses.

### **5.2.9. Skill**

This factor consists of four items:

- Item # 5 measures the skill of the Transport Provider to avoid damages. This can refer to both technical applications and handling skill.
- Item # 9 is a measure of the planning and management skills of the service Provider, in order to customize transport-solutions, in other words problem-solving.
- Item # 7: This item<sup>74</sup> is directly connected to ISO (9000)-certification. Good documentation routines could be seen as important in the control of the shipments to save time otherwise spent in these tasks.
- Item # 8: Systems and routines to avoid theft and loss.

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<sup>74</sup> "The Transport Provider has good routines for handling documents".

People's skills and capabilities to perform their tasks determine much of the performance outcome. The level of skill depends on how well a person understands the system and can manage the processes of the business. This is largely resulting from accumulated experience, training, i.e. some form of learning, but also motivation. To e.g. handle unplanned situations obviously could be dependent on skill, and ability to solve problems. Skill and problem-solving ability could thus also influence what promises the Transport Provider gives to the Transport Buyer. These promises or commitments form the basis of the Buyer's expectations of the performance. Indirectly, the Transport Providers' ability to deliver on time is directly connected to this ability to plan and design the transport (e.g. allocate resources) and often to have a functioning contingency system (reserve resources) on hand if anything goes wrong.

Item 9 (see above) could also be limited by e.g. the available information or the available shipping capacity of the Transport Provider. An example of that, apart from the ability to plan and coordinate, is to have the network resources or contacts available when needed in order to perform the actual physical transport<sup>75</sup>.

The handling skills, item 5, usually by the driver or the terminal staff, who load and secure the loads on the trucks, trains or ships, are affected by e.g. time limits. However, they could be crucial in order to avoid unnecessary damages of the goods, thus also causing delay.

The third aspect of skill mentioned is designing and following operative routines that give the system efficiency. Item 7 and 8 both cover some aspects that can and should be routinized, to avoid unnecessary mistakes and delay. Item 8 also contains a safety aspect that many times is neglected e.g. due to lack of time.

### **5.2.10. Price**

Price is the *trade-off* for the service levels. A Transport Buyer normally has a ceiling when transport becomes too pricey. However, often the Buyer<sup>76</sup> has service priorities due to requirements and needs of its customers, therefore it is not necessarily the lowest price that is the most interesting. Thus we asked for the price dimension of what weight, when deciding for a Transport

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<sup>75</sup> Network resources are though in this thesis assumed to be included in factor 7, Network Capability.

<sup>76</sup> Which is the supplier of goods.

Provider, had "one of the lowest prices" (question 24:22 of the survey, see Appendix 3)? In other words we did not ask how important it was that the price was the lowest, but *one of the lowest*, that is that the price was competitive. The reason for this was to be able to see if both service factors and price were important at the same time, or if one or the other dominated<sup>77</sup>. The average weight 5.83 signals that price, after all it is considered a very important factor, however still not the most important. The variation between the trades is considerable<sup>78</sup>.

This means that there is some substance in suggesting that this importance item indicates *price sensitivity*, that is the higher importance weight, the higher the Buyer's sensitivity is to price<sup>79</sup>.

The equivalent performance variable for this item, in other words, then represents Pricing, i.e. how the Transport Provider responds to the Buyer's price sensitivity. The more the Pricing factor increases the more the Transport Provider tries to adjust to the Buyer's desired price level (i.e. price decreases).

### 5.3. Grouping the factors

Service is a concept that we usually associate with human involvement, e.g. someone performs a service. It is, however, possible to standardize certain routinized tasks, and still maintain (sometimes even improve) the service level. So service could be bound to technical systems, such as computers,<sup>80</sup> or to persons. An attempt was therefore made above to operationalize the activities in the description of the PCA-factors and Overall Satisfaction. Normally persons handle the more complex tasks that are difficult to standardize. Therefore, when complexity grows, information also grows, and time is a scarce resource to the customer (in this case the Buyer), communication is even more important. If the automated information system is difficult to use, to understand or if it lacks transparency, it might be necessary to speak to someone instead.

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<sup>77</sup> Another question (Question 9, see Appendix 3) in the survey is complementing this factor and makes it possible to see whether the respondent is primarily time- or price-focused, or both. That question was not included in this PCA though but will be analysed separately (see chapter 6).

<sup>78</sup> Range 4.81-6.00 for different industries on a scale 1 to 7 (max)

<sup>79</sup> There is high correlation and fit between the two price questions question 9 (which measure the price pressure of the total transport solution) and question 24, item 22 (see survey form, Appendix 3). A few trades do not show this correlation. If those trades are excluded the fit for the remaining will be even better (correlation  $r \approx 0,41$  and  $F \approx 83$ ).

<sup>80</sup> An example of an automated service is a bank automat to withdraw money from a savings account.



To simplify further, in the following analysis I therefore reduce the nine Principal Component factors above into capability groups, thus “technical factors” i.e. shipping capacity, “People-focused factors”, and financial factors (i.e. money, here represented by price). The reduction is done by reasoning (discussions based on experience and analysis of the items).

This is illustrated in Figure 11. “People-focused factors” can further be divided into Information & Communication, Ability to solve problems, and On-time delivery.

Overall Satisfaction is the Buyer’s overall assessment, all things considered, of how the service is over an extended period of time.

### ***5.3.1. Technical factors***

Shipping Capacity factors is the “Technical system” which refers partly to those resources that make up the asset side of the balance sheet: production equipment like vehicles, machines, containers, computer and communication hardware and software, warehouses and other buildings. Since the structure in the transport industry has changed in recent years, the Transport Provider does not necessarily own these assets, however it is understood that they are available in the transport chain. In transport networks actors buy services from each other, not just equipment capacity.

### ***5.3.2. People-focused factors***

People-focused factors refer to the availability of people, especially their ability to carry out their tasks with skill, to solve problems, and to communicate. Note that “F2 Reliability of Service” is split up in On-time performance and Information & Communication Systems.

The Information & Communication Systems (ICSys) is the “support-system” to accomplish On-time performance, communication, and problem solving. This implies that people are necessary for the more complex problem solving in contrast to simpler, “automated” problem solving, i.e. standardized information available for the Buyer to solve problems without especially having to contact the personnel of the Transport Provider (such as price lists, track & trace, time-tables).

These factors have to do with planning, coordinating, allocating resources, and ability to solve the customer’s specific problem. That also includes good goods-handling skills.

### 5.3.3. Financial factors

Financial resources are in this study not included as such, but only represented by the transport price. The price level of the Transport Provider is a strong indicator and trade-off of the quality-level, but also of the competitive situation of the Transport Provider.

Competition, and the company size of the Transport Provider (thereby the power balance) in the dyad with the Buyer, decides to some degree what price-level can be kept. With enough customers and orders, prices do not need to be lowered, but can be used as an instrument to “regulate” the demand, thus also to avoid order backlogs.

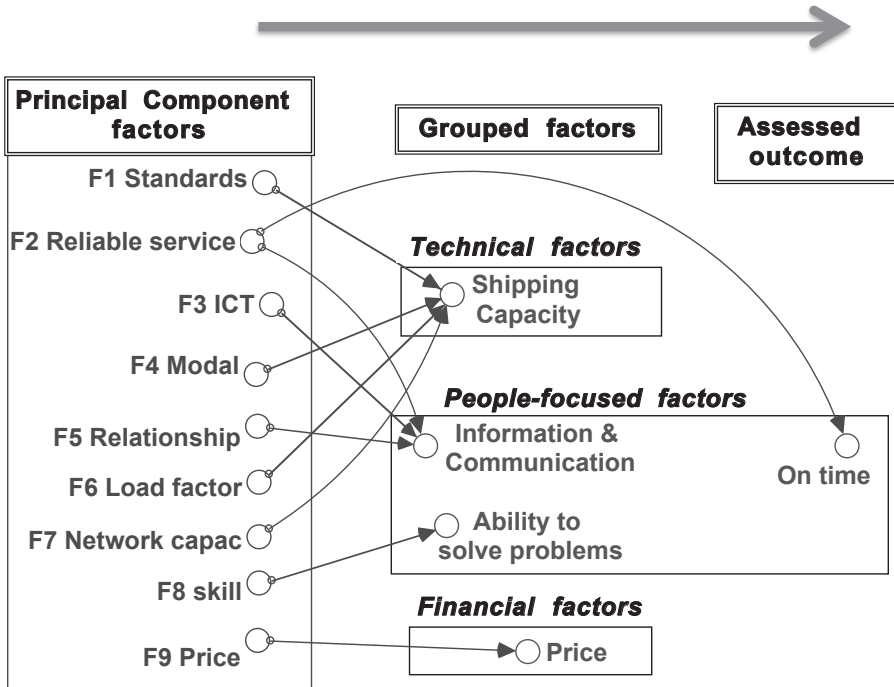


Figure 11: Reduction of the nine Principal Component factors to three factor groups: Technical, People-focused, and Financial factors. These three categories consist of five capability factors.

## 6. Findings about the performance of the Transport Provider

In this chapter findings will be presented.

Another important aspect of the delivery is how much of the goods arrive in good condition, or to revert the question, how much is damaged or is missing? These two measures, how much goods arrived on time, and how much arrived damaged, are important indicators of the quality of the service performance. This will be developed in this chapter.

### 6.1. To deliver on time

To most Transport Buyers, *delivery on time* is of high importance, because lead-times both for the order-cycle time and the actual delivery are usually very tightly planned. To deliver on time is important for the Transport Buyer in order to have a credible service offer and to show *reliability*. Also to the customer of the Transport Buyer it might be vitally important with predictable, in other words, reliable deliveries. For customers who are manufacturers with just-in-time planned production the dependency on the timely deliveries could be crucial in keeping their production going, or, if it is retailers, not to be out of stock with products. Of course the whole order fulfilment process does not totally depend on the transport lead-time and the Transport Provider, but timing is of utmost importance in supply chains, especially if they have small or minimal time- and inventory-buffers. Planning transport lead-time is based on the Transport Provider's experience, but disruptions cannot always be foreseen. Another factor in this is that it is normally the forwarder (the Transport Provider) who negotiates the design of the transport solution with the Transport Buyer, whereas contracted hauliers perform the actual physical transport. This means that as long as these business relationships and routines are the same, then predictability is higher than if new relationships are formed. New business relationships in the transport network might mean new routines, and it could take time until they are functioning.

The other factor mentioned above that affects the quality of the transport service is how much of the goods arrive damaged or missing. Also, the goal here is of course 0 %, but circumstances, inexperience, ineptitude, carelessness and rush can cause damages. Damages can happen when the goods are

loaded or unloaded. It can also happen because they are not fastened properly during the transport, or from vibrations, accelerations or decelerations, e.g. when the vehicle breaks suddenly. Damages at lift-offs by aircraft (due to too high g-force, Gooley, 2004) or sorting parcels in express goods' shipments (ibid.) is another reason. In train transport, damages are common due to shunting, and vibrations during the transport.

## ***Findings: error rates***

On an average, approximately 91 - 94 %<sup>81</sup> of the shipments arrive on time depending on the region of the customers, the highest for Finland, the lowest for Europe outside Scandinavia. For Swedish receivers the delivery precision is 92.7 %, in other words over 7 out of 100 deliveries failed to be on time!

I am using the concept "Failure rate" for the failure to deliver the shipments On Time<sup>82</sup>. Biggest differences then are between small companies (both manufacturers and wholesalers) and medium-sized and large companies, Figure 12 below. For the total population of all industries covered in this study the failure rate is 7.7%<sup>83</sup>.

Average damage was 1.68% ( $\pm 0.24$ )<sup>84</sup> of the outgoing goods quantity (n=310).

The model developed above proposed that damage and failure rates ("not on time") are outcomes of performance. These are measurable entities that also give a comparable measurement for the quality of the service. A test of this gives a strong positive correlation between Damage % and Failure rate. Correlation is the strongest for Failure rates of deliveries in Sweden ( $t= 4.16$ ,  $p<0.0001$ ), Finland ( $t=2.73$ ,  $p=0.0066$ ) and Overall ( $t=3.08$ ,  $p = 0.0022$ ). For deliveries in Denmark there was instead a negative correlation ( $t=-2.25$ ,  $p = 0.0251$ ). This means that there is indication that most damages occur with the deliveries within Sweden and they affect the Failure rates negatively (i.e. damages can cause the shipments to be delayed or to be perceived as not on time).

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<sup>81</sup> All error rates are from the Transport Buyers' data, i.e. their own information systems. As will be illustrated in a couple of the cases below, Transport Buyers and Transport Providers sometimes have different opinions whether the delivery is on time or not. The reason for that could be that they measure differently. From a service management view, it is primarily the customer's interpretation that is important.

<sup>82</sup> Assuming there is agreement between the Buyer and the Transport Provider that "on time" means "on time".

<sup>83</sup> Missing values were imputed with the average of each industry and company size.

<sup>84</sup> For total population, flow in volume equivalent tonnes.

The difference between industries is big. The seven groups of industries used in this study are also shown in Figure 13.

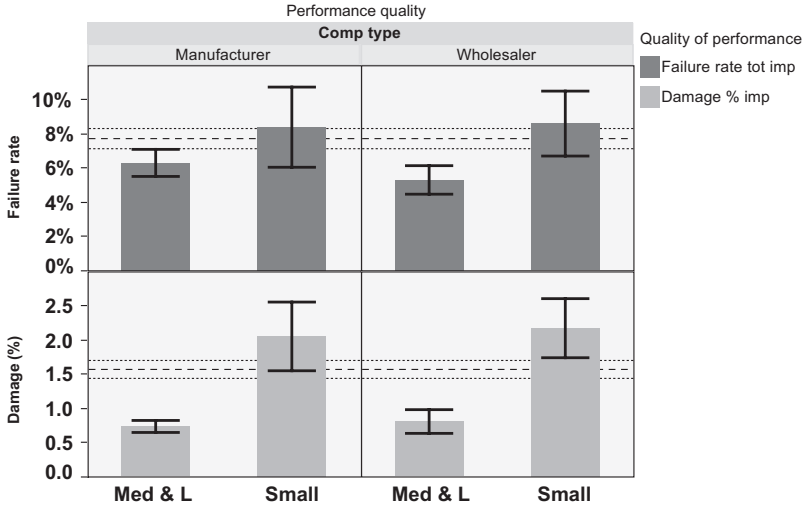


Figure 12: Failure rates (top), damage % (bottom), medium & large sized companies versus small. Manufacturers (left), wholesalers (right), means and 95 % confidence intervals shown, n = 567, tot pop.

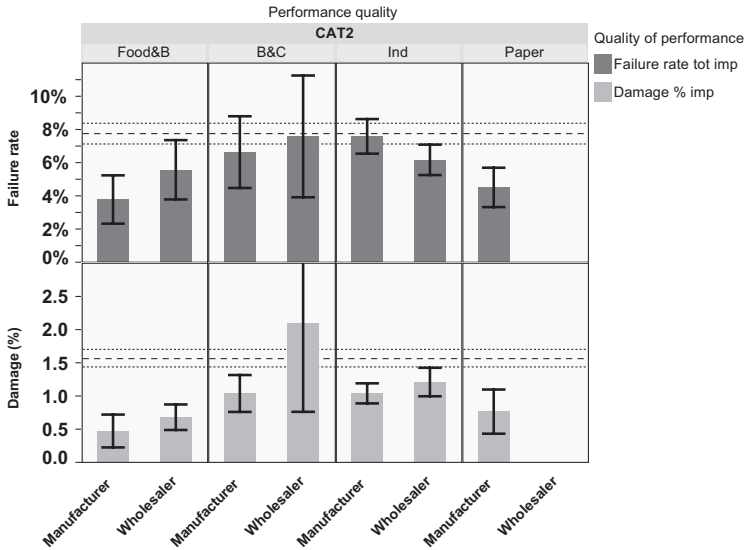


Figure 13: Failure rates (top row) and damages (% , bottom) for different industry groups, means and 95 % confidence intervals are shown.<sup>85</sup>

<sup>85</sup> Failure rates, n=537, N=7,572, damages, n = 567, N=7,832.

Figure 13 shows that there is quite a spread of the variance within and between the groups. B&C wholesalers stand out. Damage (in %) is significantly different from B&C manufacturers. Failure rate is just about significantly different.

For Food & Beverage wholesalers also show bigger measures, however it is only damages that are significantly different.

For Industrial companies there is no certain difference for failure rates, however wholesalers show lower damages<sup>86</sup>. It should be noted, though, that the manufacturers in this group consist of six different industry categories, wholesalers of three different categories. Comparing each industry and even sizes might give different results.

The paper industry is only classified here as “manufacturers”, but in reality these companies also are wholesalers, at least bigger actors. However, compared to other industries it can be seen that damage (%) is significantly lower than other industrial manufacturers, and B&C wholesalers, however, higher than for food manufacturers.

Regarding failure rates there is only a significant difference between B&C wholesalers and Food & Beverage manufacturers. However, as implied above, comparing individual industries and sizes might give different results.

When both these variables are considered, failure rate, and damages (%), four distinct groups can be seen, Figure 14. Food & Beverage manufacturers (1) have the least damages, and the lowest failure rates. Next group (2), medium failure rate and medium damage (%) consist of Food & Beverage wholesalers, Paper industry, and B&C manufacturers. Group (3), high failure rate and medium damage (%) are industrial companies. Group (4), very high failure rate and very high damage percentage, B&C wholesalers.

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<sup>86</sup> Statistical significant difference.

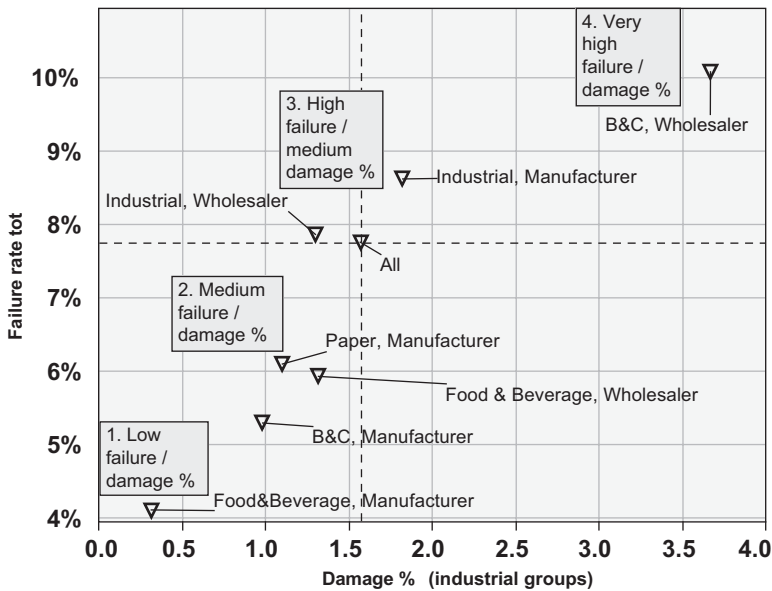


Figure 14: Failure rate (% of deliveries), and damages (in % of goods volume), means per industrial group, total population.

## 6.2. Effects of Buyer's pressures on performance

A company's ability to respond to a change in demand is indirectly a measure of its capability (Day, 1994). If response is slow this is a sign of inertia and / or potential vulnerability, i.e. how resilient the company is if resources, or capabilities, are pressured. By measuring demands against the responses and including the customer's satisfaction, it should therefore be possible to detect constrained capabilities, i.e. attributes of the service Provider that worsens or throttles the performance. Why is this important to know? In assessing the capabilities of a system one needs to know not only the risks of performance failure, but also the strengths and weaknesses of the company in dealing with unplanned or disturbing situations.

In this and the next section constraining conditions will be examined. First, in what way do the pressures defined above (Time Precision, Speed, and Price), affect the failure rates and damages (this section)? These are findings from multivariate (PLS) analysis. Second, in the next section, effects from all surveyed conditions, summarised in the Buyer's desired performance, are analysed for the seven industrial groups.

## ***Findings: time pressure effects***

Looking at all companies together, *Speed* has a noticeably deteriorating effect on damage %, i.e. it increases that variable, however does not seem to affect failure rate. On the other hand *Time Precision* has a slight (increasing) effect on failure rates, but also a lowering effect on damage rate.

Looking at different *strata* (large, medium and small manufacturers and wholesalers respectively) instead, the picture above is partly confirmed.

For manufacturing companies of all sizes, *Speed* seems to have an undesirable (i.e. increasing) effect on damage %. For large and small companies it also has a negative effect on the failure rate, especially for the larger companies. For smaller manufacturers *Time Precision* also has an undesirable (=increasing) effect on damage and slightly undesirable on failure rate.

For wholesalers there is a slightly different finding. Large companies show increased failure rates for *Time Precision*. Medium-sized and small wholesalers are more price-sensitive, and there are some increasing effects on failure rates and damages. Small companies also show some increasing effect.

To summarize:

- For manufacturers, as well as for small wholesalers: *Speed* seems to inflict more undesirable (increasing) effects on damages, sometimes also on failure rate.
- For large wholesalers: *Time precision* has undesirable (increasing) effect on failure rate.
- For medium- and small wholesalers: *Time precision* that has undesirable (increasing) effect on both failure rates and damages.

## ***Summary of time pressure effects:***

There are higher failure rates when the delivery is focused on time constraining factors, especially *Time precision*. This suggests that Buyer's time restrictions appear to increase the constraints on the available capacity of the Transport Provider, which was also hypothesized.

A *Speed*-focused transport solution is associated with higher rates of damages than other strategies, however not when transport volume is considered. This indicates that fast shipments with smaller volumes are more prone to damages.



Findings also show that there is a positive correlation between damages and failure rates, in other words, indication is that damages could possibly cause delays.

## 6.3. Effects of Buyer's desired performance

The following analysis is done in two parts; first comparing the levels between importance values and performance values, second of effects. Results are summarised in Table 5.

The second part is an analysis of effects as the inputs, including the pressures of time and price defined above, change one unit. Results are summarised in Table 6, and a brief presentation follows illustrated by six cases. This analysis is described more in detail in Saxin, 2012.

### 6.3.1. Findings from some industry groups

Figure 15 illustrates the state of capabilities for all industry groups examined in this study. This is a comparison ("matched pairs") of the Buyer's desired levels<sup>87</sup> (left bar) and assessment of the main Transport Provider's performance for the same capability (right bar, next to it).

It is apparent that Overall Satisfaction (row 1), Ability to solve problems (row 2), On-Time Delivery (row 5), and Pricing (row 6) show that performances are lower than desired. However, Shipping Capacity (the technical aspects of the delivery, row 4) are normally considered to be better than what the Buyer assesses important. So it is with Communication & Info-system (row 3), except for Food & Beverage wholesalers.

All the t-values from this matching for the different industry groups are summarised in Table 5, which shows the size of the gaps. The bigger the negative t-value, the higher is the statistical significance of the "gaps" between what the Buyer's desire and what is assessed as performed by the Transport Provider. As can be seen for Overall Satisfaction, all industrial groups have substantial negative gaps<sup>88</sup>.

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<sup>87</sup> That is, the Buyer's importance value or "benchmark".

<sup>88</sup> For example for Industrial manufacturers a t-value of -13.51 means the probability (p) is less than 0.0001 that this is a random result, i.e. not depending on an effect.

The On-Time delivery is also significantly lower performance for all industrial groups. Problem Solving shows significant negative t-values for B&C manufacturers, Food & Beverage wholesalers, Industrial wholesalers, and almost significant for Industrial manufacturers, and Food & Beverage manufacturers.

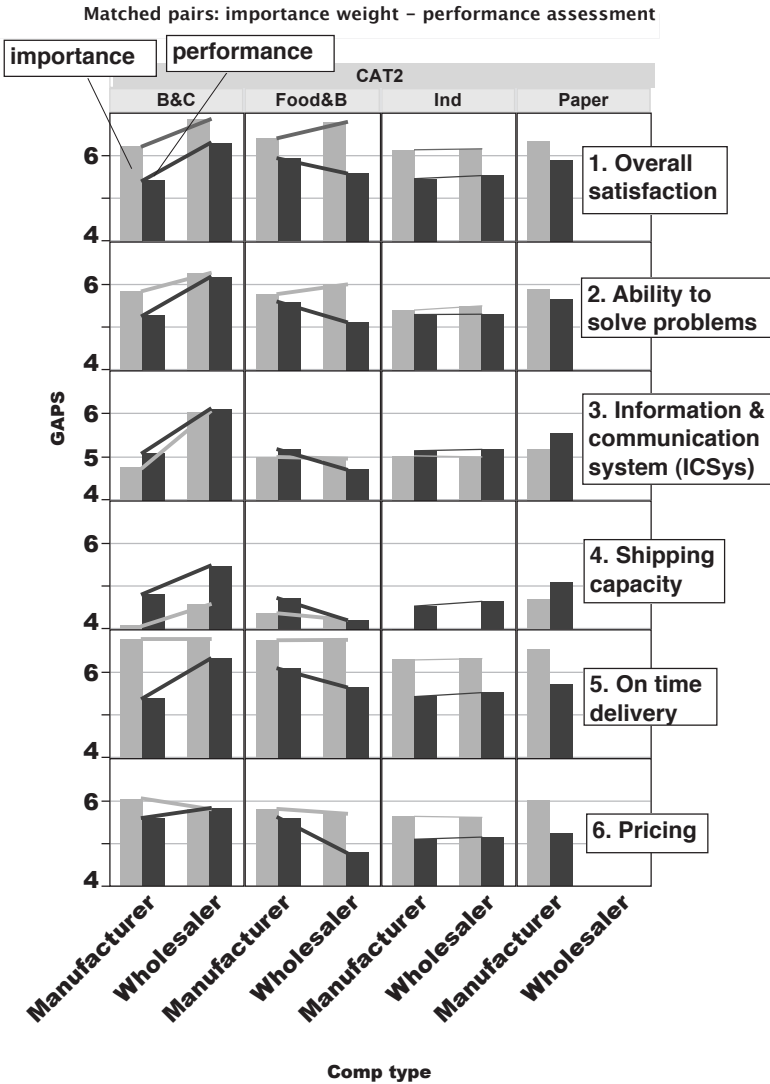


Figure 15: Matched pairs of capabilities.<sup>89</sup>

<sup>89</sup> Pairs: importance weight (left) – performance assessment (right), scale 1 to 7 (see section 3.3.2). Different industry groups, n=567, tot pop.

Table 5: Matched pairs, capabilities, t-values<sup>90</sup>

Industrial group	Comp. type	1. Overall Satisfaction	2. Ability to solve problems	3. ICSys	4. Shipping capacity	5. On-Time	6 Pricing
Food&B	Mf	-4.20	-1.89	1.87	3.25	-5.03	-1.42
Food&B	Whs	-7.63	-6.62	-2.47	-0.01	-7.46	-5.71
B&C	Mf	-5.52	-5.27	2.25	4.87	-11.06	-3.10
B&C	Whs	-3.77	-0.48	0.38	5.77	-2.30	0.08
Paper	Mf	-4.27	-1.67	5.10	4.85	-4.19	-3.51
Ind	Mf	-13.51	-1.91	2.89	12.89	-14.35	-8.00
Ind	Whs	-8.55	-2.94	3.03	11.00	-7.85	-5.71

### 6.3.2. Constraining effects

A partial least square (PLS) analysis was performed (see section 3.4.2.) to find effects and thus get indications of bottlenecks. Table 6 summarises the findings of the effect analysis for the seven industrial groups<sup>91</sup>.

Table 6: Summarising the findings for different industry categories<sup>92</sup>.

Industrial group	Comp type	Constraining effects described by Buyer					
		Overall Satisfaction	Ability to solve probl.	ICSys	ShCap	On-Time	Price
Food & Beverage	Mf		(x)	X	(x)	X	X
Food & Beverage	Whs	X		X	(x)	X	X
B&C	Mf						
B&C	Whs	X	X	X	X	X	X
Paper		X	X	X	(x)	X	X
Industrial	Mf						
Spec Ind 30, M&L	Mf	X	X	X	X	X	(x)
Industrial	Whs						
Spec Ind 518, M&L	Whs	X		X		X	

<sup>90</sup> How to understand table 5:  
The table contains "t-values". A t-value  $\leq -1.96$  means that Transport Providers' performance is significantly worse than the Buyer's importance weight, and a t-value  $\geq 1.96$  that it is significantly better (i.e. the Provider performs better than the Buyer desire). These differences are significant with 95 % confidence intervals, i.e. with 95 % probability these differences are not random. n=567, represents the total population (N=7,832).  
Mf = manufacturers, Whs = Wholesalers, ICSys = Information & Communication Systems, ShCap = Shipping capacity, On-time = On-time delivery.

<sup>91</sup> More details in Saxin, 2012.

<sup>92</sup> X = primary effects from higher time or price sensitivity, (x) = secondary effects.  
A primary negative effect I define as a significant effect that show an increase in the *measurable* dimensions (here: failure or damage rate), and a negative satisfaction (i.e. dissatisfaction), and a negative effect on any of the perceived capabilities.  
A secondary effect is as the primary effect but not giving any clear effect on both an output (measurable or perceived) and Overall Satisfaction. More about this in Saxin, 2012.

## Food & Beverage, manufacturers

Food & Beverage manufacturers have the lowest failure rates and damage incidents of all the industries in the data studied; see Figure 13 and Figure 14.

There are not many signs of serious constraints for this industry, Table 6. However, there is an indication that the Communication & Information-system and the coordination of Problem-Solving, and Shipping Capacity may be affected as time and price pressure increases. Especially time precision pressure, in itself a constraining circumstance, could e.g. make shipping capacity less available or leave less time, thus making e.g. Problem-Solving more difficult.

The following case is to illustrate what distribution decisions for a company in this group can look like.

### *Case: BISQ, manufacturer of dry foods<sup>93</sup>*

BISQ is a large manufacturer (and wholesaler) of well-assorted food products with long shelf life. Their biggest customers are wholesale food distributors in Scandinavia, such as ICA, Axfood and COOP. Some customers have a delivery time window of  $\pm$  half an hour, and a pickup time window of  $\pm$  1 hour. Half the goods volume is exported, mostly within Scandinavia. Shipments go directly to the food distributor's terminal.

BISQ's shipments have a high load factor, which indicates high price pressure<sup>94</sup>.

Most important criteria for their choice of transport solution are: Time precision and reliability, Price, Handling (i.e. undamaged goods).

However, BISQ does not really measure the delivery precision ("we are more interested in measuring costs") according to the inventory manager. Customer contact is kept through the forwarder. The forwarder solves any possible time-problems. BISQ is satisfied overall with the transport service performance, no delivery failures last year (2001) as he could recall.

<sup>93</sup> Interview 15 Feb 2002, inventory / dispatch manager.

<sup>94</sup> This is validated in our survey a year later where this company answered that the competitive price pressure on the transport solution is 90 %, Time precision 5 %, and Emission Control 5 %.

Is BISQ a typical Food & Beverage manufacturer? Overall they are showing price-sensitivity, however they have no complains about the problem solving. On-time delivery though for 2002 (survey result) shows clear problems<sup>95</sup>. It is possible that circumstances for the Transport Provider has changed in that year.

## **Food & Beverage, wholesalers**

Wholesalers of Food & Beverage show a different pattern than the manufacturers. They express even more pronounced problems with the Information & Communication Systems (ICSys), involving also the Shipping Capacity (ShCap). Damages are more prevalent than for manufacturers, and also somewhat higher failure rate, see Figure 13 and Figure 14.

High price pressure especially affects the On-Time delivery (even more for medium- and large-sized companies than small). It also necessitates a high load-factor i.e. efficient use of the shipping capacity. Therefore both the communication and the information are of special importance to coordinate resources, especially under high time pressure.

The case ICOOPDAG illustrates the importance of getting feedback and other relevant information to be able to deliver goods on time.

### ***Case: ICOOPDAG***<sup>96</sup>

These three major Food & Beverage wholesalers and distributors have very complex operations and distribution covering the whole of Sweden.

According to the transport wholesaler (A) time precision is the most crucial factor. The reason is that otherwise there will be queues with the loading and unloading of goods. This was also the case for the other two wholesalers. "Everything is time controlled...Fresh foods require (time windows of)  $\pm 15$  minutes" (B).

Wholesaler (C) states that they use time windows on all categories, especially the dry foods to avoid queues.

<sup>95</sup> Answer by the purchasing chief.

<sup>96</sup> In October 2001 I interviewed one transport coordinator and two transport chiefs for the three largest food wholesalers and distributors of food and household consumer products, ICA, KF (COOP) and DAGAB (Axfood) respectively. The "case" is therefore an amalgamation of these three actors, and consists of eight business units, however I will describe them as three corporate profiles, A, B, and C.

Use of time windows (time precision) apparently is top priority with these major actors in the Food & Beverage Wholesale industry, even though they have slightly different priorities.

Lead-time (speed) is according to wholesaler (A) important in their operations for fresh foods. For the dry foods it is less important though. For them the load factor is more prioritised — ...”trucks can be filled to 100%”.

Speed is in other words less important here, but to utilize all available load capacity is top priority.

## Building & Construction material manufacturers

There are no clear constraints to be seen for this group, from the aggregated data since Overall Satisfaction does not give us clear guidance. However, from Table 5 and Figure 14 can be seen that dissatisfaction and lack of On-Time delivery can still be problematic. So the following case, BUILD, will illustrate that studying an individual company can reveal problems.

### Case: BUILD<sup>97</sup>

BUILD is a large-sized *manufacturer* of standardized building materials<sup>98</sup>, with about 400 employees and a turnover of well over 1000 m SEK. Customers are Building & Construction companies and the DIY<sup>99</sup>-sector (retailers). Goods' flow is large; most of it is for export. However, the degree of customization of the shipments is high since the customers do not want to keep much inventory in stock. This explains the high frequency of delivery vehicles. Time precision is important with time windows of  $\pm 2 - 3$  hours, e.g. to builders<sup>100</sup>. However, bigger retailers are visited en route certain days (time table).

<sup>97</sup> I interviewed the transport chief, Feb 2002, who said that he together with the logistics and the environmental managers were deciding the quality criteria of deliveries. Survey just over a year later was answered by the distribution manager.

<sup>98</sup> SNI02 industry 20.

<sup>99</sup> DIY = Do-It-Yourself, i.e. retailers selling building materials, tools, etc.

<sup>100</sup> The time pressure is high, 40 % is described in the survey as time precision and 10 % speed, the rest price pressure.

Delivery failure (delivery not arriving on time) at the time was 4-5%, but was not allowed to get worse. A year later it was described as between 5 and 8 % depending on the geography. Delays occur mostly at the delivery point, not at the pickup. In other words disruptions seem to occur during the transport.

Important decision criteria for the choice of a Transport Provider he explained was: 1. Delivery precision (delivery time and “right day”). 2. The quality of the vehicle, that they are in good shape and clean. 3. The behaviour of the driver, “since he is our representative to the (customer) companies”.

Criteria 2 and 3 were interesting and maybe not the ones normally considered.

BUILD appears to be fairly representative to the average B&C manufacturer, however according to the survey they have a clear Overall dissatisfaction and the Communication & Info-System is much below the average (and negative). Data also show there are communication problems, and e.g. quality problems, including on-time delivery and trust. They also find the access to the system and to the staff for information and booking dissatisfactory. So is also the case for the behaviour of drivers, the aspect they considered important when meeting their customers.

## **Building & Construction material wholesalers**

As Figure 14 shows, wholesalers of Building & Construction (B&C) materials have the highest failure rates and damage percentage of all the groups studied. However there are only a few cases in the study (n=16) why the confidence interval is big and thus this finding is not statistically significant<sup>101</sup>.

B&C Wholesalers is the industry group compared that most clearly shows signs of constraints, see Table 6. Especially Time precision and Speed seem to affect Problem-Solving, Shipping Capacity, and Communication & Info-System, with serious problems for On-Time Delivery and damage (%). Findings reveal though that the Transport Providers focus well on responding to Shipping Capacity and On-Time demands by the Buyers, however other capabilities do not respond as well.

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<sup>101</sup> At 95 % confidence interval.

The following case, HARDWARE, illustrate some of the complexity.

### *Case: HARDWARE<sup>102</sup>*

HARDWARE is a large wholesaler (about 250 employees) of hardware, distributing to ironmongers, DIY<sup>103</sup> outlets and the building industry<sup>104</sup>, mainly in Scandinavia. At the time of the interview on average 35 trucks were transporting just over 200 tonnes of hardware per week. Most goods are delivered from stock.

Distribution to the customers require sophisticated logistics including night deliveries with cross-dockings. Delivery On-Time is the most important criteria. HARDWARE also delivers “fast orders” (over night, delivery usually early morning).

The industrial customers demand 99% On-Time delivery but only 97 % is achieved.

However, despite the high ambition, only 94 % arrive on time (in Norway 92%).

Distribution has a very pronounced time focus<sup>105</sup>.

Drilling deeper in the data specifically for the case HARDWARE, it is the Shipping Capacity (especially geographical coverage, ability to adjust to volume fluctuations), and Communication (not sufficient feedback), On-time and Problem-Solving that HARDWARE sees unsatisfactory. This illustrates and underlines the occurrence and importance of feedback in time-pressed situations.

### **Paper industry**

Failure rates are considerably higher for small paper companies than for bigger, as is the case with damages. Price sensitivity dominates the industry, however also the time sensitivity appears to be high. Larger companies export most of their production.

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<sup>102</sup> 11 Feb 2002.

<sup>103</sup> DIY = Do-It-Yourself, i.e. retailers selling building materials, tools, etc.

<sup>104</sup> SNI02 industry

<sup>105</sup> HARDWARE describes the competitive pressures in its choice of transport solution as time precision 30 %, speed 40 %, price 20 %, and emission control 10 %, in other words time is clearly dominant.



Paper industry has a medium high failure rate and damage %, see Figure 14.

Data also show that performance of Problem-Solving Ability, Communication & Information-system, Shipping Capacity have clear signs of constraints, and that affects On-Time delivery and Overall Satisfaction.

A conceivable explanation is that since time sensitivity is high, time pressure affects Communication & Information-System and thereby temporarily makes Shipping Capacity less available and reduces available time. Strikingly is that the communication does not seem to work well. This is visible (by looking at data closer) through the lack of feedback in situations of disruptions, and it can make it more difficult to deal with the problems.

However, even if the Communication and Information-system performs well, under those circumstances, it either might produce too much information (cf Senge, 1990:128), or else the “wrong kind” of information, to handle if time margins are too narrow. This affects the Buyer’s assessment of Problem-Solving and On-Time delivery negatively.

### **Manufacturers of industrial goods**

This quite heterogeneous industrial group<sup>106</sup> consists of a wide range of industrial production: plastics, rubber, chemicals, steel, electronics, vehicles, furniture, etc., where really individual industries can differ considerably. Average failure rate is high, so is damage occurrence, however individual industries vary a lot. No constraints could be identified in this mixed group. Therefore one industry, is chosen instead, Electronics & Household appliances (SNI02, ind code 30).

This industry (note this sample consists of only medium and large sized companies) has a price focus. The effect analysis shows that time and price pressures affect and link the performance capabilities and output. A deeper analysis shows that it is especially the modal factor, particularly the access to containers (i.e. lack of them) that could explain some of these effects, also making Problem-Solving difficult (e.g. coordination).

There are clear indications of constraints for Communication & Information-System and Shipping Capacity, and they affect Problem-Solving. Shipping Capacity and Time Pressure negatively affect overall Satisfaction and On-Time delivery.

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<sup>106</sup> n=256.

Damages seem to be linked to, amongst others, Speed, Problem-Solving, and Communication. This makes sense, since increased time pressure also will speed up handling of the goods, thus increases the risk for e.g. mistakes and accidents.

The following case is a good illustration of some challenges for Just-In-Time deliveries under price pressure.

### *Case: BRIGHT, equipment for building industry<sup>107</sup>*

BRIGHT is a large manufacturer of products mostly for the B&C industry and the public sector. 75 % are standardized products shipped directly from stock, the remainder customized to order. The transport chief I talked to sounded frustrated and stressed as he explained the problems with their distribution.

This is an example of a volume product where the load factor is important because of their packaging, etc. On average, almost 100 shipments were performed per day by truck. But half of them were small shipments of less than half a cubic metre, or 10 kg. The trend is more shipments (higher frequency) of smaller and smaller batches per customer. Therefore BRIGHT needed to improve the delivery precision, according to the transport chief. Sometimes the customer orders “from room to room” (i.e. gradually as the building process progresses)<sup>108</sup>.

But why was BRIGHT’s transport chief so frustrated about the distribution? The company had 18 contracts, the three biggest covering 37% of the transport volume and valid for 1-2 years. The biggest forwarder (X), which distributes most of BRIGHT’s Swedish volumes, was, according to the transport chief, also the biggest problem.

He exemplified the major problem areas of forwarder X: Time precision, how X handles fragile goods, their unreliable telephone notification, and pricing. For example the delivery time precision stated by X is totally wrong, freight bills are incorrect, and these were some of the things that seemed to be part of his frustration.

<sup>107</sup> SNI02 ind code 30. Telephone interview Feb 2002.

<sup>108</sup> Price pressure is described as very high: 90% and the remaining 10% for Emission Control.

The transport chief explained: (Forwarder) X measures the time precision to 98%, but our own system says 88%! “We have done spot checks and followed up with customers...”. (Forwarder) X measures wrongly. X starts measuring when the truck leaves the terminal... Sometimes it arrives on the wrong day. For example telephone notification of the arrival of the shipment is important (especially for BRIGHT’s customers), but for X this takes an extra day to perform.

—The smaller transport companies we use are better. They have better flexibility.

Possibly, he said, BRIGHT would “throw out X and choose (forwarder) Y instead. They have better coverage up north.”

Obviously the frustration of BRIGHT’s transport chief was mainly about the delivery failures, but no doubt also about the mistrust because Forwarder X (according to him) were measuring wrongly and giving wrong information. The communication and relationship problem in this example is obvious and outstanding.

### **Wholesaling of industrial supplies**

Industrial wholesalers as a group has somewhat lower average failure rate and damage percent than the industrial manufacturers, see Figure 14.

No constraints can be identified, see Table 6. Therefore one industry group is chosen, “Industrial wholesalers”<sup>109</sup>.

The large and medium-sized companies have lower failure rates than small companies.

Price pressure affects Communication & Information-System, On-Time delivery and Overall Satisfaction negatively. Increasing Shipping Capacity does not seem to improve performance, on the contrary. Neither is increasing Problem-Solving. However, Communication & Information-System seems to form a bottleneck.

Purpose of the following case, MACH, is to illustrate the communication and performance problem in this industry.

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<sup>109</sup> Basically SNI02 industry code 518.

## *Case: MACH, wholesaler of industrial machines and supplies*<sup>110</sup>

This company is a large international manufacturer of industrial products, with both machines and materials for industrial use. However, manufacturing is mostly done abroad, and this is why this business unit is registered primarily as a wholesaler.<sup>111</sup> The turnover in Sweden is 1,800 MSEK and it has 1,000 employees.

Customers are industries and resellers or wholesalers, which in turn sell to smaller or bigger industries. Most of the products are standardized and dispatched from stock. Nordic customers require delivery within 24-48 hours. The transport manager complained that forwarder X only had about 90 % time precision and forwarder Y 94-95 %. “Forwarder X does not even want to discuss delivery reliability over 95 %” was one comment. MACH wants at least 98% and unchanged price.

Delivery reliability is not measured directly, his perception came from the customer complaint statistics.

—Transport Providers today do not give feedback, he said.

However, he meant that MACH was in the process of renewing transport contracts, possibly change forwarders, and they now require certain delivery precision, follow up, statistics, etc. of the deliveries. He commented that one of the possible reasons behind the present transport solutions and problems were that they today had several carriers (with the intention to press prices), but that they now considered cutting down the number of them to increase quantity on each contract. Main reason for this was to be able to raise quality of performance (“rather higher delivery reliability than lower price”). Customers do not accept any lower service quality, or delivery reliability, he commented.

The most important criteria in choosing a Transport Provider for MACH were thus: Frequency, Speed (“lead time”), and delivery On time (delivery reliability), Price, Geographical coverage, and Track & trace. This

<sup>110</sup> I interviewed the European transport manager February 2002. He informed me that the company at that time also was building up a European central distribution centre on the continent for distribution to Central Europe. The goods to the Scandinavian distribution centre arrive via South Sweden by truck.

<sup>111</sup> In this thesis it is classified as SNI02 industry code 518, wholesaler of industrial goods, but also have some manufacturing that could be classified as industry 29.

was not necessarily a ranking of factors, but important criteria in order to fulfil their service commitments.

## 6.4. Observations from the transport industry

According to Ahldén, 2011,<sup>112</sup> (with a Schenker perspective) the biggest constraint in the transport industry, that overshadows everything is “balance”, i.e. that capacity is used in both directions. To get goods in both directions is a problem especially when the price, as in Sweden, is not adjusted, like in yield management<sup>113</sup> (which makes prices more attractive for customers). However, the transport industry prefers direct shipments, not middle storage. Furthermore, in 2002, he confirms, the employment situation was also more problematic than it is today, however there was still more time to pack the goods into the trailers etc. Smaller companies cooperate better than 10 years ago, haulier cooperations (“Lastbilscentraler”<sup>114</sup>) have grown.

According to Lundberg, 2001,<sup>115</sup> (Euroute / Norfolkline) “time is the needle’s eye” in the transport operations of a bigger forwarder like Euroute<sup>116</sup>. For example operative transport planning has to be done between 8 and 11, since the drivers need to get their instructions. He also gave an example that communication in the transport chain was not always working, e.g. in contact with the intermodal rail transport operator.

Isacsson, 2001<sup>117</sup>, described terminals and drivers as two operative bottlenecks. Regarding customer communication with them (Schenker consulting), booking normally occurs the same morning, apart from some customers who have got scheduled pickups. The short notification time often depends on that the Transport Buyers do not know themselves what the order situation is, or that their overview is not good.

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<sup>112</sup> 1999-2004 Vice President, Schenker AG.

<sup>113</sup> As an example he referred to how J.B. Hunt improved their use of return capacity this way.

<sup>114</sup> Lastbilscentral is a local or regional cooperation between a number of hauliers, generally with its own forwarding and cooperating with other forwarders.

<sup>115</sup> Corporate manager, Euroute AB.

<sup>116</sup> Euroute / Norfolkline (today owned by DFDS) then specialized in contracted, time restrained direct trailer transport for bigger companies, much of it sea bound (intermodal) in Western Europe.

<sup>117</sup> Logistics consultant, Schenker Consulting AB, Göteborg, interviews. Schenker Consulting AB was at the time a daughter company to Schenker-BTL AB, but detached from their mother company.



PART 3  
Discussion





## 7. How capability factors get constrained

The findings presented in chapter 6 give an indication of bottlenecks in the people-focused factor category, especially the grouped factors Information & Communication Systems (ICSys), Ability to Solve Problems (ASP), and the On-time delivery outcome. But how are these factors interlinked with the service delivery process, and how can they get constrained?

Assuming that companies' long-term resilience depends on their capability to handle vulnerabilities and disruptions in complex systems (e.g. Christopher and Peck, 2004; Pettit *et al.*, 2010), my intent in this chapter is to start to derive a research model that will attempt not only to explain how management control can lead to unwanted, bad, constraints, but also how awareness of constraints and service quality instead can be used to build resilience. In chapter 9 I will get back to the latter part of that attempt.

On-time delivery can be assumed to be a major goal for most Transport Buyers. As was described in chapter 4 the Buyer operates under certain pressures due to competition, customers' requirements, etc., that they also specify requirements or conditions regarding timing and pricing for the deliveries. The Transport Provider then transforms the agreement into a *work-pressure* for the employees, since a certain volume of work is to be performed in an allotted time period. Eventually the Buyer perceives the Transport Provider's capability to deliver on time. In other words, if the Transport Provider has a high failure rate the Buyer perceives this (e.g. through complaints from its customers) as if the level of performance is lower than the level of importance for the same attribute.

In this study the main focus is on the Buyer and the Provider of the transport, however also the customer of the Buyer (the receiver of the goods) is involved in the interactions and affects the conditions and pressures. This is shown in Figure 16. The transport process (simplified) is to transport goods from the Transport Buyer to a customer, the receiver of the goods. If there is an external Transport Provider involved he will coordinate the transport from "door-to-door". After the ordering, the physical transport process itself takes place. The transport can be straight from a to b, or very elaborate with storage in between. The broken arrow going from the receiver of the goods to the Transport Buyer represents the customer conditions for the transport.

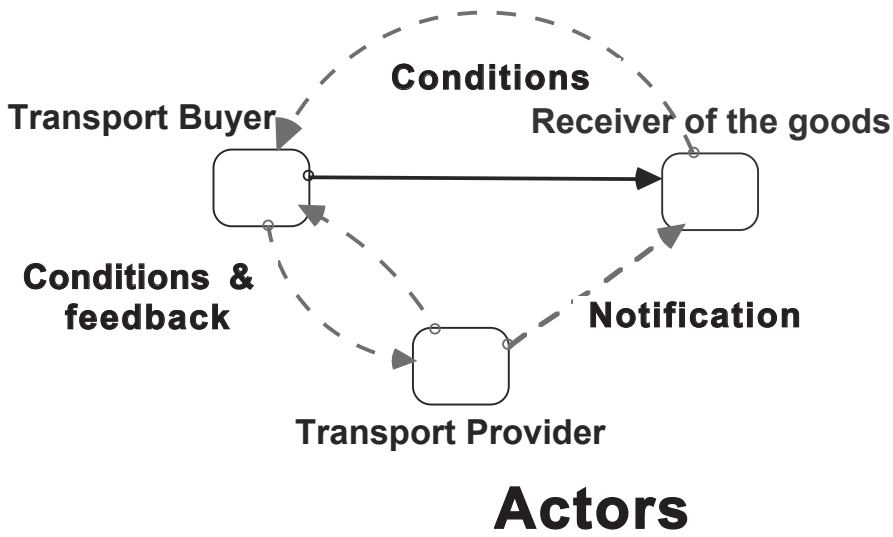


Figure 16: The interactions between the Transport Buyer and the Provider. The receiver of the goods usually has conditions of the delivery. Notification can be both at the pick up and delivery of the goods.<sup>118</sup>

From a business point of view, there are more processes involved for all this to happen: The Buyer's customer has to order the goods, the order is handled by the Transport Buyer (here the Supplier of the goods), who also has to arrange transport with a forwarder, the forwarder has to plan and coordinate the entire transport, before the actual shipment is fulfilled. This is depicted in a simplified form in the next illustration, Figure 17. Shipments can be defined as the product of resource capacity and capacity utilization (Sterman, 2000, pp. 554ff.). The performance outcome ("On time" or "Not on time") is to a large degree decided by the capabilities of the Transport Provider. Outcomes also influence the Transport Buyer's (and even more importantly: the Buyer's customer's) satisfaction with the service. This is the quality aspect of the provided service. If the "On time" share is high, Buyer satisfaction is likely affected positively (indicated by "s", change in the same direction). However, if the "Not on time" share is increasing, satisfaction is likely decreasing (indicated by "o", change in the opposite direction). Customers who are satisfied tend to order again (cf. Keaveney, 1995).

<sup>118</sup> Unbroken line means physical transport, broken lines information flows through communication.

However, before it comes to operational activities there has to be some thinking, planning, and designing of what resources are needed, and what capacity. Desired production” is the management’s planning of the operations, which means its matching of the incoming and hopefully future orders (the demand) and the production capacity (the supply). If there is not enough capacity, there will be a backlog of orders, i.e. orders (and customers) waiting to be served.

Work pressure for the Transport Provider arises due to the amount of work that needs to be performed in a certain time period<sup>119</sup>, and it becomes a driver for the capacity utilization (Sterman, 2000, pp. 554ff). If for example 50 hours’ work is scheduled in a week and the normal workweek is 40 hours, either more than one person has to do the work, or else that person has to do overtime 10 hours. In such case the work pressure is 1.25 (Desired production / Capacity = 50/40 = 1.25) on a normalized scale, i.e. 25% higher than normal.

Work pressure is in an extended way decided by the managers’ ability to solve problems and to plan. Since the resource capacity is also under the manager’s domain there is a way to balance work pressure (more capacity decreases work pressure, indicated by “o“ in the Figure).

Capacity and capacity utilization is important in this context because they are the origins of bottlenecks or constraints. If one looks at a production- or service-process, with an inflow and an outflow, it is easy to understand that a capacity ceiling sets the maximum pace, or rate, of the flow through that process. In other words, when approaching the capacity ceiling and the maximum utilization rate, the growth slows down and levels off, then finally stops. In normal work processes utilization rates should be considered normal, not “heroic” (ibid, p 555) at least in the long run. In other words, it is not a sustainable system to schedule work with limited resources and count on that increased productivity which would compensate for the lack of capacity.

The performance results in deliveries that are on time, and those, which for various reasons are not<sup>120</sup>. The quality of the performance affects the Buyer’s satisfaction, and that likely determines the long-term business relationship with the Transport Provider, i.e. if future orders are to be placed.

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<sup>119</sup> In other words time pressure in doing the work.

<sup>120</sup> In this study referred to as “failures” and / or “damages”.

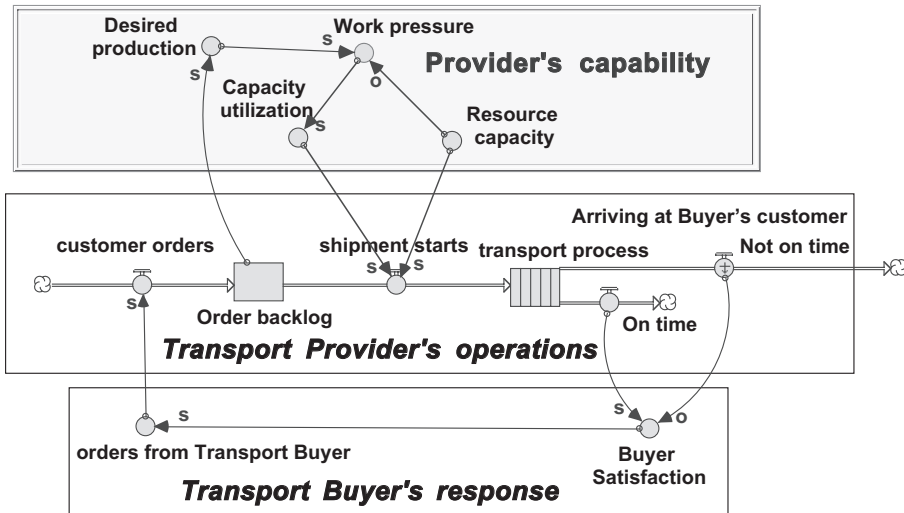


Figure 17: Transport Provider’s capabilities, performance, and the Buyer’s response.<sup>121</sup>

## ***The ability to solve problems requires relevant information***

In section 5.3, “Ability to solve problems”, and “Information & Communication Systems” were described as factors grouped in the “people-focused” category of capabilities. “Ability to solve problems” represents not only the system’s (i.e. people’s) capability to plan that deliveries arrive on time, but also to handle disruptions, or to come up with a solution of a current problem. It furthermore includes the ability to “solve” the company’s future problems, i.e. create sustainability, to develop capabilities that support the long-term survival and development of the business, e.g. by using the opportunities that occur, or innovativeness. This factor is highly dependent on skill and competence and also on the availability of relevant information, and ability to communicate.

The “Information & Communication System” is the “support-system” or the infrastructure but also the “interface” between the customer (the demand and the requirements), the staff, the available shipping capacity, the problem-

<sup>121</sup> The service process is depicted in the middle (the “pipes” with flow regulators symbolize the flows, i.e. the activities, in the direction of the arrows, rectangular symbols are the accumulations in the process). Thinner arrows are information flows, representing influences, and allocation of resources (cf. Sterman, 2000:554ff.)

solver and decision-maker. Information & Communication System is not only referring to computers and communication equipment, but primarily to the processing and communicating capacity of the problem-solver. To be useful, large volumes of data must be carefully sorted, condensed and understandable, data has to be transformed into information i.e. the quality of the information has to be increased. This requires information processing capacity. To be useful in the operations and for others, the relevant information has to be turned into knowledge and shared with others. Especially when complexity and activity increases, the data and the information volume also increase (e.g. Comfort, Sungu *et al.*, 2001), and so do mistakes and failure rates. Under high work pressure, resources may be reallocated to deal with the most acute. However, as shown in chapter 6, there can be constraining effects of these capabilities. This means that resources have to be reallocated to dissolve the constraint. This is depicted schematically in Figure 18.

Figure 18 shows the same situation and transport service process as in Figure 17, however the factor groups described above (section 5.3.) have replaced “capacity” and “capacity utilization”. This model illustrates that resource allocation has to support both short-term activities (the actual shipments or work) but also long-term (supporting, maintaining, and improving the delivery system) in order to build up capabilities.

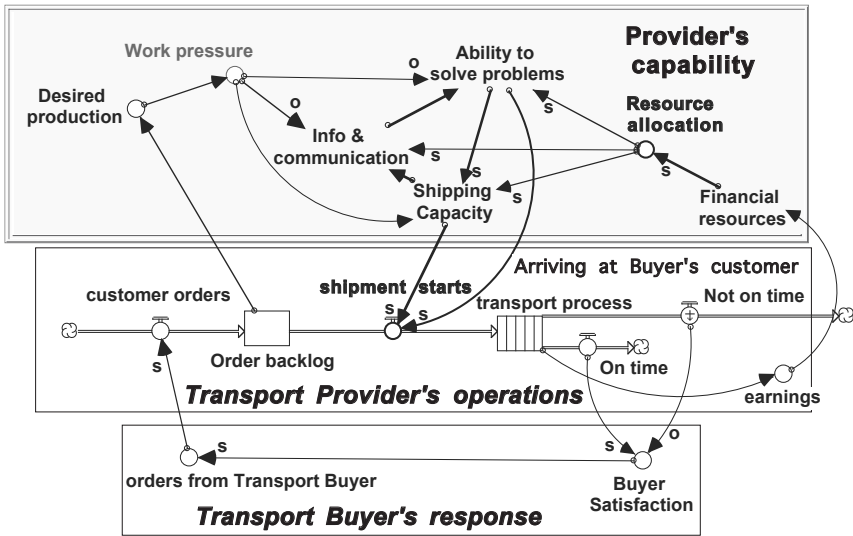


Figure 18: Same delivery process as in Figure 17, but the inputs of the transport process instead with the grouped capabilities described in section 5.3.<sup>122</sup>

<sup>122</sup> Notice the resource allocation to the various categories of capabilities, and the work pressure.

The following illustration, Figure 19, is a simplification of Figure 18. The transport process is here compressed into the box “Performance On Time delivery” and the Buyer’s response into “Satisfaction”. In chapter 6 the findings were presented showing constraining effects especially affecting the Information & Communication Systems, the ability to solve problems, and On-time delivery.

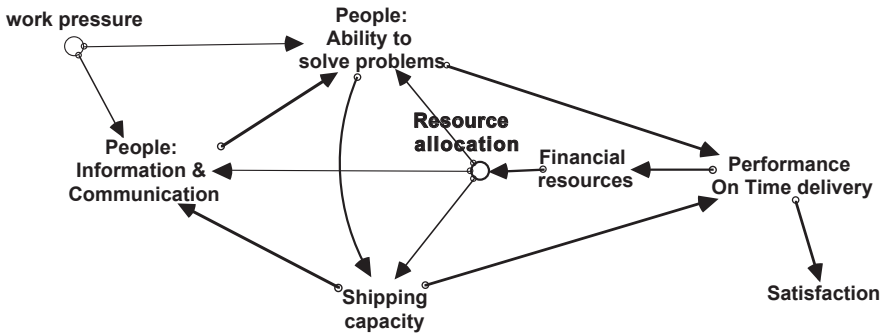


Figure 19: A simplified model of Figure 18. Arrows here mean influence, i.e. what a resource input or action affects (with or without delay).

In this chapter I have shown the link between operations, quality in performance (i.e. how much is “On time”), and the resource allocation to different capabilities, which in turn are inputs in the production (certain capacity and capacity utilization). Here is also where bottlenecks are generated.

In section 9.6. I will develop this and show the connection to resilience.

## 8. Response to demand

In this chapter, focus is on the interaction between the Buyer and the Seller. First, I describe and discuss the Buyers' and the Providers' perspectives, and then the particular situation facing services in matching demand and supply. This is a part of being able to answer the research question:

In what way does high capacity utilization affect the development of long-term resilience and competitive advantage of a service company?

Let me first re-phrase the question:

Is high capacity utilization advantageous for the development of long-term resilience and competitive advantage of a service company?

The rational actor answer would be a resounding 'yes', at least what concerns competitive advantage. Working harder obviously means you produce more! Is that so?

It depends on what is meant by working harder! If it means working at maximum capacity to keep up with the demand, the answer, I argue, would be 'no'. Short-term, I agree, yield would be higher by mobilizing everything to keep up production, but not long-term. The result would be the opposite.

Does this sound counter-intuitive?

Let me explain.

Up to a certain level of capacity use the performance will be improved, but over that level performance will decline, which will show itself in persistent quality problems. This statement will be developed in this chapter.

Research and implementation in operations and business management has in recent years focused on increasing value by eliminating waste in processes, applying lean practices. These lean principles have been based on manufacturing using "push"-strategies (Anderson *et al.*, 2005). However, even though they are developed in a conventional manufacturing context, they have practically without questioning also been deployed in services and customized production (made-to-order and "pull"-strategy; *ibid*).

In order to answer the research question I also posed two sub-questions:

- How do Transport Buyers' pressures affect the quality of service Providers' performance?

- How can constraints of the service Providers' capabilities explain performance quality problems?

The first of these sub-questions was answered in sections 6.2. and to some degree also in 6.3.

Findings showed that the alignment of Transport Buyers' requirements and the Transport Providers' performance is to some degree problematic. It could be noted that especially failure and damage rates were surprisingly high in some industries. In these sections it was shown that adverse, as well as good effects, can actually be seen from these pressures.

The second sub-question was answered in section 6.3. where it was shown that a decrease in the Transport Providers' performance of an attribute sometimes can be connected to an increase in failure or damage rate and decrease in the satisfaction of the customer. These findings give clear evidence that the ability to solve problems and to deliver On time is often inadequate, despite (mostly) better than desired Shipping Capacity and Information & Communication Systems. The synchronization of these major factors is apparently not totally satisfactory, and the reason for this will be discussed in the rest of this thesis.

## **8.1. The Buyer's perspective**

In chapter 6, time and price pressures were briefly described and discussed. In this section these pressures will be described in their distributional context of distributional channels, customer and goods categories.

### ***8.1.1. The need for transport services***

The development of global trade and production networks have in recent years increased the demand for transport services drastically (e.g. Hesse and Rodrigue, 2004:172). This is due to, amongst other things, deregulation of transport markets, the ICT<sup>123</sup> revolution, but also the changed customer requirement in logistics, such as mobility and timing (ibid.).

So more competition, more complex supply chains, increasing demand for high service quality means

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<sup>123</sup> ICT = Information and communication technology.



- a) more time-dependent service, time constraints (time windows, fast transport, frequent shipments, flexibility in dispatch, JIT),
- b) globalization, i.e. more geographical coverage and mobility,
- c) more volume fluctuation (i.e. demand volatility).

The importance of all three of these was apparent from the findings of this thesis. Volume fluctuation is a concern for many businesses, especially when seasonal or temporal demand variability is common (e.g. Stratton and Warburton, 2003:184).

### **8.1.2. Distribution aspects**

The main purpose of distribution is to create time and place utility, i.e. to make the goods or products available in either production or sales when customers need them (e.g. Grant, Lambert *et al.*, 2006).

The competitive situation of companies, their products, customers, markets, competitors, service levels, prices, production etc. determines the transport solution of the products. Manufacturers of finished products for consumption (either in industry or by consumers) tend to, if they are bigger, distribute their products via wholesalers or distributors so that an economy of scope and / or scale can be achieved both what concerns the transport itself and in reaching the markets (cf. Coughlan, Anderson *et al.*, 2001).

Economy of scale in transport means consolidation, i.e. that bigger shipments can be made in one go, which is conducive in increasing the *load factor* (i.e. the degree to which the available load capacity is used). Of course using a distributor does not in itself guarantee that the load factor will be high or that the load capacity is fully used, much of that is decided by the *service levels* of the customer.

In the manufacturing part of a supply network shipments are often arranged by the companies themselves or via forwarders. The scale of the shipment sizes is usually decided by the customer's process needs.

Economy of scale in reaching the markets is achieved by wholesalers and distributors in marketing channel arrangements (e.g. Coughlan *et al.*, 2001). Normally therefore distributors are wholesalers or distribution agents of a variety of products, e.g. household equipment, household and office electronics, building and construction materials (e.g. wood, building stone,

water and sanitation equipment, electrical equipment). Distribution is then channelled via a wholesaler or nowadays more and more directly to the end customer, in many cases a retailer or directly to the consumer. When this survey was performed (2003) B2B and B2C<sup>124</sup> sales via internet did not generate bigger volumes, but this type of channel arrangement has since increased considerably.

## **Distribution channels**

The marketing channel reflects the power situation in the supply chain and is many times a decisive factor in the transport arrangement (Coughlan *et al.*, 2001). A marketing channel normally also contains the physical distribution network, or distribution channel (Coughlan *et al.*, 2001; Jonsson, 2008). Here are some examples of different categories of distribution (see further e.g. Coughlan *et al.*, 2001):

### *Shipments to manufacturers*

#### **Semi-finished goods**

Components and semi-finished goods are either shipped directly from another manufacturer or from a wholesaler of industrial goods. Type of goods and distance decide the shipment size.

A reason for requiring time-window deliveries could be Just-In-Time production (JIT). The causes for that is to keep inventories low, to increase visibility (e.g. Christopher and Peck, 2004), to keep better quality control of incoming goods, and to have more control of the flow through the production units.

Subcontractors selling to other manufacturers: Bigger subcontractors could have their own transport planning and distribution, but would normally be using forwarders. However some bigger manufacturers (i.e. who are customers to subcontractors) perform the transport planning and arrange pick-up of the goods, e.g. Ex Works (EXW). This is common e.g. in the vehicle industry. Often shipments like this are Just-In-Time with very tight delivery margins.

#### **Industrial goods**

There are different arrangements depending on the type of goods, e.g. machines, tools, vehicles, computers. Often a distributor is operating as the sales agent, however the shipment might be direct from the assembling fac-

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<sup>124</sup> B2B = "Business to business", B2C = "business to consumers"

tory or distribution centre to the customer. This type of goods can be “make-to-order” (or “assemble-to-order”), thus there is a delivery delay built into the order. Since these shipments to a customer are irregular and not so frequent, they are not necessarily time-critical, however in some cases, such as when competition is high, they could be. However, in some cases, e.g. when a machine breaks down or a tool is needed quickly, fast deliveries at short notice might be needed (“express” delivery).

### *Shipments to wholesalers and retailers*

#### **Non-durable consumer goods**

This category includes foods and beverages, and other non-durable consumer goods.

Bigger retailing chains with their own channel structure (e.g. Wal-Mart, Tesco, Sainsbury's, Carrefour, in Sweden ICA, COOP, Axfood), buy wholesale from manufacturers and bigger wholesalers and usually have their own distribution from their own distribution centres, warehouses or depots. Distribution for this category of businesses can be characterized by a high degree of control, i.e. the classical transport solution is distribution with own vehicles and own transport planning. One reason for this is the importance of high service levels in the shop shelves, since competition is fierce, and stock outs (i.e. empty shelves in the shops) mean not only lost sales but also more seriously sometimes lost customers. Another reason is limited areas for goods reception and inventory and this generally restricts the delivery of goods to narrow time-slots. The deliveries to shops like this is thus normally done in smaller quantities, such as a pallet or a few roller-containers, or in some cases just a few boxes (Just-In-Time delivery). Since a grocery shop could stock thousands of different items it could mean a large number of deliveries from different suppliers, thus also a large number of trucks will deliver the goods. So it could be both limited unloading space and lack of storage space that restricts the delivery access to the retailer. Even *wholesalers* could have limited area (e.g. limited number of loading bridges) to unload and load the trucks, and this is why it could be a reason also for them to use time-windows.

In recent years, outsourcing of transport services (Third Party Logistics) to forwarders is more common, however, distribution is then usually performed in dedicated vehicles<sup>125</sup>. From this, one can assume that when it is a question of functional products<sup>126</sup> or normal consumer goods that are under

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<sup>125</sup> With the logo of the supplying company on the vehicle.

<sup>126</sup> Generally mass-produced, standardized products.

high competitive pressure both price of the transport and time precision is of primary importance. The price pressure is explained by the competitive supply available in the consumer markets, the variety of products that, to the consumer, is equivalent in function or quality or similar and therefore can be exchanged if it is not available when the customer visits the shop.

### **Durable goods**

Durables are e.g. TV, electronics, computers, clothes, and shoes.

Speed to market is often required because retailers do not keep big safety stocks or it is customer order products.

Sometimes price is important, especially with highly competitive products.

Examples of actors:

- Retailing chains, especially with more vertically integrated channel structure, sometimes including manufacturing (e.g. IKEA).
- “Independent” wholesalers that distribute to many different retailers, chain stores and smaller wholesalers
- Distributors of special products, e.g. high quality technical products with short product life cycle, fashion, pharmaceutical products, etc. If these products are high margin and have little competition, then it is speed to market that is the underlying distribution strategy. Normally shops and distributors do not want to have big stocks of products like this (because of inventory value and the risk of obsolescence), which means shipments have to be small and frequent, but be able to reach the markets with very short lead time. For long distance distribution therefore this category of products are distributed by airfreight or in some cases by truck. Shorter distances tend to be mostly by truck due to the flexibility.
- Internet, B2B, B2C, via Fedex, DHL, Schenker, UPS, TNT, etc. which have developed service networks all over the earth for small consignment distribution, express delivery. They specialize in fast distribution with high precision and function also as consolidators of shipments, like forwarders but with specialization to manage small shipments. The consolidating role is to achieve economy of scale in the long distance shipments; thereby the load factor can be high even though service level also is high. In normal forwarder distribution there is a trade-off between economy of scale and service level, i.e. if

fast deliveries are needed there is generally not enough time to consolidate a lot of smaller shipments.

*In chapter 7 the transport process and Transport Provider's capabilities were modelled. In the following sections of this chapter further aspects of the processes and applied strategies will be developed.*

## **8.2. The Transport Provider's perspective**

The transport can be performed by the Transport Buyer's own transport resources or by an external service Provider. But the Buyer's "own" performance does not have to mean that the physical transport is carried out by that company's own vehicles. In this thesis I mean by "own performance" that the shipment is *controlled* by the Buyer's resources, and includes the *planning* of the transport. Often a nearby haulier performs the physical transport, or else vehicles could be leased and performed by e.g. the Buyer's personnel.

When transport service is outsourced it is usually a forwarder or bigger haulier, which performs the whole transport, from door-to-door. This includes the transport planning, but that could obviously also be performed in cooperation with the Buyer.

Transport can also be arranged by the Transport Buyer's customer (the receiver of the goods), so-called Ex Works transport (EXW), however these are often also organized by forwarders.

As stated above, the main objective of the Provider is to deliver the goods at an agreed time to the Buyer's customers. If service is performed on time and reaches the receiver without damages, etc., the quality of the performance is good. Quality of a service Provider is usually perceived over an extended period (e.g. Sterman, 2000), i.e. how many shipments are deviating from plan in a certain period of time. Thus service quality could also be measured or assessed in other dimensions than time, e.g. how the Transport Provider performs if there are seasonal variations in transport volumes, or how accessible the staff is for information, anything that affects the customer's perception of the service negatively (Parasuraman, 1998). The performance of a Transport Provider is thus totally dependent on what capacity is available, and of course also how, and to what degree, the capacity is utilized.

But how the resources are used depends to a large degree on the skill and competence of the people, i.e. their training, experience, knowledge level, and motivation, but also on their ability to communicate and sometimes

being flexible or being able to solve problems, including planning and resource allocation.

Operative planning of shipments was at the time of the survey often done manually, with or without the help of computer-programmes. Communicating, retrieving and giving information was still done by e.g. phone and fax but to an increasing degree by more technical system resources such as EDI, and Internet.

The shipment takes place by using technical resources, such as loading resources, trailers, containers, pallets, traction resources, i.e. vehicles, loading areas and equipment, such as terminals, loading ramps, fork-lifters, cranes. However, people are still operationally crucial, e.g. to plan shipments, maintain and service vehicles, to handle special requests from customers, to solve problems, and of course to drive the vehicles.

The experience and work-skills to a large degree decide the performance outcome, such as avoiding goods damages, but also by not creating expectations that cannot be fulfilled by overpromising performance (cf Dion, Javalgi *et al.*, 1998; Parasuraman, 1998). The outcome of the service performed can be assessed by how well it is performed in agreement to promise (Parasuraman, 1998). So deviations from expected (= promised) performance can be considered to be quality deficient if the performance is worse than agreed upon. This leads to customer dissatisfaction.

Occasionally also a performance better than required can cause dissatisfaction, e.g. delivering something before the time window when time precision is expected. Quality is sometimes dependent on the ability to plan, but also on experience, and on knowing what actually is possible to deliver also by others in the organization. So not to promise the customer more than actually can be realistically performed, considering all difficulties involved, can be a matter of experience (cf. Zeithaml, Berry *et al.*, 1993; Dion *et al.*, 1998). Long term it is the overall performance and the ability of the Transport Provider to handle disruptions, solve problems etc. that affects the satisfaction of the Buyer.

### **8.2.1. The transport system**

As described above, logistics can be affected at several levels due to the service needs of the Buyer. The planning for the Transport Provider contains both strategic and tactical components. In the transport industry business is also often carried out in vertical arrangements between forwarders and hauli-

ers and other operators (Mentzer, Myers *et al.*, 2004; Mason *et al.*, 2007), which involves several parties in the operations. For bigger forwarders and shipping brokers, who do not normally own their vehicles or load-carrying equipment, that means to subcontract hauliers and other carriers. The planning and service offer is very much determined, at least in the short term, by the transport capacity and the category of vehicles and loading equipment available. For the haulier, investment in vehicles (normally lorries) is a strategic decision for maybe 10 years or more; the same goes for load-carrying equipment such as trailers and swap-bodies. ISO-containers on the other hand are standardized and can easily be exchanged. However, loading capacity, thereby economy, differs considerably between different types of equipment, why investment in a certain type of equipment usually is a strategic decision for the haulier.

### **8.2.2. The competitive situation**

However, the power situation between bigger forwarders and smaller hauliers is in the favour of the forwarder (e.g. Coughlan *et al.*, 2001). Since competition is fierce on the freight-moving market a forwarder can exert certain pressure on a haulier to adapt its fleet and equipment, but on the other hand a forwarder is not only dependent on the transport capacity but also on the reliability of the haulier to perform according to agreement. That means that relationships are fairly stable, since there is risk involved in changing business partners.

The fact that competition is high in the land-freight market also means that load capacity has to be used efficiently, i.e. the load factor has to be high, otherwise the haulier will suffer economically. This means freight has to be consolidated and load-carrying equipment and vehicles have to be available when Buyers want their transport. In other words, both long- and short-term planning have to be fairly complex, capacity planning has to be based on prognosis (i.e. guesses about the future), and “locks in” to a large degree, the options for the Buyer (Sterman, 2000, ch 10).

## **8.3. The interaction between the Transport Buyer and the Transport Provider**

In a *service* process context, the goods transported is not transformed, it is only “value added” through the increased *place and time utility* (Grant *et al.*,

2006). This value added is assessed or expressed by the Buyer's perception of how the service is performed, i.e. if it is what was agreed upon with the Seller, the Transport Provider. The value added is also related to the Buyer's importance weights, i.e. how important is for example speed or delivery within a certain time window.

Since a time-window restricts when a delivery should take place, there is normally more planning involved in coordinating actors and activity. If there is a time-window for the pickup, the Transport Provider has to have the transport and loading equipment available for that time. There is also some coordination between the Buyer and the Transport Provider, e.g. that certain personnel, space or equipment is available during that period of time. The same goes for the receiver of the goods if there is a delivery time-window. Any disturbances during the transport or at the reception area could cause a disruption so that trucks otherwise would have to queue up to unload or load. The transport itself would also have to be extremely well planned and timed.

Sometimes deliveries involving time-windows require fast transport, but not always. Occasionally it could mean that the goods even have to be stored at a depot in between so the delivery can take place at an appointed time. Then it is not only the pickup and / or the delivery time that is time restricted, but possibly also intermediary storage space.

However the delivery could also include a high-speed delivery. My point here is that there could be varying degrees of *logistics complexity* involved in a transport situation, especially when precision is involved as well. For example in long-distance deliveries often more than one forwarder and other operators are involved, so each link in the transport chain will have to be coordinated. Would one link not have the capacity available at the requested time, there would obviously be a delay at that point, and that could very likely delay the whole transport, i.e. a bottleneck is formed.

The ultimate purpose of the interaction is to build trust, thereby reduce uncertainties. This usually requires openness, honesty, and communication.

An important purpose of communication for *the Seller* is to retrieve relevant information so that the delivery can be performed according to the agreements with the Buyer. One purpose of this could be to nurture the relationship so that business can be developed long-term. Another is to increase the predictability of the delivery. Predictability is highly important because it affects the Buyer's service level to its customer. When the service of the



Transport Provider fails, it could e.g. mean that the customer's production processes are affected.

But what affects predictability?

The globalization of business is described as a driver for increased transport need (e.g. Neiberger, 2008). More pressure and constraining conditions on performance due to e.g. more intense competition, from society and other stakeholders also lead to increased complexity, higher demand on capabilities, i.e. more resources have to be engaged by the Transport Provider. That makes predictability (e.g. stability in performance) more of a challenge.

Another problem when complexity increases is the rising risk for service *variability*, in other words that the service quality is not stable (Manuj and Mentzer, 2008). Fluctuating quality creates uncertainties for the customers regarding the performance (Diao, 2007), thus making predictions and planning more difficult (Weick, 1995; Craighead *et al.*, 2007). This makes the equation even more problematic for the Transport Providers, especially if they also try to operate with leaner strategies than before, e.g. to use equipment and people more and slim the organization. Reliability of performances could be at stake if leaning goes too far (e.g. Zsidisin *et al.*, 2005).

However, as shown by the data of this study, quality of transport services can fluctuate or be questionable. There are many circumstances that can contribute to why quality problems occur in the first place. Parasuraman, Zeithaml *et al.*, 1985; Zeithaml, Berry *et al.*, 1988, point out that sometimes there could be communication problems involved, i.e. that there are "gaps" in how the Seller (the service Provider) and the Buyer understand the conditions and specifications. That gaps are common in interpretation of conditions and specifications also in transport services has been shown (e.g. Abshire and Premeaux, 1991; Hopkins, Strasser *et al.*, 1993).

To counteract the categories of problems mentioned above the Transport Provider can create "predictability" by pro-active work, such as to perform maintenance, to take quality-stabilizing measures, to build reliability and trust, to develop an ability to solve problems, and to communicate:

#### *Perform maintenance*

Maintenance of equipment used in the service production must function properly to avoid disruptions (e.g. Repenning and Serman, 2002). But how can companies that spend a lot of money on maintenance still have a lot of disruptions? This will be discussed further in chapter 9.

### *Take quality-stabilizing measures.*

One way to handle increasing complexity is to routinize processes. It is therefore often in the Buyer's interest to choose Transport Providers who are certified by some standard (e.g. ISO-9000<sup>127</sup> for quality, or ISO-14000 for environment). This is, at least theoretically, a "guarantor" that the company is working with (ideally developing and adapting) their routines and technical systems.

However, it is not only technical systems and standardized routines that affect the quality of the performance. The most important deviation in transport service quality is of course that the delivery does not occur in the time agreed upon, e.g. due to an unplanned disruption. Another quality deviation could be damages or loss of goods during the transport process. A third example of quality deviation could be that the Transport Provider does not have the capacity available when the volume demand for transport increases. All these examples involve people one way or the other, either in the planning- or in the operative stage. It could be a matter of planning a route, or solving a customer's problem.

Eroding standards will be discussed more below.

### *Build reliability and trust.*

*Overpromising* – a consequence of not knowing the system enough, what it actually is capable to deliver. This could be an internal communication problem (Parasuraman, 1998) and that people in the organization do not know what the processes (e.g. production and distribution) really are. It takes a deep understanding of how production etc. is done, what the difficulties are, what the potential disruptions, risks, and vulnerabilities are, to be able to make assessments, to plan, negotiate and promise service.

*High failure rate* is a sign that there are predictability or reliability problems in the system, i.e. that the service Provider cannot deliver what has been promised (cf. Grönroos, 1998). The service delivery failure rate should of course be very close to zero (i.e. delivery precision 100 % of agreed conditions), since the delivery time agreed on already should have the delivery failure margin "discounted for", i.e. the Transport Provider should already have planned for and included a safety margin in the agreement to deliver "on time". Transport Providers might see this as the "time buffer" (which it should not be, as the agreement is "on time"). By time buffer is understood

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<sup>127</sup> See also comment in footnote 67.

”safety time”, i.e. extra time (reserve capacity) to allow for emergencies or unforeseen disruptions (Goldratt and Fox, 1986; Stratton and Warburton, 2006). A possible explanation for this could be that time buffers have been reduced or taken away in the transport system, i.e. that capacity utilization is very high, and there is little or no reserve capacity<sup>128</sup>.

However, of course 100% on-time delivery is not likely or even realistic, but there will be failures. There is a “zone of tolerance” since it is not always possible to assess the quality on single service assignments. For example Dion *et al.*, 1998:84, discuss the danger of overpromising service quality, it can affect customer loyalty if performance promises are not fulfilled.

For the Transport Providers this means certain demand on flexibility, and ability to adapt the capacity.

#### *The ability to solve problems, and to communicate*

To solve problems and to communicate are sometimes intertwined. The communication may be necessary to obtain information not retrievable in the information system. Solving problems might also mean information has to be communicated to others.

Both require knowledge and skills, which have to be learned and trained. This will be central in the discussion in chapter 9.

## **8.4. Capacity**

One size fits all seems to be the approach in the application of lean management. The problem is: all systems are not designed the same way, and they need different logic. Manufacturing chains are different from service chains. It is primarily a matter of matching the demand with the supply, in other words how production resources are allocated and used. And because of the nature of the service production, service industries are particularly sensitive to imbalances between demand and supply (Armistead and Clark, 1994; Oliva, 2001). This is what I will discuss in this section.

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<sup>128</sup> It is easy to confuse the *delivery on time-rate* with the service level that retailers and suppliers calculate in order not to be stocked-out of products when a customer wants to buy. For companies stocking and selling products it is justified to have e.g. a 97 % service level, meaning that at least 97 out of 100 customers get the service they have been promised. That is a calculated risk that 3 customers in a 100 might have to wait for delivery, based on stock-keeping costs. But the service delivery of e.g. for a Transport Provider cannot have a service level of e.g. 97 % if the promise is say 99%.

### **8.4.1. The distinction between “push” and “pull”**

In a supply chain there are two basic, diametrically opposed, ways of fulfilling demands on the market:

1. to manufacture the products first then try to sell them, or
2. to first get the orders from the customer, then manufacture (or assemble) them

The first is the supply or “push” strategy, which means the demand has to be estimated or predicted first, i.e. the production has to be planned and products manufactured and stocked before they are requested (so-called “make-to-stock”, see e.g. Harrison and van Hoek, 2008; Simchi-Levi et al., 2008, for more detailed description on this topic). The product is in other words “pushed” through the system by the producers.<sup>129</sup>

The second is to produce only after the customer has placed an order (“make-to-order”). That is the demand response or “pull” strategy, the product is “pulled” or attracted from the system by the customer. In reality there is normally a mixture of these two “extremes” in production, i.e. components are manufactured in large quantities with a push strategy, then not assembled until there is an order (pull). Together this is referred to as a postponement strategy (Lampel and Mintzberg, 1996; Harrison and van Hoek, 2008; Simchi-Levi et al., 2008), which makes a certain degree of customization possible even for mass-produced products.

Applying these strategies to not only production, but also to services, Anderson et al., 2005, distinguish three types of supply chains (p. 218):

1. Inventory supply chains, i.e. interconnected firms that exchange only inventory with one another.
2. Service supply chains, companies that only manage backlogs.
3. Hybrid supply chains, companies that manage both backlogs and inventories, typically a custom-to-order product supply chain.

Number 1 and 3 apply to product chains. The first type, the inventory (or products) supply chain, is the make-to-stock product supply chain, which uses production planning or “push” strategies. The second and third, the

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<sup>129</sup> This is sometimes referred to as “speculation”, and obviously involves some risk that the products will not be sold, see e.g. Simchi-Levi et al., 2008.

service and the hybrid supply chain, both have demand logic, i.e. service or production does not start until the customer places the order. The hybrid category, is the modularised production of either “pull” or a combination of both “push” and “pull” strategies. However the point is that the customer has to join a queue (which means the backlog of orders or a literal queue) and stays there until the service or product is delivered.

They argue that supply chains show quite different response behaviour depending on if they contain inventories (i.e. stocks of products), or if they contain only backlogs (i.e. “stocks” of orders or customers waiting in queue to be served). Their point is that in operations management literature it is generally only inventory supply chains that are considered, and it is assumed that their logic also applies to service supply chains and hybrid chains.

They show that this is a mistake. Demand-driven and supply-driven chains have different behaviour.

For example to shorten lead-time is a way in inventory supply chains to make the process more “value-added”, i.e. to cut out “waste time” (e.g. Harrison and van Hoek, 2008). It also decreases the bullwhip effect<sup>130</sup> up the chain. However, in a service supply chain (or custom manufacturing setting) the bullwhip effect can rather be increasing instead — if it is not accompanied with careful capacity adjustment (Anderson *et al.*, 2005:229).

The structural differences, according to Anderson *et al.*, 2005, can be seen in Figure 20. So if the service delay in stage 1 (i.e. the backlog) is decreased that is normally considered good. However, the further up the chain the workload increases (compared to if lead-time had not been shortened!). Also Akkermans and Vos, 2003, illustrate this by a study of service operations in the telecom industry. The point is that capacity regulation to manage backlogs of orders (i.e. to be able to shorten lead times) is very sensitive: too much variability through hiring, firing, training, etc. can produce bullwhip effects through the service chain.

Figure 20 shows that the service chain, which normally uses “pull” strategy, can only manage the backlogs of orders by having sufficient capacity available. In the service chain, information and work-in-process normally flow in the same direction, in the manufacturing chain usually in the opposite direction.

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<sup>130</sup> Rippling effect where amplitudes of the fluctuations grow. Can be described as an information distortion effect (e.g. Lee, Padmanabhan *et al.*, 1997).

Translating this to a transport chain, it means that if for example the forwarder (the Transport Provider), who sells the entire door-to-door transport to the Buyer, shortens the lead-time for a transport, there will be an increased workload on the companies up the chain, the hauliers, etc., that do the actual transporting, for the same task as before. This supports my findings in section 6.2. and 6.3. that increased time pressure correlates to higher failure and damage rates.

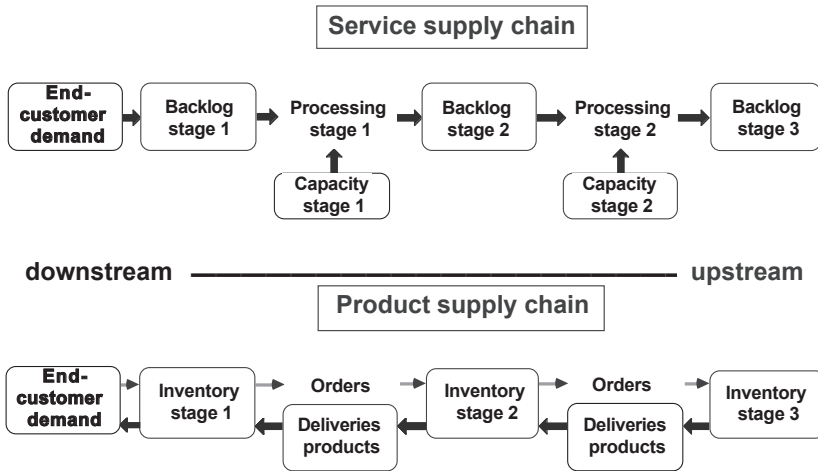


Figure 20: Supply chain of service operation versus products. After Anderson et al 2005.

Acknowledging this difference in inventory and service chains, how can the customers' demand be matched to the supply in service networks?

### 8.4.2. The matching of supply and demand

Armistead and Clark, 1994, say that there are three major challenges that face the operations manager in matching supply and demand in services (p. 5f):

1. The limited ability of the organization to alter capacity in terms of both the extent of the change and response time to make the change while having to deal with rapid fluctuations in demand.
2. The need to deliver consistent levels of customer service.
3. The varying degrees of uncertainty in demand.”

Point 1 implies that the demand in services is from time to time volatile or unpredictable, and that there can be problems in trying to adjust capacity “chasing” that fluctuation. This also implies that there is certain amount of inertia or delay with adjusting to changes. The reason for that is of course that it takes time to hire and train people, and waiting is something service customers generally don't like.

Point 2 means that the service delivery has to be consistent, i.e. fluctuating service quality is devastating. Customers have to know that they get the same service the second or third or the fifty-fourth time as the first time. This can be summarised with the concepts of reliability and trust<sup>131</sup>.

Point 3 implies that demand is sometimes illusive, uncertain or ambiguous. Too long waiting time makes customers switch suppliers. Or it could be e.g. when customers order but circumstances change, so they cancel the orders.

All three of these points are also relevant in goods transport services.

Armistead and Clark, 1994, continue to point out the structural differences in operational strategies for inventory-based product chains and service chains constrain service:

“Capacity management in service operations is a testing activity for operations managers because the nature of the service delivery process and the involvement of the customers in the process restricts the options open for controlling the process of matching supply with demand across the whole service delivery system.” (p. 6)

Oliva and Sterman, 2001, who discuss the human response to high work pressure, mean that the normal response to increased work load in service operations is

- 1) to work overtime (increase Work Intensity)
- 2) to cut the time spent on each order (decrease Time Per Order )
- 3) to adjust service capacity (invest in Service Capacity).

Oliva, 2001, also brings out the fact that service operations are quite different from manufacturing and have different degrees of freedom or response flexibility when it comes to matching supply and demand by modulating

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<sup>131</sup> See footnote 68 about the distinction between reliability and trust.

these three factors. The response flexibility depends on the structural characteristics of the service operation, in other words what constrains the choice. Goods transport could for example for long distance transport be considered to have fairly low Time Per Order flexibility, lower the more time controlled it is (pp. 39-41). So for different categories of transport there can be different flexibility to tackle increasing work pressure operatively short-term (based on Oliva, 2001).

Inventory-carrying (i.e. product) chains have, according to Armistead and Clark, 1994, four main control options: alter capacity, inventory holding, let customer wait (longer delivery times), and influence demand. However, depending on how one sees it, lowering performance standards and changing work intensity, as pointed out by Oliva (2001), is as a form of capacity altering, a change in the degree of utilization, see Table 7. Service delivery chains do not hold inventories since they cannot be produced in advance. Furthermore the ability to adjust capacity can differ, but is normally not an option if demand is volatile and if it is difficult to hire and train staff. The alternative to let the customer wait longer is definitely not a good strategy. Longer lead times than normal are seldom good for any business, product or service, but particularly not for service operations. Neither it is to compromise with service quality. Eventually the customer will perceive a change, and reduced quality is usually not order-winners.

But in reality Time Per Order and Work Intensity is what first can be used to handle demand fluctuations. The problem is if these methods are used more than short-term.

Matching demand and supply can be even more problematic for services than products, and especially services where customization to some degree is involved (Chase, 1978; Chase and Apte, 2007; Jacobs and Chase, 2008). One of the reasons for the difficulty is inertia, due to delays in the information systems and the lack of transparency, i.e. that all (relevant) information is not known in the supply chain (Christopher and Lee, 2004) or deliberately not shown (e.g. for competitive reasons, Bienstock, 2002). Information could also be available, however difficult to evaluate (ibid.). There is, of course, normally a cost trade-off to asymmetric information; it simply would cost too much to always retrieve or analyse all information available.



Table 7: Differences in control options supply chains for products or services<sup>132</sup>.

Control option	Action if demand increases	Product supply chain	Service supply chain
Capacity altering	Invest, increase Service Capacity	+	+ takes time
	Increase work intensity (e.g. overtime)	(+)	(+) quick
	Cut time per order (i.e. compromise quality)	(+)	(+) quick & very risky
Keep inventory	Products waiting for customers	+	Not applicable
Let customer wait		(+)	(+) a way to lose customers
Influence demand	Adjust price, availability	+	+

When demand is fluctuating, on what level does the Transport Provider decide its service level? To have a capacity that covers all variation is considered uneconomical, since it will not be fully used except at the top of a business cycle, and the slack carries capital cost (Sasser, 1976). In periods of high demand that would mean the order-stock increases, in other words, the backlog of work will build up and Buyers will have to wait longer for service (i.e. there will be queues to obtain service). However for a transport company with high service content (logistically more complex, such as time constrained transport or flexible deliveries) that is not a good strategy. Getting near the top of the business cycle they might lose those customers who do not accept longer lead-times. For service companies in this situation not having enough capacity, this will be a self-regulating process: When their work-backlog will be big enough, the demand for their services will decline because they cannot deliver what the customer wants (i.e. customers are not prepared to accept long lead-times). And it is most likely service with high degree of time constraints that will be affected the most, in other words logistics service that produces the most revenue.

<sup>132</sup> After Armistead and Clark, 1994, and Oliva, 2001. The “+” means long term solution, (+) short term (or risky) solution.

## Summary of findings from the literature

- Supply chain strategy is different for services and products
- To shorten lead-time locally can create more workload and quality problems up the service chain (Anderson *et al.*, 2005) — if capacity is not carefully adjusted
- Capacity adjustments in order to manage backlogs of orders are very sensitive to variability: Too much variability through hiring, firing, training, etc can produce bullwhip effects through the service chain (Akkermans and Vos, 2003).

## 9. Response to complexity

In this chapter I intend to connect the discussion more directly to some aspects of the Theory of Constraints and other relevant theoretical sources, and discuss why *reserve* capacity is even more important, not less, as complexity and work pressure grow, and especially so in services. However, to illustrate that the analysis can be quite different with different assumptions and models, I am using Allison's decision perspective theory (Allison, 1971; Allison and Zelikow, 1999) as some different scenarios.

### 9.1. Essence of decision

Allison analysed the Cuban missile crisis from three different perspectives or through three “conceptual lenses”:

1. The Rational Actor
2. Organizational Behaviour
3. Governmental Politics

The “rational actor” is the way we logically think about problems (as we assume we have all the necessary information and knowledge), how to prevent them or how to solve them. On an organizational level, this is what a company or organization often says or plans how to deal with a situation or a problem. It is what seems to be logical, based on the best possible knowledge. One could say it represents the theoretical models, or rather assumptions and postulates, we use, in our decisions. Allison proposes that this is based on the belief that the decision-maker has access to all possible, relevant information and weighs the utility of the different alternatives against each other and chooses the alternative with the highest utility. He observed though that this was not what really happened, rational actors usually leave out a lot of relevant information, and models are therefore quite simplified. In economical theory this is e.g. described as trade-offs, or optimal solutions and maximized utility.

However, reality does not always obey theoretical models. The reason for that is that theories and models are based on assumptions, limitations, that a change will not affect other variables. Another reason is that we seldom have the total information.

Organizational behaviour is thus often different from the outcome we expect. Why? Allison proposes amongst others: Decision-makers tend not to look at the whole picture, but break down the problem after the organizational limits, departments, functions, etc. Also lack of time and resources cause decision-makers to settle for the first plausible proposal. This is what Simon, 1979, called “bounded rationality” or to have satisfactory solutions<sup>133</sup>. Allison also meant that the tendency is for leaders to prioritise to eliminate the short-term uncertainty over the long-term solution. It is easier (and short-term cheaper) to follow set routines. One obvious reason for this is that all necessary information is not available in the first place, it simply would be too costly to retrieve it, if even at all possible, since organizations (especially between companies in a supply network) are not always willing to reveal it all. Increased complexity does not make that any easier.

Allison’s political model is based on the propositions that actions are the result of politicking and negotiations. He means that it depends on the leader’s ability to get consensus from alliances or groups. Actors, stakeholders inside and outside of the organization, sometimes have their own agendas and other goals than what the Rational Actor solution would suggest.

But, deep down, more or less, all of us feel we are “rational actors” in our decision-making, however we base our “rational decisions” on what information is available, and it is constrained by our mental frames<sup>134</sup>, our own set of values, our emotions, and our personal goals. Not looking for more information could also be a rational way of limiting accountability!

How could the research question be answered in the different perspectives?

I rephrase it with two questions that one might start off asking about the data presented in this thesis:

- 1) Why are the failure rates so high?
- 2) Why are Buyers not satisfied with Providers’ capabilities?

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<sup>133</sup> That’s why this also can be referred to as the “bounded rational actor’s” model.

<sup>134</sup> Morecroft, 1994, describes a mental model as “...a dynamic pattern of connections comprising a core network of “familiar” facts and concepts, and a vast matrix of potential connections that are simulated by thinking and by the flow of conversation.” (p.7), i.e. the view a person has of the world, how one thinks the world works.

### **9.1.1. The rational actor**

A conceivable explanation of how a rational actor would answer the questions:

1: The failure rates are high because... Transport Buyers are not working hard enough. This is mostly a staff recruitment problem for the Transport Providers. The reason for that is that the labour market is not flexible enough. It is difficult to get competent and motivated personnel today when it is needed.

The competitive pressure is high on the transport market. Therefore the Transport Providers have to apply lean principles (just like the Transport Buyers) in their service production. A low cost per unit is required. Therefore they always adjust their capacity to demand in order to have a high load factor. Excess capacity is very expensive. Bigger forwarders, which dominate the long-distance transport, normally don't perform the physical transport themselves, but hire hauliers to do that. So, when there is a downturn in the business cycle forwarders have to disengage the hauliers, and they in turn have to downsize. But when the demand picks up again, it takes a long time to recruit new personnel, because there is such bad flexibility in the work-market. It is difficult to get the right competence, so training takes additional resources, which, however, sometimes have to be compromised with due to the high workload. Apart from that, the ordinary personnel also have to work overtime to try to keep the service level up. Inexperienced personnel make a lot of mistakes while getting into their jobs, and that takes time and resources to correct. This causes work pressure to increase even more, which sometimes gets the ordinary personnel even to apply for other jobs. So the cause is primarily external, it is the inflexible work-market that is the problem.

2. The Buyers are not satisfied with the Providers' capabilities because... it leads to many time failures, which however occur mostly in international transport. This is because international transport is still unreliable, despite very meticulous and detailed specifications. It could e.g. be that border crossings and customs delay shipments in some countries, things that should not have happened, but because of bureaucracy and corruption it does. However, Transport Providers assume that Buyers have understanding for this since this is out of their control, hence that they will still stay anyway due to long relationships. Despite everything, this is the best predictability of the shipments that can be achieved.

Regarding damages, they occur mostly in shorter transport, because Buyers feel the Transport Providers have too many new and inexperienced personnel or they are in too much of a rush, therefore they don't bother to fasten the goods well enough. This is because they are forced to, out of competitive reasons, to use their machines to the maximum. After all, the Buyers are pressing the prices.

### **9.1.2. Organizational behaviour**

The organizational behaviour model, resulting from the bounded rational actions, offers a different explanation. A possible scenario of how a bounded rational actor (Simon, 1979) would answer the questions:

1. The failure rates are high because... there is too much conflicting and ambiguous information coming in, which sometimes is misunderstood or takes time to follow up for the Transport Provider. Occasionally also unforeseen things happen, and since Transport Providers are going lean, there are not always extra resources set aside to deal with them, but situations have to be improvised. This occasionally backfires, especially when there is a shortage of personnel and Buyers are getting anxious to get things delivered on time. When pressures are high more mistakes also tend to slip in.

The growth in network complexity has increased the information flow for the Transport Providers considerably, especially with new ERP-systems<sup>135</sup>, which also require more attention. This can give problems in retrieving relevant and correct information. There is no way a decision-maker would be able to take in all that information even if it had been available before the decision. Just to get all the information together and synchronized is often not feasible, because resources are not available, since they have to be used in production instead. However, based on long experience in the industry, management feel that they know how their business works, so often decisions or choices are predetermined by existing policies and routines.

2. The Buyers are not satisfied with Providers' capabilities because... they feel the Providers are not adapting to their demands quickly enough. Part reason for that is the increasing pressure from Buyers to perform faster and with higher precision, and this has made it necessary for bigger Providers to organize in large networks, not the least to cover more destinations

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<sup>135</sup> ERP= Enterprise Resource Planning, i.e. computerised administrative systems, generally databases that also can provide system information.

geographically. Transport Providers thought this would be possible due to the ICT<sup>136</sup> development, especially in the 1990's, since ICT had attributed unprecedented abilities to collect information, plan, coordinate, monitor, trace shipments and control the operations even down to parcel level. Software developers ensured that the new ERP-systems could be adapted to access just about any operational information in real time and that incompatibility between systems would soon be history. Decision-makers thus had almost all relevant information reachable with just a few finger pressings on the key-boards, at least so they thought. Transport Provider vendors trusted that the new ICT-systems would make the increased complexity manageable and really thought they would be able to align to the Buyers' conditions with increased pressures of timing, price and emission control for trucks. This especially since the Internet and broadband became more available.

However, they did not think of that all actors in the transport chain had to have compatible information systems to exchange data, or were even able to provide updated, reliable information. Neither did time pressure permit them to check up everything with foreign partners and the smaller subcontracted hauliers. They assumed they would handle the situation based on industry experience and new technology. They also assumed that the Buyers would renew their contracts since they had a long relationship, historically with a high loyalty factor.

Buyers, who after having been promised a certain service level, perceived eroding service quality, thought the Providers simply had overpromised just to get the contracts, and that they really had margins but were holding back. Thus they increased the pressures even more to send signals to the Providers.

## 9.2. The Theory of Constraints

So, how are the capability factors, which were defined above<sup>137</sup>, connected to constraints? Using the Theory of Constraints (Goldratt, 1990) to explain why problems (i.e. on-time failures, damages) occur in the flow may add more to the picture. So let's consider the potential constraints of these factors, i.e. the consequences of their limitations.

The Theory of Constraints is a normative theory in that there is a methodology offered not only to explain why constraints exist and persist, but also

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<sup>136</sup> ICT= Information and Communication Technology.

<sup>137</sup> Shipping Capacity, Ability to solve problems, and Information & Communication Systems.

how to “get rid” of them. The approach should be systemic, i.e. global or holistic, not just local. It is not always intuitive what to do. Goldratt means that the tendency just to fix problems as they occur, so called “fire fighting” or quick fixes, is not a good method, in fact might be a part of the problem. The problem-solver needs very good insight and understanding to see how the system really works and what limits it. He means that it is essential to analyse constraints and recurring problems more deeply, to see what the underlying root cause is, and deal with that instead. “Solutions of compromise” (p. 36) which only addresses the effect could even lead to resistance to change (i.e. more constraints) in the organization. Especially if there has been an attempt to fix a problem, and it hasn’t worked, and the problem persists<sup>138</sup>.

But what is to be dealt with? Goldratt and Fox, 1986, point out that it is primarily the *major* bottlenecks that need to be dealt with; fixing “non-bottlenecks” will not have any improving effects on overall performance, but might, on the contrary, even drain resources from the organization. Sometimes even peak performances at non-bottlenecks could be mistaken for bottlenecks, and lead to investment in more capacity there, whereas the real problem could be e.g. a badly synchronized production. A better production planning could thus spread the capacity utilization better over time, so that non-bottlenecks never form such temporal constraints.

And how could the constraints be dealt with? To downsize capacity and take away time buffers in the service Provider’s transport chain must be done with caution, if adaptability to fast changes in demand is going to be kept. Goldratt and Fox, 1986; Goldratt, 1990, argue that time buffers are necessary in front of sensitive or vulnerable processes. Transport Providers do not keep inventories of products, but their “inventories” are rather their stock of orders not yet fulfilled, and sometimes they might have unused loading capacity. Since adaption time is long, cutting down load-carrying capacity only works if the demand is stable over a long time period. When demand is volatile a time buffer must be available to cope with increases, what Goldratt and Fox, 1986, in a manufacturing context call “synchronized manufacturing”<sup>139</sup>. In the service context, in analogy with this, I therefore suggest it could be called “synchronized service processes”, however, the meaning is the same:

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<sup>138</sup> It has also given quality improvement programmes (such as TQM and BPR) a bad reputation (cf Repenning and Sterman, 2001), so that efforts to achieve continual improvements have even been stopped.

<sup>139</sup> Synchronization of the flows in various processes, not the capacities. The starting point is to identify the bottleneck resource, and let that decide the rate of production.



information and actions in management have to be synchronized otherwise they can have counteracting effects. Note though that the same principles of control or management are not usually applicable to services (according to Akkermans and Vos, 2003; Anderson *et al.*, 2005).

So, looking at transport services, there could be “technical” constraints of the shipping capacity, there could also be limitations in people capacity, such as availability of staff and / or their skill, and ability to solve problems. There could furthermore be constraints in the communication and information flow, which could affect the policies and the decisions that are made in managing the business processes. Such circumstances could also affect e.g. how people actually solve problems. So let’s continue with the Theory of Constraints glasses on and discuss constraints of the shipping capacity, people, and policy formation.

### **9.2.1. Shipping capacity constraints**

Goldratt and Fox, 1986, maintain there are few capacity constraints of production resources. They refer to manufacturing companies, but as far as I know there is no research on the prevalence of constraints across industries. However, the technical capacity (machines, vehicles, etc) is the easiest to measure and estimate, so let us assume they primarily refer to the productivity constraints limited by machine capacity and access to materials<sup>140</sup>. For the transport industry this could of course be referring to transport equipment or infrastructure constraints in a transport network. Especially if several actors perform the transport internationally and serially, somewhere in that chain less transport resources or possibly bad infrastructure could form a constraint (cf Mentzer, Myers, *et al.*, 2004).

Originally the Theory of Constraints addressed shop floor problems, with the underlying logic that production should be demand driven<sup>141</sup> (i.e. have “pull” strategy). The Theory of Constraints points out that excess inventories (i.e. “push” strategy) cause many of the bottleneck problems with the flow.

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<sup>140</sup> Their “soldier analogy appears to cover the concept “capacity” in an amalgamated or systemic sense that does not clearly distinguish the various kinds of resources: production materials, machines and equipment, people and their skill. However, assuming a business places their staff so that they can use machine capacity etc. as much as possible, then the machine capacity would form the constraint.

<sup>141</sup> So called “kanban” (Japanese for “sign” or “instruction card”, Jacobs and Chase, 2008:230) or make-to-order-logic, in other words production is not to start until there is a customer need for the product. A kanban, however, is not directly transferable to a supply network, however, the underlying logic is the same.

That does not mean that inventories all together are bad. As mentioned above some inventory (or "time buffer") is needed in front of sensitive processes, to avoid that the flow slows down somewhere else<sup>142</sup>.

These service operations can work very well without capacity change if the transport need can be predicted in advance, and there is no drastic change in demand. But when the complexity of the transport solution increases, the movable equipment could become a constraining factor compared to a normal transport. This could be because the time requirements are more restrictive (e.g. "time windows"), and the equipment is simply not returned as quickly and made available for other transport. An example of that could be empty containers not returned fast enough for new shipments. Zanuy, 2009, describes e.g. the imbalances in the freight flows<sup>143</sup> and the growing problem of repositioning containers geographically. Another example of this is the automotive industry, with big relocation problems of containers (Williams, 2011). This problem was also visible in the findings of this study for Paper industry and Machines & Tools manufacturers<sup>144</sup>, indicating dissatisfaction with quality fluctuation, volume inflexibility, and relationship tension. Also infrastructure, e.g. terminal space, could of course also be a limiting factor in flows.

### **9.2.2. People constraints**

Human involvement in services is crucial. The main unit normally used to measure input of people's work is *time*, such as hours of work. Depending on experience, skill, and motivation, the individual performs with certain productivity, i.e. works at certain speed and with a certain skill. Goldratt and Fox, 1986, classify productivity as a potential constraint, in other words the *experience and skill* can limit the performance. One person can solve a problem, or plan, maybe not faster, but with a better result than someone else. For example, one transport company may also have fewer damages than another comparable because their staff have a better knowledge and skill of how to load, fasten and unload the goods, drive, etc, than another company.

This, as well as shortage of staff or not training and developing skills, can over time obviously affect performance. However, there can be various reasons for lower or fluctuating quality, not necessarily that there is a lack of

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<sup>142</sup> That is, forms constraints or "bottlenecks" elsewhere in the organization.

<sup>143</sup> More goods in one direction than in the other.

<sup>144</sup> SNI02 ind. code 21 and 29.

skill. For example increasing complexity of task or time pressure, or uncertain information, can be other reasons. Maybe not all parts in an organization develop in a synchronized way to e.g. support that.

In people-intense services that require more customization and interaction with customers (which could be the case in working out transport solutions), quality of performance can become a problem (Chase, 1978; Chase and Apte, 2007; Jacobs and Chase, 2008), especially when the financial pressure is rising and productivity growth is slow (Oliva and Sterman, 2001). According to Oliva and Sterman, 2001, if extended, this can lead to that capacity utilization increases overly much. If that means a lot of overtime over an extended period it can lead to fatigue or even burnout, and this in turn can cause performance problems (cf Armistead and Clark, 1994).

Labour shortage worsens or cements the capacity utilization problem if the service Provider cannot use necessary shipping capacity in situations of increasing demand. Market data show e.g. that there is, on average, almost a chronic shortage of labour for Swedish haulier companies, even when there is a business recession<sup>145</sup>. When this is the case that can also lead to more financial problems, due to lost opportunities and less revenue (assuming the fixed cost for unused shipping capacity is there).

Obviously it also takes some time before the upsurge in a business cycle is noticed or can be established, and it is not likely that carriers start employing more personnel until that is noticeable. As Oliva and Sterman, 2010:343, describe it for service industries in general:

“The desired workforce is determined by desired service capacity and management’s belief about average productivity. However, because labor is costly and slow to change, management does not act instantaneously on labor requirements. Instead, the desired workforce adjusts with a lag to the level indicated by desired service capacity and perceived employee productivity.”

However, if personnel capacity is increased, there is also the aspect of training due to lack of experience. If work-pressure is high, training might have a lower priority though, especially when there are many new employees (Sasser, 1976). Training and building skills often takes time, and this is why there is some inertia in expanding capacity (e.g. Akkermans and Vos, 2003). So, also according to Repenning and Sterman, 2002, skill and capability

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<sup>145</sup> Well over 20 % of haulier companies in 2002 stated they have this problem according to Konjunkturinstitutet (Konjunkturbarometern, 2004).

could become constraints, especially for personnel with key positions (e.g. involving planning and problem-solving).

So both for the short-term problem-fixing of disruptions and the long-term problem-solving of companies it is necessary to reduce uncertainties. Sometimes unwanted constraints, like skill problems or too high turnover of the personnel, or other capacity problems can make both these processes ineffective. Such constraints can undermine the competitive edge and seriously jeopardise the long-term development of the business.

But underlying action are usually policies or other rules, which guide people's day-to-day choices. This is what the following section will illustrate.

### **9.2.3. Policy constraints**

As mentioned, Goldratt argues that it is usually not those capacity resources that are constrained, but rather the *policies* regulating the production that limit the processes (Goldratt, 1990; Stratton and Warburton, 2006:670). Policies are decision rules<sup>146</sup>, which are dependent on information and people's judgment, and, implied by Goldratt, their whims, opportunistic behaviour, and politicking (cf Allison and Zelikow, 1999). The point is that bad or inconsistent and counter-active policies can cause fluctuations or quality problems or otherwise obstruct processes, which injure the overall efficiency. However, the positive thing with that insight is that if policies are questioned, analysed and changed there is room for operative improvement without really adding to the assets<sup>147</sup>.

An example, mentioned above, of an inconsistent policy used, based on (at least in some situations) wrong logistics thinking, is the trade-off between batch size and set-up cost, especially since it can lead to a build-up of inventory (Goldratt and Fox, 1986).

Another example of the more opportunistic kind, is the "emotional resistance" to block continued improvements in an organization. Sometimes, Goldratt means, there are even cultures of punishing those who improve performance e.g. by laying them off (Goldratt, 1990:91f)<sup>148</sup>. Production

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<sup>146</sup> Will be expounded below.

<sup>147</sup> Stratton and Warburton, 2006, describe this as moving the operating frontier towards the asset frontier.

<sup>148</sup> The logic of this is, according to Goldratt, that if a department has managed to remove a constraint and it becomes a non-constraint, but new constraints have appeared somewhere else in the organization (where no improvement has been made), it is likely that those who have improved so that they have slack capacity are in more risk to be laid off if the company wants to cut cost (p 92).

capacity might have increased by e.g. quality improvement, but a constraint to further growth in Throughput is identified. However for some reason someone blocks it or disagrees. He gives an example (ibid:93f): If e.g. the production department has spare capacity due to improvements, but marketing department has reached its budgeted goals, blocking an increase in sales can be caused by e.g. intra-organizational rivalry for a position. If each function has accountability for results (which is common), an increase in sales will, short-term, give the production department a better result (higher Throughput and no increase in Operative Expense since there is no capacity constraint there), however the marketing department will get a worse result (e.g. Operative Expense will increase if new employees have to be hired and trained). However, as implied this is just temporary, and long-term their result would also have benefited.

If e.g. there is, as in this example, little or no communication between these two departments, it could simply be because there is no deep insight or understanding or tradition in sharing information. This culture or atmosphere could simply be because there is not enough knowledge about the other processes or due to someone's "political" ambitions.

This example also illustrates what Allison (Allison and Zelikow, 1999), would describe as the Political model. Opportunistic behaviour could be rational e.g. to guard one's position or job (definitely if accountability for short-term results is important). But it could also illustrate how someone in the organization acts irrationally as a gatekeeper and for other reasons guards positions or has other personal agendas. Actions then are short sighted, information is asymmetrical or totally disregarded, usually because there is not enough time and resources to get a better picture. But if it is not opportunistic politicking behind the behaviour it could simply be because there is limited (or sometimes too much) information available. Due to time limits decisions are made on limited, or bounded, information, what Simon, 1979, calls "satisficing". Normally it is predetermined routines, policies or "culture" that guide the decision-maker, not necessarily the facts.

### **9.3. Policy questions**

Tying back to Allison (Allison, 1971; Allison and Zelikow, 1999), the findings in chapter 8 and the perspective of the Theory of Constraints, there is one more question that needs to be asked:

- 3) If the Transport Providers' policies have such a crucial role in the development of their capabilities and competitiveness, why is the performance not better?

### ***9.3.1. The rational actor answers***

A conceivable explanation of how a rational actor would answer the question:

...Top management must have full overview and control of what is going on, therefore only company policies are needed. This is a kind of standardization of decisions and actions, which makes efficiency very high, no one really needs to think, just execute orders, a kind of assembly-line thinking. And it is in line with lean thinking. Competitiveness will be worked up by having the lowest costs, or by outcompeting everyone else. However, if these policies are not followed properly, the desired results will not substantiate. And that is what must have happened.

### ***9.3.2. The bounded rational actor answers***

A conceivable explanation of how a bounded rational actor would answer the question:

...Time is the limiting factor and there is less and less of it. At least the Buyers think it is possible to increase speed and shorten lead-times infinitely. This constrains the time for problem solving.

There are also a considerable number of changes in the market, since the development is very fast for Buyers being served. Their customers also have increasing demand for timing, more service flexibility, and lower price. This means there are often fluctuations in the demand, and that makes it increasingly hard to plan. At the same time the major Transport Providers are increasingly bigger companies, which have instructions from owners and top management to utilize the production resources to the maximum since fixed cost is high. A lot of emphasis is on yield, minimised costs, and maximised productivity. Because of this more time has to be spent on the operative aspects of optimising the use of machines and personnel time, etc., especially when backlogs of orders are building up. Since customers furthermore want fast transport, some shipments have low load factor, and a lot of time has to be spent trying to find return cargo. Then there might not be time for e.g. maintenance or skill training.

All this requires decisions, and it is not really possible to take in the flow of information, far less to analyse it and reflect on e.g. what all the changes mean. Sometimes customers complain and therefore some quick fixes have to be applied, otherwise it will have rippling effects on all the other customers. Thus most decisions are policy-driven, with focus on the shortest possible time, why simply standard solutions usually have to do. Had there been more time, and then policies could have been updated, which possibly could have improved performance.

### **9.3.3. Matters of policy**

Policies are decision rules that govern the rates of flow (activity rate) in systems (Sterman, 2000:515). Sterman, 2000, describes a decision rule as an “information processing procedure”. Forrester, 1994:58, compares it to a form of “transfer function”, which in a decision process means the conversion of information into action. Forrester, 1994, thus defines “policy” as “a formal statement giving the relationship between information inputs and resulting decision flows.” (p 58). The decision-maker can of course only act on the available information<sup>149</sup>, however that is sometimes time-delayed or distorted (e.g. Sterman, 1989a; Forrester, 1994; Sterman, 2000). But also the “mental models”<sup>150</sup> of the decision-makers, as well as e.g. organizational and political factors, influence how information is selected (Morecroft, 1994; Sterman, 2000).

To change the state of a system, the decision rules therefore have to be changed. Change of e.g. growth or reaching a target, is really only possible if there are no (bad, i.e. unwanted) constraints, including missing resources (Sterman, 2000:577). But decision rules can also be affected by information that is not fully understood, or misinterpreted, e.g. due to long time-delays, and that can lead to unintended side-effects. This is sometimes referred to as policy resistance (e.g. Sterman, 2000:11), which means that even though the policy is set for change, the system does not improve its performance<sup>151</sup>.

However, sometimes it could even be the decision-time that is the constraint, i.e. it takes some time to get information, to do calculations, to eval-

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<sup>149</sup> The Baker criterion, see Sterman, 2000 p 516-517.

<sup>150</sup> See footnote 134.

<sup>151</sup> An example of that could be when politicians try to get unemployment down by directed policies to stimulate employment or other activities, but the unemployment rate is still as high (or even higher than before). The medicine does not “take” because there are constraints in the system that counteracts the intended measures. More examples in Senge, 1990; Dörner, 1996; Sterman, 2000.

uate information, to discuss, to make decisions (cf. Sterman, 2000). And if changes are fast, e.g. by the increase in demand, that decision-delay might be too long, with the result that an order or customer could be lost, or once the decision is made, the demand-situation has changed, and the decision cannot be carried out.

Uncertainty, sometimes due to inexperience, makes judgments and evaluations difficult<sup>152</sup>, therefore decisions are delayed or do not happen at all (Tversky and Shafir, 1992; Gneezy, List *et al.*, 2006). Dörner (1996) means that especially when people are faced with uncertainty *under time pressure*, sometimes behaviour gets distorted: they deal with the situation in either of the following ways:<sup>153</sup>

- 1) “by acting hastily on the basis of minimal information” or
- 2) “by gathering excessive information, which inhibits action and may even increase our uncertainty” (p. 104)

So Dörner means that under high time pressure our decision-making gets more prone to risk-taking or even recklessness because we simply ignore or suppress important information, in other words there is an inverse relationship between readiness to act and the amount of information the decisions are based on, Figure 21. The less information, the quicker the action. Failures often do have logical explanations!

Figure 21 also implies that the importance for high quality information increases with growing complexity.

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<sup>152</sup> Weick, 1995, uses the expression equivocality, and means that reduced equivocality makes it easier to understand cause and effect, whereas with much equivocality, i.e. uncertainty, judgments and evaluations are difficult.

<sup>153</sup> Dörner (p 100 ff) relates an experiment by Rüdiger von der Weth involving trading off profits in a production process with unwanted side effects of toxic emissions. The experiment showed two kinds of behaviour: 1) one category of the participants (ignoring the unwanted side effects) took in significantly less information initially and made many decisions, and 2) another category (conscious of the bad side effects) which initially in the process took in much more information and were cautious to act until they had secured a solid base of information.



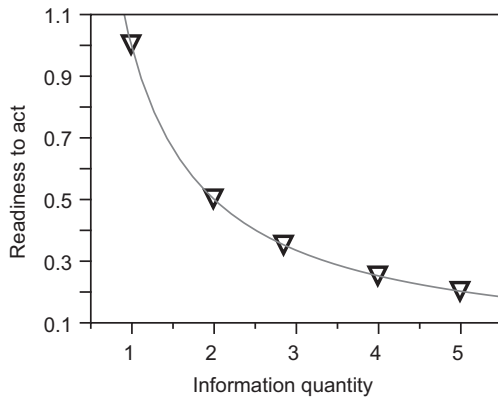


Figure 21: Decision-making under time pressure: The relationship between information gathering and readiness to act. Based on Dörner 1996, pp. 98-101.

From the discussion so far I make the following propositions:

- Short term:  
Building up problem-solving skill is necessary when complexity is high. Increasing complexity makes a system more vulnerable and less predictable. This means interruptions are more likely and can cause quality problems. Recurring problems need to be analysed and the operations of the system to be understood so the systemic root cause can be addressed.
- Long term:  
Accumulation, and sharing, of problem-solving skill and knowledge is important for development of capabilities. Therefore e.g. high turnover of personnel, especially key ones, could in the long run affect the firm development negatively by organizational “brain-drain”.

The point here is that policies are guiding or controlling decisions and actions (i.e. the flow rates in production), but policies can be based on more or less relevant and often incomplete information, and as implied above even wrong assumptions. The access and selection of information is therefore important, but also the application or conversion of it into action. So

apart from locating and removing constraints in processes another crucial factor is information processing in decision-making. This means acquiring information from the Information & Communication Systems, and synchronization, i.e. coordinating phase-lagged information, but above all that the decision-makers have deep operational knowledge of how their system works.

### **9.3.3.1. Support from the findings**

As shown in Table 5 there are considerable gaps between what the Buyers desire and what they perceive as their Transport Providers' capabilities to perform. It is especially the Overall Satisfaction, the ability to deliver On Time, and Ability to solve problems, which show the biggest negative gaps. These gaps are significantly different for all seven industrial groups compared. Concerning the Shipping Capacity on the other hand the Buyers overall feel the Providers perform to expectation or much better than they feel is necessary. When it comes to Information & Communication Systems all industries, except Food & Beverage wholesalers, express that performance is at least (on average) as they desire or better. However, Food & Beverage wholesalers show a negative gap, i.e. they are not satisfied with the Information & Communication flow.

Looking at the effects of an increase by one unit (which could be a scenario of pressures or demand increase) of the input<sup>154</sup>, constraining effects are visible for the Food & Beverage industry (especially wholesalers), B&C industry (wholesalers), Industrial manufacturers (electrical and mechanical equipment etc.), Industrial supplies' wholesalers, and the Paper industry. It is especially the Information & Communication Systems and Ability to solve problems that show signs of constraints, sometimes also involving Shipping Capacity, and seriously affecting On-Time delivery, see Table 6.

Of the special cases related above<sup>155</sup>, two companies, BRIGHT and MACH, stand out, both which clearly illustrate communication, skill and relationship problems with their Transport Providers. These are examples of quality erosion, i.e. when the service standard has been lowered (Oliva, 2001). Also the data for e.g. cases HARDWARE, and BUILD reveal feedback and quality problems.

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<sup>154</sup> That is the Buyers' importance values and the pressures. This is shown in Saxin, 2012.

<sup>155</sup> See section 6.3.

BRIGHT is the company producing electrical equipment (“industrial manufacturing” company), especially to the Building & Construction industry, whose transport chief was so frustrated over e.g. their biggest forwarder’s inability to communicate with them and their customers. The forwarder (according to the transport chief) also gave BRIGHT wrong feedback about time precision, and they handled fragile goods carelessly.

MACH is the international wholesaler of industrial machines and supplies, which had relational problems with two of their major forwarders and especially with one, which did not even want to discuss delivery reliability (time precision) over 95%.

### **9.3.3.2. Interpretation of findings**

As pressure increases, Information & Communication Systems appear to be involved in generating dissatisfaction and measurable failures or damages in several of the studied industries. Sometimes these effects are indirect by affecting the Ability to solve problems, and On-Time Delivery. Since Information & Communication Systems represent the data and information flow from customers and operations, it indicates that there is a problem at the “interface” between that system and the decision-makers. But the Buyers own assessment of the state of the Information & Communication Systems did not indicate that (except for Food & Beverage wholesalers), so how logical is a conclusion like that? I would say it is very logical that the Buyers feel the Providers’ systems are even better than they want. What the Buyers could mean by that is that they feel the quantity of available information is ample. The problem is however the Problem-Solving. If there are limitations (i.e. constraints) in people’s ability to sift out, process, and synchronize all the information (e.g. lack of time, or vital information might be missing), that means there can be mistakes and failures because people don’t understand the information or it is uncertain. Or there is simply too much of it, there is not enough time to take it all in, or to pass it on to the managers. It is thus ignored or considered irrelevant, and the existing policy is applied instead. Limitations could be cognitive, but also a lack of skill due to missing knowledge and understanding of how the system actually works.

This could be the case if a customer complains e.g. over late arrival. It is not likely that the information is passed on in the organization every time it occurs if time is short. This could also be the case e.g. when a new computer system is taken into use. Systems that are developed externally by computer system experts might not be totally understood by everyone who handles

them (e.g. complex ERP-systems<sup>156</sup>). People might learn what buttons to press to get access to certain information, but they do not necessarily know where the information comes from or why, or how the models and algorithms are constructed. This means they learn a skill to follow procedure in handling the equipment, and how to tackle the bugs, but do not necessarily know what certain results really mean or what is the cause of a failure.

In some cases also the Shipping Capacity shows signs of constraints. That was seen e.g. for Paper industry and Machines & Tools manufacturers, which according to the data most likely is a lack of available containers. This obviously could have consequences for e.g. Problem-Solving and On-Time delivery.

How is this supported by theory?

As discussed above, information from the processes, customers, markets, etc. can have different quality, more or less complete, more or less relevant, more or less biased. There is also a quantity dimension involved, with either too much or too little information, described by e.g. Dörner, 1996.

Large quantities of information and data can be difficult to process and digest to allow interpretation. There is a link between growing complexity of an organizational environment and both quantity and range of information, which affect performance negatively (Comfort *et al.*, 2001). This is enhanced under time or work pressure or in situations of disruptions, or crises. For example Pettit *et al.*, 2010, describe a number of factors that increase vulnerabilities and risks, such as resource constraints, external pressures, and connectivity (connectedness). They mean that increasing vulnerabilities have to be matched with increasing capabilities, but all this also increases the information flow. In other words, if delivery failures are many or serious, that in itself generates uncertainty<sup>157</sup>. The transfer of information quantity into information quality<sup>158</sup> thus requires capacity to process, communicate, and analyse information, i.e. to reduce uncertainties and to sift out relevant information that can lead to new insights, for example what

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<sup>156</sup> ERP = Enterprise Resource Planning systems, often modularized information systems that are integrated with the business and accounting system. This market was literally "mushrooming" in the 1990's and early 2000's.

<sup>157</sup> I.e. info quantity increases, e.g. through uncertainties about what causes the failures and what to do about it.

<sup>158</sup> By info quality I mean here the reduced, relevant and digestible information that reaches the decision-maker. In information theory info quality can refer to the valence of the information, i.e. if it is positive or negative and how that affects the receiver. However, in this study I am limiting this discussion to the capacity aspects of information processing.

is causing the problem, or even finding opportunities that will develop the business. Factors that constrain this process could be time available, costs to retrieve the information (for example from the ERP-system, or communicating with customers or potential customers), or even the cognitive limitations of the decision-maker (Comfort *et al.*, 2001)<sup>159</sup>. The crucial factor here is the information processing capacity<sup>160</sup>, which includes the ability to communicate. If this capacity is too low, the information search process will be very limited to the pre-set policies, or personal choice criteria, etc. There is a risk that new data and information will be ignored or denied, which in a resilience perspective will give low information quality.

To increase the capacity to process information, e.g. by improving the staff's ability to communicate and skill to reduce uncertainty, the information retrieval will result in better information quality. Failing to increase this capacity, or worse, to cut it down could create constraints in the Information & Communication-System and the Ability to solve problems, i.e. the incoming information causes "flooding"<sup>161</sup> of information. This "flooding" is experienced as uncertainty, and can lead to rash decisions which temporarily reduces the uncertainty, however can explain some relational problems, for example when the customer questions why a problem still persists (Dörner, 1996, also Deming, 1986).

It could also be lack of information that causes the uncertainty or conflicting information (Dörner, 1996). The reason for this is often that information in supply networks simply is not passed on or shared, due to competitive reasons or that the information is uncertain (i.e. they don't know). That might instead be the time to actively search for information. My point is that people's process capacity cannot be substituted with computerised systems when complexity grows. Both too much and too little information can cause problems, and it requires skills to sift out information or to find new information. Sometimes uncertainties simply can be cleared by good communication. That is when people's ability to communicate and to process information instead has to increase.

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<sup>159</sup> Polesie, 1991, gives an example from a longitudinal study of a transport company ("Helios"), which was a part of a company group. Helios introduced a new computerised accounting system, which generated relevant information about the financial development and their transport flows. However, bad communication within their own company group led to that they did not take action to find alternative uses for their capacity, as their company group in fact was in dissolution.

<sup>160</sup> I am here primarily talking about people's capacity, not the computer system capacity, even though that is highly important as well.

<sup>161</sup> Comparing it to the flooding of a river.

Another way would be to reduce uncertainty is to reduce and manage fluctuations of processes and demand (e.g. Deming, 1986; Stratton and Warburton, 2006).

In the following sections I will describe and discuss the importance of reducing fluctuations, to have protective capacity, and to develop the ability to solve problems.

The improved information quality will increase learning, the ability to handle situations and to solve problems. This will be discussed further in section 9.6.

## 9.4. Reserve capacity gives flexibility

### 9.4.1. Reduction of fluctuations

Variability and uncertainty make predictions difficult (Stratton and Warburton, 2006). Since complexity in itself can be a source for variability and uncertainty, it implicates that reduction in complexity also would reduce variability (Manuj and Mentzer, 2008:213f, referring to Frizelle and Woodcock, 1995), thus improve predictability.

Goldratt, 1990; Stratton and Warburton, 2003, mean that fluctuations are present in all systems. The fluctuations can be internal, stemming from the production process, or external, e.g. from the market demand (Stratton and Warburton 2003). Variability is considered to be “the number one enemy” (Leitch, 2001, p. 172).

Sterman, 2000, means that fluctuations or oscillations are induced in a system due to the following reasons:

“Oscillation requires both that there be time delays in the negative feedbacks regulating the state of a system and that decision makers fail to account for these delays — ignoring the supply line of corrective actions that have been initiated but not yet had their effect.” (p. 663f)<sup>162</sup>

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<sup>162</sup> Negative feedback is the same as correction feedback, i.e. deviation from a desired result (target) or measure and it triggers a corrective action. An example of that is a thermostat, which switches on and off to keep a certain target temperature in a room. However, there are usually delays involved in negative feedback, i.e. it takes time for the system to respond to the corrective action. For example Sterman, 1989b; Dörner, 1996, describe through experimental tests (simulations) that some people, including professional decision makers and academics, fail to account for delays or inertia in systems, therefore rather amplify deviations than diminishing them. The result is oscillations or instability.

According to Sterman, 2000, it is stocks (e.g. inventories) that give systems their behaviour, not the flows. Inventories are stocks or accumulations of some sort, and these give their systems inertia, such as materials, components, modules to be assembled, or finished products waiting for customers. An order backlog is thus a “stock of orders”.

Internal fluctuations can be due to “normal” disruptions, e.g. the breakdown of a machine, set-up time, maintenance, etc, but could also be a consequence of misapplied lean management, removal of time buffers as waste, downsizing with the unintended side-effect of constraining the capability of sensitive processes. Bottlenecks affecting critical processes can also make the system very sensitive to demand fluctuations and disruptions (Stratton and Warburton, 2003).

External fluctuation is usually demand uncertainty or volatility due to variations in demand, market instabilities and business cycles. Difficulties to match supply with demand, as discussed above, often lead to accumulations of inventories and information distortions in the supply network, in other words affect other companies as well (especially bullwhip effects; e.g. Forrester, 1958; Towil, 1996; Lee *et al.*, 1997).

As described above, service supply chains are especially vulnerable to demand volatility (Armistead and Clark, 1994; Akkermans and Vos, 2003; Anderson *et al.*, 2005; Jacobs and Chase, 2008). The reason appears to be that service operations are “pull-systems”, and it is the capacity that is the buffer (Akkermans and Vos, 2003; Anderson *et al.*, 2005), not inventory as in manufacturing networks operating as “push”-systems. This is especially obvious when the service is capacity-constrained, which is normal e.g. for airlines, and hotels (Armistead and Clark, 1994). This could also be the case in goods transport services, when shipping capacity is limited.

Leitch, 2001, points out that variability actually also can increase Work-in-process as well as cause delay (i.e. longer lead-times, totally in agreement with Little’s law). Increased delays, especially in combination with increased uncertainty, would decrease the time available for analysing, reflecting and learning.

### **9.4.2. Capacity buffers**

Sources of process disruptions could e.g. be due to poor maintenance, skill and quality problems in production, or accidents (e.g. Peck, 2005; Pettit

*et al.*, 2010). So according to the theory of constraints (Goldratt and Fox, 1986) there has to be some reserve capacity, or buffers, in front of the constraint to absorb variations or disruptions in order to protect the flow, i.e. to make the flow smooth and more predictable<sup>163</sup>. Such a system is flexible, i.e. it can change and adjust to normal (random) variations and disruptions (Goldratt and Fox, 1986; Sterman, 2000). This means that a system cannot just be followed up and corrected once, but there has to be continual monitoring and management of the stocks<sup>164</sup>. What is important to remember here, though, is that Goldratt is primarily considering manufacturing companies. As was pointed out above, service companies do not handle inventories, but stocks of orders, which under demand uncertainty acts as buffers. As the order backlog decreases something else has to buffer, and that is the performance capacity (Anderson *et al.*, 2005:229). In goods transport that means the available shipment capacity and people's work hours and skills.

As also pointed out above, capacity in services is usually not possible to increase in a short time, since there are delays in recruiting and training new personnel. It is therefore important to know what demand variability to expect, and to plan staff and needed skills with a longer time horizon (Akkermans and Vos, 2003; Anderson *et al.*, 2005) in order to get less fluctuation in performance quality. Here is where the ability to increase information and communication quality (i.e. ability to reduce uncertainty) is of special importance, which might require reserve capacity.

However, intense competition and complexity sometimes lead to compromises, visible e.g. through quality problems, and throughput unreliability. Local cost optimisation of processes (sub-optimising) and trade-offs still seem to be strong drivers of business development in manufacturing industries, but increasingly also in service industries (Stratton and Warburton, 2006).

The original ("Toyota") lean, did however *not* intend reserve capacity to be considered as "waste", but as a protective buffer. The westernised version of lean ("Fordism"), on the other hand, minimizes capacity margins and uses instead (in manufacturing) level scheduling and finished products' inventories as buffers (Stratton and Warburton, 2003). According to Chase and Apte, 2007, there is also a strong influence and increasing trend from Tay-

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<sup>163</sup> Cf. Schmenner and Swink, 1998, the "theory of Swift, Even Flow".

<sup>164</sup> Cf. Dörner, 1996, discussion on "ballistic" behaviour in decision-making (p. 177ff).



lor's philosophy<sup>165</sup> in service industries, such as health care, fast foods, financial services, and airlines.

However, the cost–quality trade-off is problematic. Ferdows and De Meyer, 1990, show e.g. that it is primarily improvements in 1) quality, 2) dependability, 3) flexibility (there defined as “reaction speed”), in that order, that need to be addressed before cost efficiency should even be considered. This is in line with the original lean thinking based on Deming's and Ohno's work, that the causes for variability have to be removed or minimised, and that will in itself, long-term, lead to better efficiency and lower costs. Just to focus on minimising cost (or maximising profits) through local and short-term productivity gains do not necessarily lead to an improvement in quality, thus value for the customers.

On the contrary, according to Oliva and Sterman, 2010:354:

“It is common for managers at all levels, from supervisors to the CIO, to be told ‘technology is improving, and our shareholders expect double digit net income growth. You have to do more with less.’ The long delays in adjusting service capacity coupled with unpredictable variations in service demand mean an organization must maintain a strategic margin of reserve capacity to avoid the corner cutting, standard erosion, and other behaviors that trigger the death spirals. However, to many senior managers, reserve capacity looks like waste, leading to continual pressure to reduce budgets and headcount. Worse, financial stringency often prevents organizations from undertaking the process improvement initiatives that could lead to genuine improvements in productivity (Repenning and Sterman, 2001, 2002).”

So, the long delays to adjust capacity to fluctuating demand generate inertia in service systems. This is because it requires time to discover deficiencies, to react, to analyse, to assess and reflect over consequences, to decide, to implement. Therefore it is necessary to have some reserve capacity in the systems. Not all decisions done under time-pressure lead to productivity gains. Long-term development sometimes takes monitoring, testing, following up, and reflection before decisions can (or at least should) be made.

### ***9.4.3. Quality protecting zone***

A strategic reserve capacity could thus be described as a “quality protecting zone”. This is what Armistead and Clark, 1994, call the “coping zone”.

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<sup>165</sup> Frederick Taylor, Principles of Scientific Management, 1911 originally (now also available on-line).

Zeithaml, Berry *et al.*, 1996, talk about a “zone of tolerance” but that is seen from the customer’s point of view, the zone between desired and adequate service quality. The Quality Protecting Zone is instead the situation seen from the Transport Provider’s point of view, in a constraints’ perspective. The Quality Protecting Zone is the planned portion, or reserve capacity, which should be allocated for each service (this implies that it is not the same for all services) depending on demand stability, customer sensitivity, competition, etc. The Quality Protecting Zone primary function is thus e.g. to:

- “absorb” difficult-to-foresee demand fluctuations
- deal with (unexpected, random) events, disruptions (as a contingency system)
- perform proactive maintenance (to distinguish from reactive maintenance)
- monitor quality
- keep customer records and follow up
- enable skill and knowledge (i.e. training and learning) to be developed,
- improve and develop processes, and design

For example Ng, Wirtz *et al.*, 1999, found in a study of 36 service companies that reserve capacity can have a strategic purpose in developing and consolidating businesses, e.g. to strengthen customer relationship, and to keep quality up if something unforeseen happens.

Reserve capacity is in other words not waste, but should be used primarily proactively to ensure future throughput and business development by improving capabilities.

So how much can and should the capacity utilization be (i.e. for the service delivery)? For manufacturing companies with highly predictable demand (i.e. with little variability in demand e.g. functional products) the utilization rate can be fairly high, depending on the category of process, as “push” strategies are used<sup>166</sup>. However, services, as mentioned, normally have more

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<sup>166</sup> Sometimes nowadays a combination of “push” and “pull”, or customized strategy where final assembly is postponed as much as possible, see e.g. Lampel and Mintzberg, 1996; Harrison and van Hoek, 2008; Simchi-Levi *et al.*, 2008.

volatile demand than manufacturing and "pull" logic. Jacobs and Chase, 2008 (p 69), referring to Haywood-Farmer & Nollet (1991), mean that approximately 70 % capacity utilization is the optimal ("best operating") in service industries<sup>167</sup>. This figure must of course vary somewhat depending on what type of service it is. Services differ widely in, among others, the degree of direct customer contact the server has, and how standardized it is, see Figure 22. The more person-to-person contact or customization that is required, the more reserve capacity is needed to absorb fluctuations, since unplanned events are likely to occur. Also, the less the staff's skills are, the more reserve capacity is needed. One example could be to give information about a shipment. The length of e.g. phone calls could vary depending on how many questions the customer has, how often they use the service, etc., but also depending on the experience and problem-solving skill of the person answering the call.

	Value added back room	Value added front office
Customized	Front to back room driven	Client interaction driven
Standardized	Operations driven	Customer participation driven
	Customer contact low	Customer contact high

Figure 22: Service categories affect how much reserve capacity is needed. Figure after Armistead and Clark, 1994.

Even in operations-driven transport services (e.g. sending a parcel by postal services) require margins to deal with unforeseen events, and absorb fluctuations in order to keep promised delivery times.

<sup>167</sup> Jacobs and Chase, 2008:54 define "Capacity utilization rate = Capacity used / Best operating level".

Armistead and Clark, 1994, discuss at some length the balancing act between capacity management and quality management, and coping strategies for various kinds of service operations.

## 9.5. Ability to solve problems

Standardization and often also automation are methods used to both improve quality and lower unit costs of products in manufacturing. Effects on services are not always the same, which will be illustrated in this section.

### 9.5.1. Work-pressure

A main finding of the above-mentioned study by Akkermans and Vos, 2003<sup>168</sup>, is the importance of keeping process quality up in order to have workloads in check. Their explanation of that is that higher, extended, workloads have a deteriorating effect on process quality, which leads to more rework (p. 219). This is in line with the above mentioned findings by Oliva, 2001, looking at different types of flexibilities that service firms have, in order to adapt to increasing workloads. Akkermans and Vos, 2003, also found in their case study that as the workloads pass a certain level and backlogs increase, not only do lead-times increase but process quality deteriorates as well (p. 214). They mean that this could be caused by an increasing number of errors, as more orders are processed per time unit<sup>169</sup>, which are added on to the workload. Not only that, they mean that “errors made upstream would cascade down to subsequent process stages” (ibid.).

They also illustrate the danger of heavy automation of service processes. Automation with reduction of staff clearly increased error rates and workloads in the case they studied. The staff’s major role became to correct errors (p. 221). They show by simulations that quality of performance can be affected along the service chain due to amplified workload upstream the service supply chain in so-called bullwhip fashion:

“Automation is a typical example of a two-edged sword in service companies. On the one hand, it increases the productivity of the operational process; on the other hand, automated systems tend to be more vulnerable to errors.

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<sup>168</sup> Services in the telecom industry.

<sup>169</sup> Cf. Time Per Order, (Oliva, 2001; Oliva and Sterman, 2001) discussion on flexibility in responding to work pressure, section 8.4.2. in this thesis.

Automation often results in substantial layoffs of staff. The role of the remaining employees becomes one of error correction. When quality problems arise and error rates double or triple, this smaller group easily becomes flooded with correction work. Subsequently, these errors often cascade throughout the entire supply chain, as we observed in our case company.” (p. 221)

However, they also found that strict quality control is very effective in reducing the negative effects of workload fluctuations (pp. 218, 220-221). Also e.g. Oliva and Sterman, 2001:913, suggest high quality pressure to counteract quality erosion. Monitoring of performance quality is therefore central. However, when negative signs are visible, such as quality problems, it could also, they point out, be a case of underinvestment:

“Underinvestment in service capacity is frequently masked by eroding operating standards, so that servers, their managers, and customers all come to expect mediocre service and justify current performance based on past performance. Because firms monitor and benchmark on each other’s performance, industry norms reinforcing expense control and productivity become increasingly influential in shaping individual firm decisions, and entire industries become locked into a vicious cycle of underinvestment and standard erosion.” (p. 895)

This brings me to the question of problem solving when work-pressure is high and increasing.

A person under increasing stress might at first cope well. However, according to Rudolph and Repenning, 2002 (p. 18), if high work-pressure is extended over a long time, the ability to deal with disruptions and variability will decrease. For a person, increasing stress levels have at first a positive effect on resolving problems or coping, i.e. up to a certain point people improve their performance as shown by Rudolph and Repenning (ibid., pp. 3-4)<sup>170</sup>. However, as work-pressure increases the stress level beyond that, a negative effect of stress triggers, i.e. it counteracts the positive effect (Rudolph and Repenning, 2002; Rudolph, Morrison *et al.*, 2009). As the optimal effect of work-pressure is passed, the system really gets into an unstable state, and the person has now less ability to handle disruptions. With further pressure, or especially higher frequency of disruptions, this goes on until the “tipping

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<sup>170</sup> They analyse among others two airplane accidents: the Tenerife airport disaster in 1977, and the USS Vincennes incident of shooting down a passenger plane by mistake in 1988, see literature in Rudolph and Repenning, 2002. These are excellent examples of how many small interruptions of otherwise well-known processes combined with ambiguous information and novel situations under time constraints can cause a breakdown with disastrous effects.

point” is reached, over which the system can even be pushed into collapse or disaster by very small events (Rudolph and Repenning, 2002). As utilization of the system capacity increases, the tipping point will come earlier (Rudolph and Repenning, 2002) since there is less (or no) reserve capacity to absorb disruptions and variability. They show by simulation, that, under stress, as disruption frequency grows in quantity, it is increasingly difficult to deal with variability (pp. 4, 21), in other words it is harder to cope and solve problems under such circumstances, which in turn can lead e.g. to increased error rate or postponed disruption handling, and in fact lower performance than expected (pp. 22-23).

The tipping point phenomenon describes the sudden loss of resilience as a system is pushed near or over its constraint; there is in fact a limit that cannot be transgressed without collapsing the whole system (p. 16).

### **9.5.2. Developing the ability to solve problems**

From the above description it is clear that as complexity and pressures on the organization grow, so do the risks for mistakes and failures.

My findings of the studied companies in this thesis also confirm this. In chapter 6, I showed clear negative, constraining effects from various pressures, especially time precision, speed and price, on failure rates, damages, and the Buyers’ satisfaction with performance.

Mistakes, as they occur during the delivery, usually have to be corrected directly as “fast fixes” or else be ignored. The latter obviously is risky and can erode quality.

This is a situation where most of the “problem-solving” is in the short run, error fixing, like “fire-fighting”<sup>171</sup>. That is not what Deming and Goldratt mean by problem solving. They mean solving the root cause of the problem, in other words the systemic cause (Deming, 1986; Goldratt, 1990). Womack and Jones, 2005, highlight the problem that lean production has not meant the same improvement in customer service as in manufacturing, and they want to extend the lean concept to include the customer’s perspective. Their six “principles of lean consumption” are:

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<sup>171</sup> Cf. Repenning, Goncalves *et al.*, 2001, who discuss this phenomena in product development. Fire fighting can obviously be present in any kind of operation where disturbances have to be dealt with.

- “1. Solve the customer’s problem completely by insuring that all the goods and services work, and work together.
2. Don’t waste the customer’s time.
3. Provide exactly what the customer wants.
4. Provide what’s wanted exactly where it’s wanted.
5. Provide what’s wanted where it’s wanted exactly when it’s wanted.
6. Continually aggregate solutions to reduce the customer’s time and hassle.”  
(p. 61)

The idea is to increase the value of service to customers by reducing problems and hassle. Sometimes, however, companies’ automating or standardizing of services lead to more time wasting for the customers. What at first seems like a good idea because it increases productivity, does not really at all solve the *customer’s* problem, but rather makes it worse<sup>172</sup>. Therefore they suggest:

“Rather than assigning the least knowledgeable personnel to deal repetitively (but “efficiently”) with the same customer problems, a lean provider deploys highly trained personnel who not only solve the customer’s specific problem but also identify its systemic source. Management can then put permanent fixes in place, integrating the various elements of the solution, so that consumers no longer need to complain.” (p. 61)

Deming’s (1986:315) estimation that most causes for faults, mistakes, accidents was with the system (“common causes”, meaning management responsibility). However, he meant that in most cases it is still the individual who gets the blame for the failure.

Highly trained personnel do not occur from anywhere, and it is not static. Since the scene changes with time, not the least due to competition, training and process development have to be continual. But what happens when the competitive pressures increase?

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<sup>172</sup> Womack and Jones, 2005:62, give a good example of this in how the company Fujitsu Services helped the airline BMI (previously BMI British Midlands) to improve their customer service and technical support helpdesk. Since the complaint volume for BMI at the time was high and caused serious problems with the operations, such as planes being delayed for take-off, missing their time-slots, etc., it affected BMI financially. By applying a problem-solving approach rather than a “help-desk-management-approach”, Fujitsu Services analysed and removed the root causes of the high failure rate complaints and costs connected to that which could be reduced drastically. The corollary of this is that even though Fujitsu Services reduced their potential revenues (they were paid per call), they made their service more valuable to the customer by improving the quality of their services, and on top of that cutting their customer’s costs.

The question is if the focus on “Fordism”, also in the service sector, leads to this kind of capability building? Hines *et al.*, 2004, say that value for the customer used to mean “cost reduction” or cutting out waste. The value concept has in recent years developed to also include increasing the value by adding features or service, e.g. “shorter delivery cycle or smaller delivery batches” (p 997), like the “principles of lean consumption” quoted above. This is also what has happened in the goods transport industry, since transport has been deregulated, especially road and air transport. However, the high failure rates found in this research indicate constraints in the system.

To build ability to solve problems, allocation of resources (especially time) may be necessary as pointed out above, see Figure 23. This could affect the policies (hopefully in a positive way). Policies affect the performance, both the throughput and the quality. When performance is competitive and generates enough financial resources, these can be allocated to building Ability to solve problems, which also leads to learning and is necessary for future capabilities. However, Ability to solve problems is dependent on insight, which usually is dependent on some kind of transmission of experience and knowledge, e.g. dialogue, i.e. communication, experimenting, and reflection (Senge, 1990; de Geus, 1997).

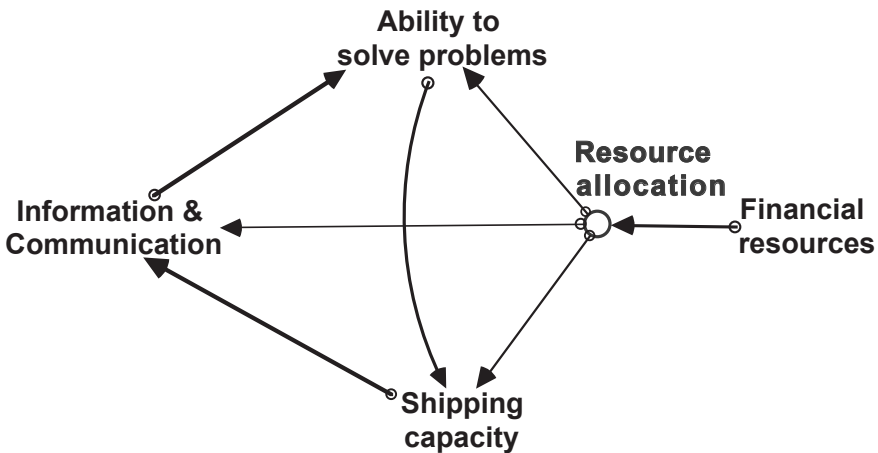


Figure 23: Part of the capability model in Figure 19. Resource allocation (especially time for reflection) is necessary to develop abilities to solve problems.



## 9.6. Resilience in the long term

The discussion so far has been about the nature of quality and efficiency problems: bad synchronization of information, variability and constraints. Disruptions and problems can be dealt with short-term as they occur by a contingency system. For recurring problems, this can also be done long-term by finding and removing the root cause, such as process or policy problems.

To survive in a highly competitive situation or to create sustainability a company needs to be *adaptable* to change. Adaptability is the ability a company has to respond and recover from disturbances, and alignment to long-term changes, which also could include dealing with opportunities (Ponomarov and Holcomb, 2009; Pettit *et al.*, 2010), and this presupposes some kind of flexibility. There is also a short-term fluctuation from day-to-day, as well as season-to-season, e.g. it tends to be less transport of certain industrial goods in the summer holiday period, and more before Christmas. Transport Providers cannot design their capacity based on the maximum demand over the business cycle, but that level will be e.g. at the average demand of a certain period. At the same time, in a, (relatively speaking) fairly low-margin industry like goods transport it is vital

- a) to have a high load factor, i.e. to use the capacity as much as possible, and
- b) not to lose market shares, i.e. to lose business because there is not the available capacity to serve when customers need extra service.

There is obviously a trade-off here that has to be addressed.

An increasing demand from a customer can be dealt with short-term by letting the personnel increase work-intensity, i.e. by doing overtime. However, if increasing activity is persistent, it might not be possible for the Transport Provider to cope with the growing work-volumes without increasing service capacity, i.e. employing more people, and /or to get more vehicles and load-carriers in operation. Adaptability is then more a long-term alignment or adjustment as a response to increased work-pressure, and is thus very much dependent on available network and market information. However, in services a quick response in handling situations when things go wrong is particularly important even in the short term since that affects quality perceptions and overall customer satisfaction (Armistead and Clark, 1994:9).

Arie de Geus, who was a coordinator of the planning for the Royal Dutch / Shell Group in the early 1980's, relates how they studied 27 companies older than their own company to see if they could find explaining factors for their success to survive that long (de Geus, 1997). The findings were summarised in four key factors in common with the studied companies (p. 6 ff.). They were:

sensitive to their environment

cohesive with a strong sense of identity

tolerant to the point of "decentralization"

conservative in financing

Sensitivity to the environment is the company's ability to learn and adapt. Cohesion and identity are intertwined, according to de Geus, which, among other things, means for people to have overview and to understand their own system. Tolerance is a measure of openness in the system and ability to build constructive relationships with other entities. By conservative financing de Geus meant an organization's ability to control its own growth and development.

Polesie's empirically based study of 18 companies, had the focus on organizational identity (Polesie, 1991). He discussed in depth its interaction with the companies' financial situation, and how this influenced their strategies. Identity in Polesie's work is related to what de Geus referred to as connected to cohesion. However, it is not the purpose here to analyse the differences.

Tengblad *et al.*, forthcoming, also use a number of longitudinal company studies. They discuss resilience based on a resource-based model of economic, technical, and social perspectives. Technical resources they explain as products, production, and logistics, all resources necessary for producing products and services including "know-how". They explain social resources as trust-based relations to owners, customers, employees, and external relations.

The risk perspective is important as interdependencies grow in complex networks. This perspective is included by Ponomarov and Holcomb, 2009, in an even broader attempt to develop a conceptual model from various research perspectives mentioned above, and from emergency management. Emergency management is an interdisciplinary field that uses knowledge from both physical and social sciences, and deals with risks, disruptions, and

recovery at different levels, and in a very direct way (p. 130). In a business context, that is dealt with in risk management (*ibid*).

Ponomarov and Holcomb, 2009, describe resilience in three successive phases: readiness, responsiveness, and recovery. Readiness means some kind of alertness for disturbing events, in order to reduce risks in supply networks. This is not talking about planning but more different scenarios, since disturbances cannot always be predicted. Responsiveness is to have the response capacity (e.g. flexibility, information sharing) to deal with a problem when something unforeseen happens. Recovery is the “repairing” after a disruption, i.e. the ability of restoring or “fixing” the problem.

Resilience is important in supply chain risk management, especially in times of uncertainty (Ponomarov and Holcomb, 2009). From a resource-based view, resilience development is proposed to be linked to capabilities, which are coordinated by dynamically integrated logistics capabilities, and some important psychological principles that are also necessary in order to enable the flexibility and responsiveness<sup>173</sup>: control, coherence, and connectedness (Reich, 2006). Principles and logistical capabilities like that are described to be present in emergency situations like natural and man-made disasters (Reich, 2006; Ponomarov and Holcomb, 2009):

Control is to follow up, to be in charge of the situation, and to make necessary correcting for e.g. efficiency and to keep quality up (Ponomarov and Holcomb, 2009:135-136).

Coherence is “the drive to know, the desire to remove uncertainty” (Reich, 2006:795), by enhancing meaning, direction and understanding when something happens. It is a deeply embedded need in people to create order and structure. In other words, there has to be some kind of openness and understanding of what the situation is really like, which means there has to be knowledge about how the system works.

Connectedness is the ability “to band together” (*ibid.*) or in a supply network to coordinate and integrate actions effectively between different actors, e.g. to share relevant information, integrate systems, or cooperate. A synonym is “connectivity”, which Pettit *et al.*, 2010, define as “Degree of interdependence and reliance on outside entities” (p. 11), i.e. organizational couplings

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<sup>173</sup> Ponomarov and Holcomb, 2009, point out that such concepts as flexibility, responsiveness, agility, visibility are by some authors considered to be logistical capabilities, whereas others view them as important to resilience (p. 133).

within and outside of the organization. This increases the reliance on information, but also the size of the information flow (e.g. Comfort *et al.*, 2001; Pettit *et al.*, 2010).

Risk mitigation through risk assessment and risk sharing in the supply chain is an important aspect in building resilience (Ponomarov and Holcomb, 2009). Their suggested relationship of these factors is depicted in Figure 24. This model has left out the capabilities since it is beyond my purpose to discuss them here.

In a recession it is usually difficult to perceive the turning points, and if an increased demand is a temporary fluke or if it is the start of an “upturn” in the business cycle. Therefore, it could take companies a long time to decide to begin hiring more labour, and once they have decided it might become more difficult to find the people with the right skills. In that situation, hiring of inexperienced people could result in an even bigger drop in the momentum of aligning to the upsurge of the business cycle, thus also a drop in productivity. It also takes time to train people, and relatively inexperienced people will likely make more mistakes, or will not have the same skill to deal with disruptions and to solve problems, as those experienced ones who possibly were laid off in the downturn of the previous business cycle. So, the signals and the quality of the information from the customers and the market are vital, but the skill from performing problem solving in different situations is especially important in order to sense the shifts on the market. Ellis, Shockley *et al.*, 2011, argue that information uncertainty could have drastic effect on risk assessment.

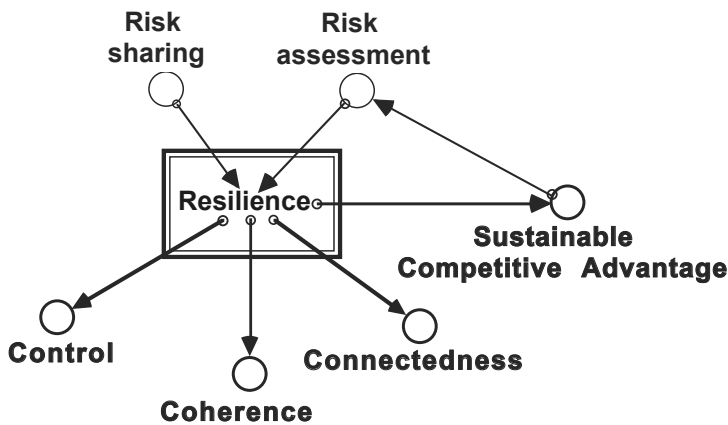


Figure 24: Important principles for resilience development and long-term competitive advantage (acc. to Ponomarov and Holcomb, 2009)

However, if more flexibility and adaptability to disruptions and change is needed to gain competitive advantages, why is so much focus on increasing capacity utilization of production resources, which rather constrains flexibility? That raises the question: What should the resource allocation be between the short-term “quick” fix, or a “contingency approach”, and the long-term process improvement (in this study referred to as “ability to solve problems”)?

### ***9.6.1. Response to increased work-load***

To build capabilities and resilience requires some resource allocation to “reserve capacity”, if the rest of the allocation is for performing the actual work (i.e., in this study, the shipments). However, as shown both empirically and from theory, there are occasionally failures, and they need attention, which is the “Recovery Phase” described above. The recovery action, or rework, can either be a “fast fix”, or it can be a correction of the cause, i.e. process improvement and capability building.

Repenning and Sterman, 2002, address the question of short and long term resource allocation to deal with immediate problems and to develop capabilities. They discuss the “capability trap” problem in a manufacturing process context, but it could also be applicable to service processes.

“The capability trap arises from the interactions between judgmental biases and the physical structure of work processes. For example, machine operators or design engineers facing a shortfall may initially work harder ..., do more rework ..., or focus on throughput ..., all of which reduce the time available for improvement. These responses are tempting because they yield immediate gains, while their costs are distant in time and space, uncertain, and hard to detect. But, while throughput improves in the short run, the reduction in time dedicated to learning causes process capability to decline. Eventually, workers find themselves again falling short of their throughput target, forcing a further shift toward working and away from improving. Instead of making up for the improvement activity they skipped earlier, their own past actions, by causing the reinvestment loops ... to work as vicious cycles, trap them in a downward spiral of eroding process capability, increasing work hours, and less and less time for improvement.” (p. 282)

It is a matter of two contrasting ways of response. Repenning and Sterman, 2001, call these “Work harder” and “Work smarter” respectively.

The “Work harder” policy means that almost all time is focused on the throughput (and fast fixes of the errors). At first, this actually increases the yield considerably, but then after a while productivity falls, a “better-before-worse” situation (p. 73). The reason for that is that since maintenance and improvement activities are cut back, capability eventually gradually erodes, however that affects output long-term (ibid). Why? Because high workloads and /or highly standardized or automated tasks make people perform without really understanding how the system works. So when errors occur, it might not be obvious what is causing them or how to get rid of them more than temporarily. And eventually, neglected or procrastinated maintenance starts causing problems, such as equipment break down or give disturbances.

Time is then allocated from building capability to take care of the increasing number of errors. The increasing errors also push the total workload up. If maintenance is only done when there is an emergency or absolute necessity (not shown), it increases disruptions even more (also the number of fast fixes), and costs. However, customers also eventually start noticing the increased failure rates, and above all, the increased lead-times for service, so they cancel some of their orders. This leads to less revenue. Less revenue and increasing costs means fewer resources, which means that allocation to do the work has to increase even more.

For the “Work smarter” policy it is the opposite, a “worse-before-better” situation (Repenning and Sterman, 2002). The investment in maintenance, process improvement, and skill building take some time, but eventually that will have an increasing effect on output. Total workload will then decrease. Why? Because of the learning and the increased skill-level, the performance will have less mistakes, and be faster, since people understand better how the system works, and can take better corrective actions. Or when it comes to proactive maintenance: machines and equipment will be more reliable than if service is performed only when they break down. And most importantly: Long-term capabilities will increase since time is allocated for that purpose.

### ***9.6.2. A resilience and constraints framework***

I have so far discussed constraints from a negative point of view, i.e. those constraints that cause unwanted bottlenecks, blockings. The reason for that has been to find a way to explain the opposite, i.e. how “good” constraints are linked to the development of long-term resilience in an organization. This will also be an explanation of my research question:

In what way does high capacity utilization affect the development of long-term resilience and competitive advantage of a service company?

In this section, I will develop a conceptual framework of the constraints – resilience relationship primarily based on the five grouped factors (described in section 5.3; they are also modelled in chapter 7).

As described in section 9.6, the three psychological principles are considered to be a requisite for the development of resilience in diverse situations, so also in the context of supply chains (Ponomarov and Holcomb, 2009). My assumption is (as these concepts have been described above) that connectedness has to do with communication and information sharing, in other words, with the relationships and interdependencies in the supply network.

The coherence phase has to do with the “sense making”, to reduce uncertainty<sup>174</sup>. A decision maker must have knowledge based on relevant information about the situation before he can understand what is best to decide. Since the future can bring surprises, to create readiness there should be optional plans, for example what can be described as “scenario planning” (de Geus, 1997). These steps, more or less explicit, are a part of the information retrieval and processing for the decision and the action stage. The decision might mean to correct some previous beliefs, make necessary adjustments<sup>175</sup>, synchronize, assess quality, bottlenecks, etc. This then leads to what is called the Control phase, the action stage when the actual performance or work takes place. More communication with other actors in the chain (Connectedness phase) might have to take place before performance is carried out, and so on. This will complete a “cognitive circle”, which really describes the learning and adaption in the different phases of building resilience. This conceptualization is illustrated in Figure 25.

Connectedness represents the inter-organizational complexity, the network, the relationships, the cooperation, and the information retrieval. A reason for increasing interconnectedness is to improve availability and efficiency by sharing resources in business relationships and, according to the resource-based view, could also be to achieve competitive advantages by novel or unique combinations of resources. But maybe the overriding reasons are to increase stability (improve “predictability”) and efficiency in resource use (economy of scale).

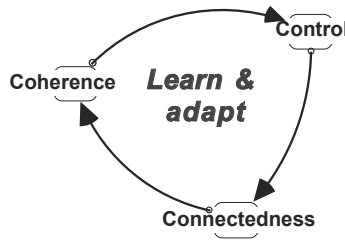
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<sup>174</sup> Compare the Enactment model by Weick, 1995.

<sup>175</sup> To avoid “ballistic behaviour”, see Dörner, 1996:177ff.

**Develop ability to solve problems:**

- *reduce uncertainty*
- *identify errors*
- *increase understanding*
- *increase knowledge*



**Take action:**

- *find direction*
- *coordinate*
- *follow up, correct*
- *quality & efficiency*

**Cooperate:**

- *relationships, network,*
- *information, communication*
- *stability*

Figure 25: The psychological principles in resilience building

But networks need coordinating, and to be continually followed up and assessed. However, this starts with control, ambitions and plans made to achieve cooperation or have some kind of partnership in the enterprise with another company (i.e. to create constraints that benefit both parties). So increasing planning, risk assessments, and coordinating, etc. should forego the connectedness. In other words, increasing control is proposed to increase connectedness. On the other hand growing connectedness increases complexity, which in itself decreases control. As connectedness changes, the effect on production resources will be a change in the same direction for shipping capacity, and thus for performance. In other words, growing network is suggested to increase the shipping capacity, which in turn will have an increasing effect on performance.

However, as discussed in section 9.6.1., there can be unplanned disruptions, or process defects that can cause problems (deliveries can for example not be on time, there could be damages, or goods missing), thus the above described effects might not come about as planned. For example, increasing connectedness might contain a delay before shipping capacity increases. A lot of rework (“fast fixes”) might also slow down performance.

Increasing connectedness also means more information as complexity increases (e.g. Forrester, 1994; Comfort *et al.*, 2001). More information should mean increasing coherence, better overview, and knowledge, but that is only if the information is transparent, comprehensive, condensed, and without ambiguity, i.e. if the information quality also increases. As described above, connectedness is really “to band together”. If there is, for some reason, network building with lower levels of “banding together,” the “cognitive



cycle” described above is also affected negatively. The result is, I propose, an increase in uncertainties due to too little relevant information (however a lot of irrelevant), too much ambiguous information, or bad synchronisation of the information (not enough communication, as if there are different agendas, not enough “banding”).

Therefore it takes more processing and assessment of information, which might require the receiver of the information to communicate with the sender. The receiver might also need additional information. My point is that it takes skilled “information processing capabilities”, probably also more capacity, to reduce the uncertainty and distortions in the information, so it will be understandable and useful. But, above all, it takes time, since there is inertia built into these processes. Figure 26 below depicts the process. If work pressure gets very high, it obviously will affect the information processing and communication negatively (indicated by “o“, change in opposite direction, at the arrowheads going to “Reduce uncertainty” and “Ability to solve problems”). Also if e.g. “Information process capability” is allocated less capacity uncertainty will increase, since reduction also will decrease (“s” at arrowhead to “reduce uncertainty”).

If there is a bottleneck between the source and the receiver of the information, it will affect the quality of the information, thus Ability to solve problems and everything that comes after it (according to the theory of constraints). The process of reducing uncertainties is thus crucial for the decision quality and how e.g. risk assessment is being done. Ellis *et al.*, 2011, point this out and suggest that when ambiguity or uncertainty level is low, then individuals may take precautions if they can clearly relate an event to a known underlying risk pattern. However, when ambiguity level is high, then enactment precedes perception of the risk (i.e. trial-and-error behaviour<sup>176</sup>), but might only become apparent much later on when problems occur (ibid. p. 91).

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<sup>176</sup> That is, risk is not perceived at all since the decision maker does not have, or ignores, the available information. Cf. the discussion above in section 9.3.3.

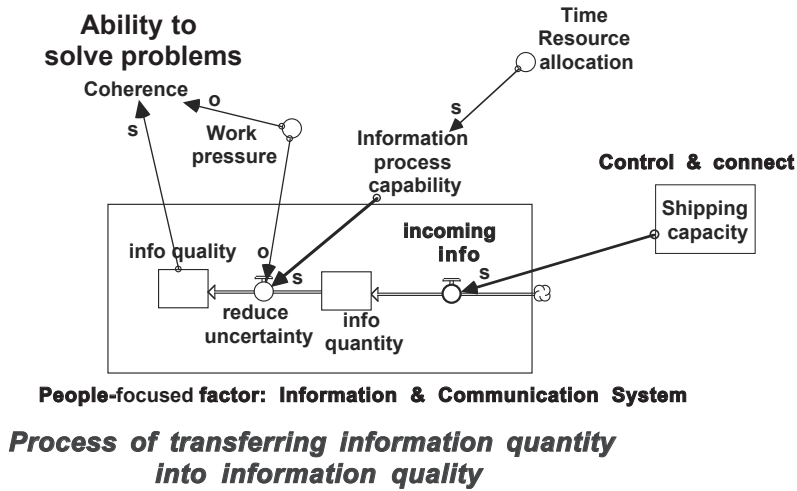


Figure 26: The process of reducing uncertainty (the process goes from right to left). Large quantities of incoming information are processed so it can be understood and contribute to knowledge increase.

The quality of the information (i.e. what level of uncertainty there is in the information) in other words affects the Ability to solve problems and make decisions. The decision maker’s understanding (knowledge level) affects how resources (capacity) are going to be allocated in an organization. The allocation of capacity to work (performance), capability building, or maintenance decides the constraints, i.e. what the limitations are. This is shown in for example how much time (resources) can be spent on training skills, improving processes, or maintaining equipment. Figure 27 below is a conceptual explanation of the structural relationships between the resource allocation decision (i.e. the constraints), the information retrieval, and the resilience formation. The point numbers in the headings below refer to the numbers in the model.

### Create stability and efficiency: Point 1 in model

Creating stability and efficiency is what I described above with control and connectedness. In this model they are shown as one variable (“Control & connect”). This is the interaction between control and connectedness to build up network resources to enable better predictability, and to use resources efficiently. As Control & connect changes, there will be a change in the same direction (“s” at the arrowhead) in performance, however with a delay due to inertia. However, as mentioned above, increasing connectivity

also increases complexity, thereby risk exposure and the quantity of information. This could also be the case during performance if interruptions occur.

### **Reduce uncertainty: Point 2 in model**

To reduce uncertainty is therefore necessary if effective problem solving is going to be possible. This is part of the Coherence stage, i.e. when understanding and insight is increased. To process large quantities of information, good information processing capabilities are necessary. The uncertainty reduction process was described and illustrated above in Figure 26. As these capabilities increase, coherence also increases (change in the same direction, “s”), since uncertainty is reduced.

### **Learn and adapt: Point 3 in model**

Learn & adapt is the outcome if coherence actually increases. If, for example, failures are detected and analysed, corrections can be made (adaptions). The better the information quality is, the more likely it is that knowledge levels increase.

### **Correct deviations to standards: Point 4 in model**

This is a pivotal point: correct deviations (gaps) to standards. Guiding ethical principles and operative quality standards, in themselves constraints, influence the overall constraints, i.e. the conditions and resource limits, allowing a quality-protecting zone (see section 9.4.3.). These standards direct or “guide” the decisions and actions, i.e. deviations can be assessed to keep within the constraints, which saves resources. To know the constraints decreases the adjustments (the resource allocation). This lessens the risk that unwanted constraints, i.e. bottlenecks, form in the on-going or the future operations (i.e. forming of capabilities and resilience).

However, if the quality standards are missing, there is no guide for e.g. capacity utilization, as discussed above.

Also, if the uncertainty level is high (e.g. a lot of complex, ambiguous information) the capacity allocation might result in bottlenecks, simply because the decision-maker does not have a clear picture of the situation, and corrections counteract or transgress the guiding constraints (knowingly or unknowingly). As discussed in section 9.6.1, if e.g. the backlog of orders is increasing, management could allocate more resources to “Work”, but cut down on “capabilities,” since there is not enough manpower available, eventually erosion of capabilities and skills will affect performance negatively (changes in the same direction, “s”).

### Generate resources: Point 5 in model

Generate resources: What resources are available to be allocated is, in the end, dependent on what performance has generated, here called “Finance” (money). Changes in finance affect the resources to be allocated (in absolute terms) in the same direction, “s”.

### Build resilience: Point 6 in model

The building of resilience is long-term. It depends on capabilities. However, according to e.g. Gunderson, 2000; Holling, 2001, there is also a negative influence (i.e. a constraint) of increasing Connectedness on resilience building (due to, among others, standardization and economy-of-scale). As “Control & connect” (and complexity) grows, resilience therefore decreases (change in the opposite direction, “o”).

Lean (“Fordism”) has a strong focus on area 1. “Control & connect”, with heavy emphasis on standardisation and simplification to increase predictability. This has thus a negative effect on the forming of resilience, since resilience requires flexibility. Lean has on the other hand high robustness (high resistance) to keep variability in the processes low, and to enable high capacity use (since “idle” capacity is considered waste). However, when it comes to dealing with complex problems lean is not well equipped, since that requires diversity according to the law of requisite variety (see below).

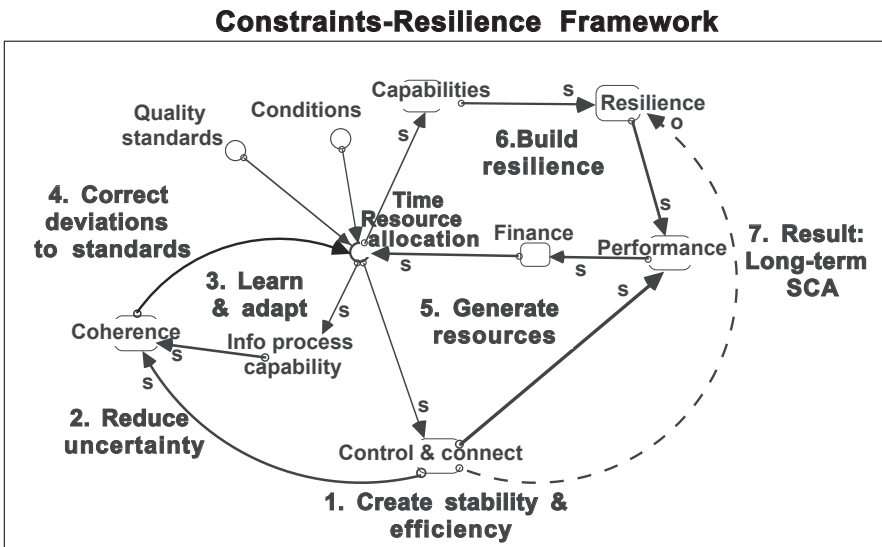


Figure 27: Conceptual model explaining the relationship between information retrieval, constraints, and resilience. Arrows show proposed influences.

## Long-term competitive advantage: Point 7 in model

The long-term result of increasing resilience is shown in Figure 27 above as the effects of resilience on performance (change in the same direction, “s”). With the same logic, a decrease in resilience lowers the performance, and generates less financial resources. Here is the “catch-22” of less resource allocation to capabilities making sense: More utilization of the staff’s capacity to “Work”, lowers the time allocation to capability building, which lowers the resilience, which lowers the performance, which lowers the revenues (and increases costs), which puts the pressure on management to cut costs, e.g. by cutting down capability building, and utilizing staff capacity more to work (overtime, etc.). If e.g. the “information process capability” gets less capacity (more computers, however less human resources to do “uncertainty reduction”), increased uncertainty is likely to result, thereby more “risky” decisions. Disruptions or unexpected events can be very costly<sup>177</sup>.

### 9.6.3. *The principle of requisite variety*

As implied under point 6 above, this model also accommodates another crucial principle of building resilience: diversity or “requisite variety” (Ashby, 2011 (1968)). This principle is based on the observation that the variety of a disturbance can only be dealt with by at least the same variety in the problem-solving, i.e. only “variety can destroy variety” (p. 207). That means that problems in complex environments always require complex solutions<sup>178</sup>.

Ashby, 2011 (1968), pp. 202ff., points out that constraints are all around us. They are very important so we can get some kind of direction, and that things can be done efficiently, as also shown in my conceptual framework model. Without these constraints things will appear chaotic (ibid). This is included in the “coherence” concept in the model, in other words the ability to solve problems is based on understanding the constraints (the conditions, the limitations), and to have good knowledge of the operations, customers’ satisfaction and opinions, and e.g. market and societal development.

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<sup>177</sup> An example of this is BP’s and Deepwater Horizon’s oil drilling failure in the Mexican Gulf 2010 which lead to an oil catastrophe, due to e.g. a lot of ambiguous information, unclear communication, misunderstandings, low capabilities, low resilience, high connectedness, complexity and high time pressure, see Oudhuis and Tengblad, forthcoming.

<sup>178</sup> Illustrations of this is given by Edström, with examples from the Swedish textile industry (examples like the companies Algots and JC), Tengblad, consumer electronics wholesalers (example of Circuit City and OnOff), and Andersson, a supplier in the vehicle industry (all in Tengblad *et al.*, forthcoming).

The problem seems to arise when the operation becomes too complex, then communication and information processing have to increase, and overview becomes very difficult, especially if this is not matched with increasing capacity and / or requisite variety to deal with it. That is when the humanly induced mistakes or the “bottlenecks” are likely, and these decrease, rather than increase, overall productivity, and throughput.

The corollary of this is that there is a point in the growth (complexity) of operations, above which the operation will be “too big” and cause bottlenecks in information retrieval, communication, and problems-solving ability. Such harmful bottlenecks cannot be tackled unless both the capacity and “requisite variety” will match this increased complexity of the task. Requisite variety rests on discernment and good judgment of contexts.

PART 4  
Conclusions





## 10. Conclusions

### 10.1. Reflections

Increased complexity in the operation, coupled with higher time pressure and restrictions, such as narrower time windows, naturally make transport planning and capacity allocation more challenging. If at the same time lean principles are applied, machines and equipment must be used more efficiently, e.g. more hours per week, that is utilize the capacity (number of vehicles, staff, etc.) more.

Since the studied period was also in an upsurge of a business cycle (Konjunkturbarometern, 2004) obviously the increased demand situation must have exerted extra pressure on some transport companies. The staff situation, such as lack of drivers, seems at the time to have been a significant problem. This has also likely been the case with the skills of newly employed staff.

The data from the surveys indicate above all that there are constraining problems with communication, information, and skill or handling, and on-time delivery. But traces of time pressure are not only visible in the survey statistics.

“Balancing” problems as Ahldén mentioned (Ahldén, 2011) from a Transport Provider perspective, can obviously partly be a consequence of too short notification time. As I showed in Table 3 (section 4.6.) the customers’ notification time is often very short, e.g. on average 6-18 hours before delivery for B&C wholesalers, but in some industries it can be as short as 2 hours, and seldom more than a day. This leaves very little time for planning, and, if necessary, to find return freight. That operative planning can be under time pressure was exemplified above (Lundberg, 2001).

The findings from the survey of the Buyers’ horizon were supported by the cases BRIGHT, MACH, BUILD, and HARDWARE (see chapter 6). They experienced slow feedback or none at all from their main Transport Providers, and even uncertain information. It is apparent that bad communication is also possible within the transport chain. At least the first two are examples of quality standard erosion, which indicates that the matching problems could go a bit deeper.

As examples of observed resilience, BRIGHT’s comment can be noted that, in their experience, smaller transport companies had more flexibility and

better performance than the larger. Also Ahldén's (2011) comment of the development in recent years for smaller actors supports that.

Furthermore the interviews showed that some Transport Providers do give feedback about delivery precision, though they seem to have different methods in measuring. However most of those transport buying companies<sup>179</sup> did not measure transport precision systematically, but got indications of delivery failures from their customers' complaints (Saxin, 2002a). This underlines the importance of Buyers having good communication with their Transport Providers.

## 10.2. Synthesis

### ***Bottlenecks***

Findings in the data showed that error rates can be high in certain industries. In some cases increases are correlated to high time pressures.

There are also clear indications of bottlenecks in the factors Ability to solve problems, Information & Communication Systems, On-time delivery, and sometimes Shipping Capacity. This was summarized in Table 6 (section 6.3). The findings are more pronounced in some industries than others. From this can be concluded that there is a significant discrepancy between the quality pressure of the Buyers and the performance of the Transport Providers, and this can be explained by e.g. a lack of capacity, or possibly synchronization problem, or both, in other words, some kind of bottleneck or inertia. Inertia can e.g. increase due to increasing sizes of network and complexity.

### ***Information and communication bottlenecks***

The main conclusion from the findings is that it is primarily the problem-solving ability, probably in combination with unsatisfactory availability of relevant information and / or communication that lies behind many performance problems. This indicates a "blockage" or constraint in the information or communication flow to the decision-makers and reveals that there is a lack in understanding of how the system operates or functions, or possibly a lack of time.

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<sup>179</sup> Buyers, n=20, medium- or large sized companies.

The unsatisfactory ability to solve problems could in fact be explained by low information quality on which to base the decisions. This could be the case when there e.g. is:

- lack of relevant information, which could include uncertain, ambiguous, or distorted information due to the fluctuations in processes and especially the demand (e.g. “bullwhip-effects”),
- sufficient information, which however is fractioned and spread out, and time / resource consuming to retrieve or synthesize,
- too much information, which, with lack of time, is not possible to process.

Considering that the Buyers themselves generally assessed the Information & Communication Systems as “better than needed”, it seems more likely that there is too much information available, but too little time to retrieve it, to reflect on and interpret it effectively.

High time pressure can cause cognitive bottlenecks when there is too little time to take in the information, or to evaluate it. Reflection is usually necessary to turn data and information into useful knowledge.

Communication problems can also be relational, depending on reliability and trust, past performance, communication pattern or even communication system. Many customer problems can easily be solved by personal communication instead of letting the customers find out themselves.

It could also be a case of not enough “requisite variety” to solve the problems, in other words that organizations have become so complex but production resources so lean that the sheer volume of information is too overwhelming to (cognitively) process. In other words, there are cognitive bottlenecks for one reason or other (policy, lack of time, lack of knowledge, lack of skill, or lack of motivation).

## ***Understanding the system***

According to a resource-based view it is the combination of resources that makes the product or service more or less valuable. That, however, often presupposes that the companies already have well-developed capabilities. But is that always the case? In this study I have looked at how the resources are used in the sense of high utilization of capacity (i.e. in a constrained state of the

resource), how that can affect the quality of the performance (therefore also the value according to the resource-based view), and above all the development of long-term resilience.

Thus an overall conclusion of this study is that it is not only the combination of resources, but also the understanding of how the system operates, the logistics of the system, the demands, the delays in the processes, the synchronization of information and the allocation of resources between short- and long-term production supportive activities that are crucial, in order to improve its capability.

## ***Resilience***

To process large information flows takes special skill to retrieve and analyse information and to reduce possible uncertainties. Decisions and problem solving are dependent on reliable information, otherwise the risk is increasing that there will be more disruptions and problems in the delivery process.

Some smaller disruptions, which can be foreseen or expected, can be taken care of by decision-rules and routines. That is the “resistance” of the system, the pre-planned contingency system, which is meant to give the system robustness. This is the technical control applied by tools, such as “six sigma quality” in lean, to handle fluctuations in the process, in themselves good methods. However, not all disruptions can be foreseen and be covered by pre-planned routines and control. Furthermore, when less frequent disturbances occur they can have a big impact. Also with high uncertainty levels in the information, then the importance of resilience increases. That is when people have to use their own judgments and capabilities to deal with the situation so that damage of the situation will be minimised.

Three principles necessary for resilience forming have been discussed above: connectedness, coherence, and control. These were described as psychological principles necessary especially when uncertainty is high. There was also a fourth principle of resilience identified: requisite variety or diversity.

These principles supporting resilience building are:

- **Connectedness:** The ability to “Band together” in order to create transparency, better communication, relationship, and thus better information quality, which favours trust, stability, quality and efficiency.

- **Coherence:** The ability to provide order and structure, to reduce uncertainty in order to create more understanding and knowledge of the situation or the system, which will increase the ability to solve problems.
- **Control:** The ability to take action, to have a direction, to coordinate, follow up, to regulate, and to make adjustments. This is a part of carrying out commitments and to show reliability.
- **Diversity:** Requisite variety in problem solving, not “one size fits all”. The more connectedness grows, the more diversity is also needed as problems and disruptions get more complex. This also means that the capability of discernment (i.e. to distinguish information), and judgment has to match.

These principles are important in the adapting and learning process in keeping up quality in the performance, but also in dealing with change, and to create the necessary resources for long-term capability building.

## ***Quality Protecting Zone***

Another conclusion is that reserve capacity is even more important for services than for inventory chains. It is especially critical to understand the delicate balance between high capacity utilization and service quality. Reserve capacity, or a quality-protecting zone, is an important aspect in forming resilience in service operations.

The reason is that manufacturers with planned production apply push strategy, i.e. products are made in advance (make-to-stock), whereas services apply pull strategy (demand-driven, i.e. the customer waits for the service, perform-to-order situation). A service operation therefore cannot be buffered by inventories like in product chains, but only by the backlog of orders (queues) and that can only be regulated by the service capacity (usually meaning people). Services furthermore have comparatively volatile demands, and, generally speaking, disruptions are more likely, the more the service is customized.

## ***Reserve capacity is essential***

Another conclusion is therefore also that reserve capacity is not waste that should be used to increase short-term or local productivity. In fact, I have

shown that with a better resource allocation between production, maintenance, disruption handling, and problem solving, there are long-term potential overall productivity benefits due to the improvement in capabilities. This would also reduce variability, which in turn reduces information uncertainty, another important aspect of resilience.

## 10.3. What have we learned?

### *Theoretical contribution*

There is much to be observed out there. Data is turned into information by being reported back (or observed) by the decision maker. How useful that information is to the decision maker depends on the quality of it, i.e. how truthful or how distorted it is. How do distortions come about? Allison gave three explanations:

1. The decision maker is a rational actor. He thinks he has all the information available, and carefully selects the optimal solution. In reality there is very little or narrow search for information or for lasting solutions to problems, and for example simple and linear models weigh more than real observations and evidence. (If the map is wrong, change the world to fit it.)
2. The real decision maker is a bounded rational actor. He is overwhelmed by all the ambiguity and uncertainty in available information, and there is simply not enough time to look into or analyse everything. Organizational policy and routines really is what determines how to solve problems. Therefore most new information is ignored, including warning signals in disturbances. It is BAU (“Business as usual”).
3. The negotiation game. The real decision maker is the leader of the company or group, either directly (sometimes with very little updating of the real situation), or as a result of negotiation with trade-offs not based on reality but on “politics”, dependence, power, local monopoly, saving face, opportunism, position, or feelings. This could e.g. mean that the Transport Provider (the forwarder) has promised the Transport Buyer a certain service level that is not really possible to deliver (by the haulier, because the forwarder’s planning is too optimistic).

Another explanation of perceived distortion of information could be misperception of the information due to delays, inertia, or multiple information feedbacks (e.g. Sterman, 1989a), or the data is not compatible. Information like this is not easy to “simulate” in the head, but usually needs to be first analysed then possibly computer simulated and tested for different scenarios.

Another conceivable explanation is that the decision maker is informed with distorted information from the source, i.e. information that knowingly or unknowingly is simply misleading.

The conceptual framework constructed above (see section 9.6.2, Figure 27) is an attempt to operationalize the processes and structure that explains why resilience forms or erodes, and how that is important for a company’s long-term development and survival. The model also shows the link from constraints to resilience, and the road goes via the resource allocation, and the capabilities.

Out of this crystallizes the insight that constraints have a short-term perspective<sup>180</sup>, whereas resilience has a long-term. They are interdependent. But increasing capabilities to retrieve and process information also helps the decision maker in forming or adjusting constraints. How do we know? By the data, e.g. signals of deviations (that cause disruptions or increase risk) from the operations, which are followed up and analysed. Bottlenecks, such as backlogs or queues, are typical signals of e.g. wrong capacity allocation.

Capabilities are the many operative skills and competences that have to be learnt over the years. But it takes the coordinating or “logistical capabilities”, i.e. capability to retrieve relevant information, and turn that into knowledge, and wisdom to implement any changes without causing unintended bottlenecks, compromised quality, etc.

Constraints are the conditions, the limitations or restrictions, and guidelines we have to work within. They focus our attention, and initiates direction (e.g. Ashby, 2011 (1968)). That is how high productivity is achieved long-term.

However, as things change over time, external conditions and pressures usually make adjustments or adaptations necessary. Here is where learning comes in, which in the long term can lead to the forming of resilience. If adjustments are not made there they can form bottlenecks instead, which throttles the flow.

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<sup>180</sup> Observation pointed out by Thomas Polesie in discussing the framework.

Five categories of constraints have been identified from the data:

- Ability to solve problems
- Information & Communication Systems
- On-time delivery
- Shipping capacity
- Financial

The first three of these are “people-focused”, shipping capacity is “technical” or physical, and so is the financial. Bottlenecks were found in all of these to varying degrees in some of the industry groups (see chapter 6).

There is also a recruiting problem, described and discussed above. No doubt, that situation affects the capacity situation, especially the “people”-factors. These are all “capacity” that has to be in place when demand is increasing, and of course there will be bottleneck problems if any of them are missing. However, my discussion showed that behind all these circumstances there are decisions made by people, based on their best judgments. The judgments are based on available information, and much of that comes from monitoring or measuring, but also through communication, signals from customers or from staff, or else perceptions of the Transport Provider’s performance, or possibly eventually through financial problems (which sometimes is too late).

My point is that there is a “ranking” of constraints, based on the theory of constraints, in the sense that the factor nearest the source of information is the most “important”, i.e. the capability factor I labelled “Information & Communication”. This is directly influencing the decision-maker’s / staff’s understanding of the situation, the “Ability to solve problems”, which in turn affects the decision quality and the performance result. If the information retrieval / communication process is suppressed (i.e. constrained), disruptions will be dealt with as “quick fixes”, the action will just follow policy, and routines, or not be done at all.

I pointed out the underlying difference in “push” and “pull” strategy in supply situations. To know the constraints and how to balance capacity utilization and service quality is crucial in many services where queuing is not appreciated. In such a situation “self-organization” is also important. Self-organization is a built-in ability in the learning and adapting process of resil-



ience. The point is that knowing the constraints empowers a person to act efficiently because limits are not transgressed. The problem with unintended constraints (bottlenecks) is that the methods used to overcome them are usually by increasing pressure, coercion, or to pretend they don't exist. That is when the “system fights back” (there will be a “flooding” of the system<sup>181</sup>). Systems are dynamic, not always predictable, but constraints are “warning signals” of potential system instability that should not be ignored<sup>182</sup>.

This underlines the importance that the staff understand the system, its processes, and are continually updated to be able to respond and make necessary adjustments, and to deal with disturbances, get feedback from customers. This also gives more opportunity to detect new trends and needs. Opportunities for development can otherwise be missed when processes get too automated, or too time-trimmed. Rigidity increases, in other words resilience is reduced.

An overall conclusion of all this is that the people factor is the most important, since it affects all the other factors. Effects of the people factor could have a considerable delay though, and this is why it is not at first obvious that a change in the factor hurts the business. The long-term effects of thwarting or constraining the people factor (i.e. the shrinking the reserve capacity of the “Quality Protecting Zone”) will be loss of capabilities, eroding resilience, increasing vulnerability, thus higher risk, thus potential loss of the competitive advantage.

## ***In the knowledge factory***

The proposed conceptual framework (Figure 27, explained in section 9.6.2.) is an extended operationalization of Polesie's resource-based model: People – Objects – Finance. In this thesis this is described with the following dimensions: People-focused, technical, and financial (money) factors. I have shown above that there are interdependencies between these variables (section 9.6).

Input to the People-focused factors is information. As shown above information can contain more or less uncertainty, which has to be reduced if it is going to be turned into new knowledge. The alternative is that the uncertain information is ignored; however then there is the risk that problem solving

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<sup>181</sup> Compare this to the effect of the flooding of a river.

<sup>182</sup> For example to ignore maintaining a system will sooner or later result in more failures, and probably also higher total costs.

and decisions will lead to bottlenecks and other problems. The primary outputs of people-focused factors (over time) are knowledge (if learning takes place), and allocation of resources.

Knowledge, coupled with allocated resources (time), leads to skill development, and competence building, capabilities that strengthen the competitive advantage. So increased capabilities of the personnel increase their capacity (less mistakes, higher quality performance, higher productivity). Better performance and even (non-fluctuating) quality-levels build up reliability- and trust-levels with the customers (and improves reputation, which can attract more business). More trust also leads to better communication with customers. When the customer knows the supplier is reliable, they are more tolerant of the occasional disruption, if the Service Provider communicates. With higher skill levels the personnel are also better equipped to solve problems, they have more response capacity (resilience in difficult disturbances). Better relationship also leads to more transparency in the communication, therefore information will be less uncertain, knowledge formation will lead to even more skill, etc.

Allocation decisions form the constraints. Input in the technical dimension (network, own production equipment, information systems, etc.) is some kind of investment (money, time, etc.). Output is technical production capacity. Technical capacity can also substitute people capacity. This is shown below in Figure 28<sup>183</sup>. Financial input is then only the result of production, and revenues (addition of owner capital will not be considered here). Revenues though, are affected by people capacity and technical capacity. People capacity is work hours and skill (productivity). Technical capacity can be shipment capacity per day e.g. for certain geographical areas. Output will be costs for operations, investments, and profit.

Time / money allocation represents the “constraint generator”. However, also the unintended constraints, the bottlenecks, start here. In complex business situations, the problems start when people-focused resources are cut down or substituted by technology. This is shown by the “o” at the arrow-head (change in the opposite direction, an increase in technical solution leads to decrease in people-focused resources). The loop from people-focused to allocation and back contains a time delay. However, decision makers regulate how capacity is to be allocated between people and technical factors.

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<sup>183</sup> By input I mean input of resources or information, by output any process result or outgoing influence.

According to e.g. de Geus, 1997, the business world has shifted in the last half century from being dominated by capital to one dominated by knowledge. Knowledge is produced by people. Arie de Geus continues:

“With the capital easily available, the critical production factor shifted to people. But it did not shift to simple labor. *Instead, knowledge displace capital as the scarce production factor — the key to corporate success.*” (p.18, his emphasis)

However, management strategies (and the thinking and actions of many politicians) still continue today as if capital was the scarce production factor. Today, there are two major and genuinely scarce factors: raw materials, and knowledge. It is necessary to find sustainable ways to use raw materials, and that is through knowledge development. Knowledge is in other words *the* most critical factor — *all categories!*

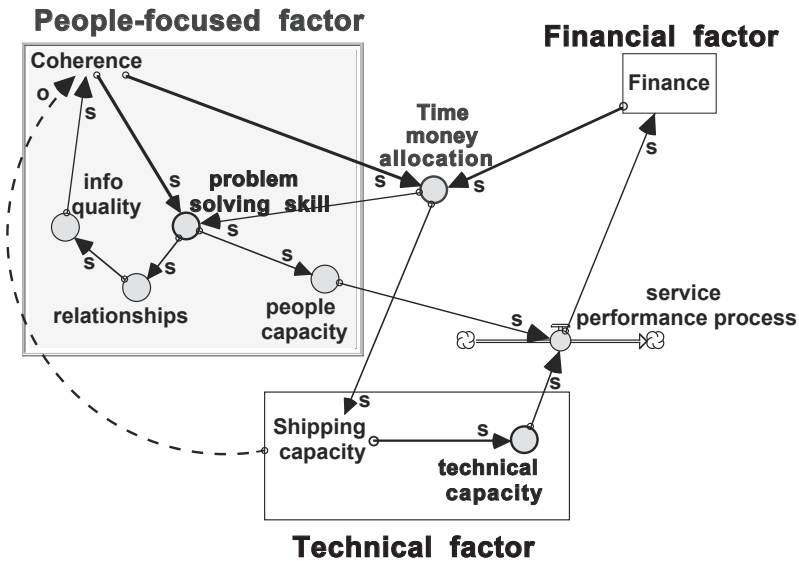


Figure 28: The People-focused factor. <sup>184</sup>

<sup>184</sup> Resilience not shown out of clarity, but is embedded in “Problem solving skill”. Change in Technical factor here proposed to give the opposite effect in the People-focused factor (broken line).

Also service operations with high complexity need knowledge and skill development to keep quality levels stable, and for the development of long-term competitive advantage.

So instead of having a thinking model with the priority order: 1) Finance (capital), 2) Technical, 3) People, I mean the ranking order should be reversed, that is:

- 1) People (knowledge-based)
- 2) Technical
- 3) Finance (capital)<sup>185</sup>

Obviously this can vary with the type of enterprise. I am discussing here businesses with some degree of complexity and need for skill.

This is made possible if there are quality standards with which to compare. I am not talking about international standards like ISO-9000, etc., which are good, if they are followed. However, if they are not they can even be destructive. An ISO-certification means that everyone trusts everyone else in the delivery chain. That relaxes people so they will not be observant about signs of deviations, quality deficiencies, and it shifts responsibility to “someone else”<sup>186</sup>. Standards like that are capability eroding if the company does not also have e.g. industry-based standards based on ethical and moral grounds (e.g. not cheating the customer, do they get value for what they are paying for?<sup>187</sup>). My point here is that there has to be some guiding definitions as to what is acceptable standard for product / service A, B, C, etc. If not, then standards will erode, which will affect people’s judgment, actions, and eventually capabilities.

## ***The information – knowledge paradox***

Lean management philosophy has the top-down view on what is the critical factor in production. It is organized around the mental model with the following ranking order of importance: 1) Money 2) Technology 3) People.

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<sup>185</sup> Having said this, I realise that for the individual who starts and tries to build up a company (speaking also from my own experience) that the order of importance could be, depending on capital need, finance first, then people, and technical, but then the discussion is on the initial constraints level. For a business to develop, however, I maintain that the priority order is the above.

<sup>186</sup> Illustrated by the BP and Deepwater Horizon disaster case mentioned in Footnote 177.

<sup>187</sup> If e.g. a company sells 100 % beef hamburgers, it is unethical if someone in the supply chain mixes in horse or pig meat.

From a knowledge perspective on business development, that could explain why strategies to substitute people by technology are used.

The source of this thinking is Frederick Taylor's "Scientific Management". The focus in scientific management is on the design and management of individual jobs, not on the total (Morgan, 1986:30). Its carrying principles are, amongst others, that the thinking should be separated from the doing, in other words the thinking, and responsibility, should be reserved for the managers, everyone else just do what they are told or follow policy. Another is that the task and the worker's performance, and processes, are to be highly specified and monitored. The bottom line of this is that work and tasks are to be fractioned and divided into small parts, task performance trimmed by time and motion studies. This is a standardisation model applied to assembly line work in order to achieve high productivity in task performance. This highly specialised and standardised fractioned thinking is designed for mass production of standardised components. It does not work as well with variety, and when complexity is involved. In services, for the reasons discussed above, it is even more problematic.

It is here the thinking and logic of lean philosophy breaks down, because it is normally not possible for a few decision makers at the top to know all the processes and disrupting events "below", except in very limited and controlled operations. This is not how knowledge and capabilities can be built, and developed in an organization into resilience. Resilience is formed over time if people in the organization have overview and understanding of the common purpose for their organization's existence. This is called identity (cf. Polesie, 1991; de Geus, 1997). Resilience is accumulative, and grows with experience, learning, knowledge forming, skill-development, communication, honesty, reliability, ensuing trust, etc. It all starts out with constraints, which give the conditions, but also the chances to learn and develop. A strategy is required with a quality-protecting zone, which will result in good quality production or services, loyal customers, innovations or in finding new opportunities for business development.

So this is an illustration of what I want to call an information-knowledge paradox: Thinking that leads to more complexity generate more uncertain information, which leads to less knowledge production. Less knowledge production leads to more uncertain information, etc. Increasing time pressure furthermore crowds out time to reflect on data and information. This is not the recipe for sustainable development.

In lean thinking the technical substitution for people (automation, robotization, etc.) or too rigid and tight control by policies, long term decreases the organizational knowledge production. Standardisation of production means economy of scale, i.e. mass production of e.g. components or services. The advantage of that could be high product quality<sup>188</sup> – if everyone knows what they are doing and makes no mistakes. However if someone makes a mistake it can have far-reaching and quality- (and trust) destroying consequences.<sup>189</sup> Normally, though, lean leads to high resistance, (a kind of robustness that sometimes is confused with resilience), however, due to complexity from extensive control and tightly coupled interdependencies, resilience will be eroded.

This generates vulnerabilities in the processes, which also can increase business risks. This is an example of an area that could be looked into in further research.

How can this be done? The framework given in this study can be the starting point, since it can explain how constraints are connected to resilience.

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<sup>188</sup> Large series, the learning curve gives that we learn the specific task better the more experience we get.

<sup>189</sup> Example: all the problems Toyota has had recently with e.g. gas pedals, break pedals, rubber mats, etc. One reason for the big volume of problems is that standard components are used in many different cars.

# 11. Implications for further research

## 11.1. Implications for Transport Buyers

There is a short term and a long-term perspective in all business. As de Geus pointed out, there is no reason why the average life expectancy of a company should not exceed 12.5 years<sup>190</sup>. Resilience is a way to make that happen and to create competitive advantage (e.g. Christopher and Peck, 2004; Ponomarov and Holcomb, 2009). Resilience does not just happen, but is built up by strategies to improve the business. In a highly interdependent supply network, companies cannot act selfishly and sub-optimize performance to satisfy only short-term goals. As de Geus, 1997, shows long-term perspective of learning can generate a lot of business, survival and development.

As has been shown and discussed in this study especially work pressure can worsen bottlenecks. It was also shown that e.g. notification time is often quite short. Sometimes maybe better customer contact and planning can make timing less pressing for shipments.

## 11.2. Implications for Transport Providers

“Leaning” in services cannot usually be done by the same logic as in product networks. Excess price pressure can lead to too much slimming of capacity by the service Provider, with the effects I have been trying to illustrate in this study. Excessive time pressure could make investment in equipment and staff inevitable, if the use approaches the carrying capacity.

However, maybe the most important, most constraints, as discussed above, are not necessarily due to reaching the carrying capacity of a specific resource, but due to synchronization, policy resistance, or ambiguous information. To find leverages for improved performance (i.e. overall efficiency) and long-term development, I have attempted to highlight the importance of developing the long-term, systemic, problem-solving ability, but also to establish quality standards and a high quality pressure to avoid quality erosion, and to know where the constraints are and how to avoid creating bottlenecks.

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<sup>190</sup> According to the webpage Knowledge@Wharton, 2013, Standard & Poor's 500 company estimation life expectancy for a US company has decreased from an average of 75 years in 1937 to 15 years in recent years.

However, in a world where change is rapid, complexity is growing, and demand is progressively volatile, it is even more important to keep learning. To learn, heuristics or trial-and-error might not be enough. Especially in the presence of complexity, insight is needed about how things really work, getting more than one perspective on problems. Trial-and-error is also a costly method to gain knowledge. Insight is sometimes dependent on dialogue and discussions, i.e. communication, partaking of other people's experience and knowledge, then reflection (Senge, 1990; de Geus, 1997). A complement to this is to model the problems and to use computer simulation and scenario technique. These are good learning tools to improve the problem-solving ability.

An aim with this thesis has been to illustrate that too much cost-focus and local optimizations can have severe long-term effects on overall productivity, especially for a company that applies such a strategy, but also for other companies in a supply network. Too much cutting out "waste" in capacity can lead to constraints with serious negative consequences for quality and loss of response flexibility. As customers eventually perceive this, they might take their business somewhere else, with the consequence that demand decreases, revenue decreases, cost increases, capacity has to be cut even more, and the process repeats itself. Long-term resilience suffers and makes it harder for the company to develop or even survive.

### **11.3. Further implications for Service Providers**

It is thus clear that lean management has to be applied to services with great care. The more complex and customized the service is, the more attention has to be paid to capacity management. Reserve or protective capacity cannot generally be considered waste, and there has to be a balance between service delivery operations, pro-active maintenance, problem fixing, and process development – especially when competition is fierce.

Services that cannot be standardized or automated (e.g. for the operative focus and quality reasons) have to be designed to be agile rather than lean, i.e. response and flexibility is more important, especially if the customer expects high quality. This is achieved by having enough reserve capacity, partly to absorb the variability, but also to develop the problem-solving ability and resilience.



The bottom line in this is that service operations with a certain amount of complexity require more flexibility and communication with customers and employees so that disturbances can be minimised or eliminated. A key in all this is knowledge development to increase capabilities. This is also important in avoiding increasing vulnerabilities and business risks.

In services there is an interaction between capacity and service quality management (Armistead and Clark, 1994; Oliva, 2001; Akkermans and Vos, 2003), and the manager needs to be especially aware of the quality eroding effects of too high capacity utilization. However, research shows this is not always intuitive, the awareness and handling of constraining resources and situations is considered to be a key to better performance. Knowing and removing some bottlenecks could on the other hand be leverage points for better performance.

## **11.4. Further research**

### **Follow-up constraint – resilience research**

This study can be replicated and tailored to the purpose of interest. That means that relevant questions could be used, while others might not be needed or can be rephrased if the purpose is slightly different.

The proposed conceptual framework (described in section 9.6.2., Figure 27) needs to be empirically tested. The framework can also be used for studies at different levels, e.g. on a supply chain level, country level, industry group level, industry level, comparing sizes of companies within an industry, or even as comparisons between a number of cases.

Methodologically: the Principal Components Analysis can with this kind of data be used if the number of cases is at least 50, but it is better with more. The Partial Least Square can though be used with fewer cases, also when there are a lot of independent variables (X-variables). My experience is that perception-data (attitudinal data), such as was analysed in this thesis, should be analysed together with “real” output or production data (in this thesis statistics over failed or damaged deliveries). That will increase the validity, since that will show if there is correlation between perception and data, or if the respondent is uncertain (maybe doesn't really know).

In my study the Information & Communication factor contains both people-focused attributes (like relationship aspects) and technical (such as IT system for the customer's self-service). I suggest that factors like this is

“tagged” so people and technical and automated aspects can be distinguished in an analysis, if this is of interest.

There are two areas which I feel are especially interesting to follow up in further research, information and communication bottlenecks, and to develop the knowledge around the role of the four principles involved in the forming of resilience.

## **Information and communication bottleneck problems**

### *Bottlenecks due to the quantity and quality of information*

A main finding of this study was that the ability to solve problems is affected by bottlenecks in the Information & Communication Systems. Especially relevant could be to assess information retrieving and the process to use the information to improve or keep up quality in performance. This would be to look at the quantity and quality of the information flow, communication flows, bottlenecks in this context, and how this affects decision-making and long-term results.

Can bottlenecks actually be perceived (e.g. large amounts of data that never gets analysed), or other blockages in the processes? What is the company's view on this? Are they e.g. aware of missing to detect problems (e.g. fluctuations in quality, getting longer lead times, missing deliveries, losing customers or sales), or opportunities because they are not updated?

The same thing can be studied with the customer contacts of the supplier. How does automation of communication (e.g. customers do their own bookings via internet, search for information themselves instead of being able to talk to personnel) affect the service level for business contacts and business results of such a company? Are their customers of the same opinion regarding the service level? Does it affect the customers' overall satisfaction with the service? Is this an important aspect for the development of competitive advantage for the supplying company?

Factors to explain bottlenecks have been described and discussed above in this study. The degree of complexity, and the type and size of company (for example task complexity, special skills or knowledge) are important parameters in this context. Also the degree and type of customer contact affect operations, complexity and thus information quality.

This type of project could be carried out using a qualitative research design, preferably a longitudinal study of different categories of companies. Inter-

views and collecting some examples of operative data types used, if possible find out how communication between suppliers / customers and the focal company on different levels is performed, what prompts communication, and how does the focal company respond to its customers? Is it possible to get access to customers, make a random selection and ask them how they perceive the supplier's communication? Do they get good service, does the supplier help them to solve their "problem", what is the situation when there are disturbances? How compatible are information and communication systems within and between the companies?

#### *Bottlenecks due to information quality*

Another relevant study could be to compare how differences in information quality (i.e. what information actually is available and used in the decision) affect a company's long-term competitive ability. In that context it would be of interest also to consider how the personnel situation, such as personnel turnover, influences results and to what degree that can explain differences in companies' ability to solve problems and their respective competitive advantage. This should be fairly easy to operationalize e.g. different kind of data sources (granted that companies give you access), e.g. how compatible different kinds of data are, what kind of information sources are used, or not used, how data is selected, and analysed. It is not a matter of gathering huge volumes of data, but more to look at the quality of some data and information used. In that context interviews from a number of people might be of more importance, which should give clues to how data and other information is retrieved and how it is used.

#### *Bottlenecks across boundaries*

Another interesting angle, not much researched, is to look for boundaries in organizations and between companies, since that can be natural bottlenecks for information and communication.

Wolstenholme, 2003, discusses this problem. Organizational boundaries can often "hide" unintended consequences of decisions from the decision-makers because the information flow is blocked or distorted. Examples of this can be accounting boundaries, or management team boundaries, but it can also be inter-organizational boundaries (ibid). These boundaries often change or are moved without people being really aware of the change (ibid.). This makes cross-boundary communication even more important in order to increase the quality of the information. The finding in this study that feedback and communication between Buyer and Provider sometimes did

not work satisfactorily was an example of that. The question is why and what consequences that has on the performance and e.g. long-term profitability? Is it due to communication and / or information flow problems, or skill and capability problems, e.g. from too little training, knowledge, high staff turnover or simply too high work pressure, or both of those?

Is that important to find out? Loss of business due to quality problems and dissatisfied customers can be costly, because it can also stain or ruin a reputation. For a service industry like goods transport or logistics service it is for example vitally important to keep service lead times short, to avoid queues. However, sometimes things do happen that cause delay, and information sharing can give the customers options to act and also a feeling that the Provider is attentive and has response capacity and is capable of handling the disturbance.

## **Coherence, control, connectedness, and requisite variety**

### *Knowledge and capability development*

As was concluded: the people-focused factor is the most important one. Development of capabilities and resilience is based on continual learning, and increasing the ability to solve problems. The psychological principles of coherence, connectedness, and control, together with another principle, requisite variety or diversity, are central in the development of resilience, as described above. Very little research has been performed in the business or organizational context about these concepts, apart from emergency or crisis management. Here is room for conceptual development.

The constraints-resilience framework could also be used in this context. What importance has factors like personnel strategy, training, and experience for the development of capabilities? What are for example the effects on long-term learning and capability development of having own personnel, respectively insourced temporary staff? How does it influence communication and information flow in the company long-term? How does it affect innovation, the development of new business? How does it affect long-term identity with the permanent staff?

Many companies also have outsourcing strategies with the motivation that they focus on their “core” business. How does this affect these processes? Does the loss of a capability, which has been in-house before but is being outsourced, affect the development of other capabilities? How does it affect coherence and identity? How does it affect requisite variety? How does it

affect the personnel's ability to solve problems? How does it affect the development of new business?

If this is a big change, how long does it take until the personnel feel in control again? This is a resilience aspect that could be included.

If long-term resilience and competitive advantage is of interest, especially longitudinal case studies can therefore be suggested in this kind of project.

### *The importance of communication and customer perspective*

This study has been done with data from a customer perspective. Many businesses and organizations, however, still apply "production perspective" in their management. With a customer perspective, i.e. to place yourself in your customer's shoes, can give insights, which have been illustrated by this study. The findings in the data reveal that customers (the Transport Buyers) and suppliers (the Transport Providers) are not always on the same wavelength and that communication is not always working. This was discussed also in the light of the lean thinking paradigm, which has clear production logic, even though there are indications of more customer-focused reflections (Womack and Jones, 2005). The question is, what are the effects of this in a constraint – resilience perspective?

Enquist discusses (e.g. Enquist, 2003; Enquist and Johnson, forthcoming) development of value in public transport, based on the development of dialogue between different interest groups in society (i.e. politicians, traffic authorities, operating traffic contractors, and customers, the users of public transport). The importance of developing the communication in that context and use a more customer-oriented service perspective is another resilience aspect that could be pursued in the context of my CORE-framework in further research. This is applicable also in the industrial business world. A deeper dialogue with customers can increase the quality of information, give better service value to customers, and reveal new opportunities for the Service Providers.

### *Recovery*

Especially in services the recovery step is considered important, because it has been observed to considerably affect the customer's perception of quality (Armistead and Clark, 1994). This is where resilience and reserve capacity are extra important. How do companies handle this situation when disturbances happen? How do they solve the problems? What role has communication in this, e.g. can the supplier solve the problem by contacting the customer?

This study could also compare how different companies act in situations like this, and to what degree adaption and learning is achieved. Can differences in the long-term competitive position be observed?

*Requisite variety*

Requisite variety, or diversity, is also an important aspect of resilience, discussed above (section 9.6.2. and 9.6.3). This is especially important for growing businesses, since a change in connectedness and complexity can give problems with greater complexity. The following is one example of a study:

Can companies be found which allow or have allowed diversity<sup>191</sup> and have good (or bad) track records? This should preferably be older companies. Comparisons can be made with companies that apply the opposite strategy, i.e. highly controlled production, only very narrow training (for specific tasks), etc. (lean category).

Are there differences in how these different categories develop?

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<sup>191</sup> Should be understood as that they are not highly controlled, but allowing initiatives for problem solving, and personal capability development.

# References

- Abshire, R. D. and S. R. Premeaux (1991). "Motor Carrier Selection Criteria: Perceptual Differences Between Shippers and Carriers." *Transportation Journal* 31(fall): 31-35.
- AffärsData (2002). Retrieved feb, 2002, from <http://www.ad.se>.
- Ahldén, G. (2011). Internal seminar, Handelshögskolan, 7th Dec Göteborg.
- Akkermans, H. and B. Vos (2003). "Amplification in service supply chains: An exploratory case study from the telecom industry." *Production & Operations Management* 12(2): 204-223.
- Allison, G. (1971). *Essence of Decision: explaining the Cuban Missile Crisis*, Harper Collins Publishers, Harvard.
- Allison, G. and P. Zelikow (1999). *Essence of Decision: explaining the Cuban Missile Crisis*, Addison-Wesley Educational Publishers Inc.
- Anderson, E. G. J., D. J. Morrice and G. Lundeen (2005). "The "physics" of capacity and backlog management in service and custom manufacturing supply chains." *System Dynamics Review* 21(3): 217-247.
- Armistead, C. G. and G. Clark (1994). "The "Coping" Capacity Management Strategy in Services and the Influence on Quality Performance." *International Journal of Service Industry Management* 5(2): 5-22.
- Ashby, W. R. (2011 (1968)). "Variety, Constraint, And The Law Of Requisite Variety." *Emergence: Complexity & Organization* 13(1/2): 190-207.
- Banker, R. D., S. M. Datar and S. Kekre (1988). "Relevant costs, congestion and stochasticity in production environments." *Journal of Accounting and Economics* 10(3): 171-197.
- Bergman, B. and B. Klefsjö (1990). *Kvalitet från behov till användning*, Studentlitteratur.
- Berry, L. L. and A. Parasuraman (1991). *Marketing Services. Competing Through Quality*, The Free Press.
- Bhamra, R., S. Dani and K. Burnard (2011). "Resilience: the concept, a literature review and future directions." *International Journal of Production Research* 49(18): 5375-5393.
- Bienstock, C. C. (2002). "Understanding buyer information acquisition for the purchase of logistics services." *International Journal of Physical Distribution and Logistics Management* 32(8): 636 - 648.
- Carlsson-Wall, M. (2011). *Targeting Target Costing — Cost management and inter-organizational product development of multi-technology products*. Business Administration. Stockholm, Stockholm School of Economics. Ph.D. thesis.
- Carpenter, S., B. Walker, J. M. Anderies and N. Abel (2001). "From Metaphor to Measurement: Resilience of What to What?" *Ecosystems* 4(8): 765-781.
- Catton, W. R., Jr. (1984). "Probable Collective Responses to Ecological Scarcity: How Violent?" *Sociological Perspectives* 27(1): 3-20.
- Chase, R. B. (1978). "Where does the customer fit in a service operation?" *Harvard Business Review* 56(6): 137-142.
- Chase, R. B. and U. M. Apte (2007). "A history of research in service operations: What's the big idea?" *Journal of Operations Management* 25(2): 375-386.
- Christopher, M. and H. Lee (2004). "Mitigating supply chain risk through improved confidence." *International Journal of Physical Distribution and Logistics Management* 34(5): 388 - 396.
- Christopher, M. and H. Peck (2004). "Building the Resilient Supply Chain." *The International Journal of Logistics Management* 15(2): 1-13.

- Churchill, J. G. A. and D. Iacobucci (2002). *Marketing Research. Methodological Foundations*, Suth-Western, Thomson Learning.
- Comfort, L. K., Y. Sungu, D. Johnson and M. Dunn (2001). "Complex Systems in Crisis: Anticipation and Resilience in Dynamic Environments." *Journal of Contingencies & Crisis Management* 9(3): 144.
- Coughlan, A. T., E. Anderson, L. W. Stern and A. I. El-Ansary (2001). *Marketing Channels*, Prentice Hall.
- Craighead, C. W., J. Blackhurst, M. J. Rungtusanatham and R. B. Handfield (2007). "The Severity of Supply Chain Disruptions: Design Characteristics and Mitigation Capabilities." *Decision Sciences* 38(1): 131-156.
- Day, G. S. (1994). "The Capabilities of Market-Driven Organizations." *Journal of Marketing* 58(Oct): 37 - 52.
- Deming, W. E. (1986). *Out of the Crisis. Quality, Productivity and Competitive Position*, Cambridge University Press.
- Diao, Y. (2007). *Control Theory for Service Systems*, IBM Thomas J. Watson Research Center.
- Dion, P. A., R. Javalgi and J. Dilonzo-Aiss (1998). "An Empirical Assessment of the Zeithaml, Berry and Parasuraman Service Expectations Model." *The Service Industries Journal* 18(4): 66 - 86.
- Dörner, D. (1996). *The Logic of Failure*, Basic Books.
- Ellis, S. C., J. Shockley and R. M. Henry (2011). "Making sense of supply disruption risk research: A conceptual framework grounded in enactment theory." *Journal of Supply Chain Management* 47(2): 65-96.
- Enquist, B. (2003). *Intressentdialoger inom kollektivtrafiken. En probleminventering och diskussion kring behovet av ett stödjande forsknings- och utvecklingsprogram för kollektivtrafikområdet*. Karlstad University Studies, Institutionen för ekonomi.
- Enquist, B. and M. Johnson (forthcoming). *Styrning och navigering i kollektivtrafiknätverk*, SAMOT, Karlstads universitet.
- Ferdows, K. and A. De Meyer (1990). "Lasting improvements in manufacturing performance: In search of a new theory." *Journal of Operations Management* 9(2): 168-184.
- Fiksel, J. (2003). "Designing Resilient, Sustainable Systems." *Environmental Science & Technology* 37(23): 5330-5339.
- Fisher, M. L. (1997). "What Is the Right Supply Chain for Your Product?" *HARVARD BUSINESS REVIEW* March - April: : 105-116.
- Flodén, J. (2007). *Modelling Intermodal Freight Transport*, BAS, School of Business, Economics and Law, University of Gothenburg. Ph.D. thesis.
- Forrester, J. W. (1958). "Industrial Dynamics." *Harvard Business Review* July - Aug: : 37 - 66.
- Forrester, J. W. (1994). *Policies, decisions, and information sources for modeling. Modeling for Learning Organizations*. J. D. W. Morecroft and J. D. Sterman. Portland, Oregon, Productivity Press.
- Frizelle, G. and E. Woodcock (1995). "Measuring complexity as an aid to developing operational strategy." *International Journal of Operations & Production Management* 15(5): 26-39
- Gadde, L. E. and H. Håkansson (2008). "Business Relationships and resource combining." *The IMP Journal* 2(1): 31-45.
- Gadde, L. E., H. Håkansson, M. Jahre and G. Persson (2002). "More instead of less" - Strategies for the use of logistics resources." *Chain and network science* 2(2): 81 - 92.
- Gallopin, G. C. (2006). "Linkages between vulnerability, resilience, and adaptive capacity." *Global Environmental Change* 16(3): 293-303.



- de Geus, A. (1997). *The Living Company. Habits for Survival in a Turbulent Business Environment.*, Harvard Business School Press.
- Ghosh, P. (2011) Agra swamped in Delhi, Haryana muck. Livemint.com 23rd Jan 2011 2nd Feb 2012
- Glaser, B. G. and A. L. Strauss (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research.* Aldine de Gruyter, New York.
- Gneezy, U., J. A. List and G. Wu (2006). "The uncertainty effect: When a risky prospect is valued less than its worst possible outcome." *The Quarterly Journal of Economics*(Nov): 1283-1309.
- Goldratt, E. M. (1990). *Theory of Constraints.* Great Barrington, MA, The North River Press Publishing Corporation.
- Goldratt, E. M. and J. Cox (1989). *The Goal,* Gower Publishing Company Ltd.
- Goldratt, E. M. and R. E. Fox (1986). *The Race,* North River Press Inc.
- Gooley, T. B. (2004). "Don't take it lightly." *Logistics Management* (April): 49 - 54.
- Grant, D. B., D. M. Lambert, J. R. Stock and L. M. Ellram (2006). *Fundamentals of Logistics Management.* European edition., McGraw-Hill Companies.
- Grönroos, C. (1998). "Marketing services: the case of a missing product." *Journal of Business and Industrial Marketing* 13(4 / 5): 322 - 338.
- Gunderson, L. H. (2000). "Ecological Resilience--In Theory and Application." *Annual Review of Ecology and Systematics* 31: 425-439.
- Gupta, A. K. and S. S. Nair (2010). "Flood risk and context of land-uses: Chennai city case." *Journal of Geography and Regional Planning* 3(12): 365-372.
- Hair, J. J. F., R. E. Anderson, R. L. Tatham and W. C. Black (1992). *Multivariate Data Analysis,* Macmillan Publishing Company.
- Harrison, A. and R. van Hoek (2008). *Logistics Management and Strategy,* Prentice Hall.
- Hesse, M. and J.-P. Rodrigue (2004). "The transport geography of logistics and freight distribution." *Journal of Transport Geography* (12): 171-184.
- Hines, P., M. Holweg and N. Rich (2004). "Learning to evolve. A review of contemporary lean thinking." *International Journal of Operations & Production Management* 24(10): 994 - 1011.
- Holling, C. S. (2001). "Understanding the Complexity of Economic, Ecological, and Social Systems." *Ecosystems* 4(5): 390-405.
- Holmén, C. (2007). *Financial Services — En kompletterande verksamhet som förändrar bilindustrins affärslogik.* Göteborg, BAS, School of Business, Economics and Law, University of Gothenburg. Ph.D. thesis.
- Holweg, M. (2007). "The genealogy of lean." *Journal of Operations Management* 25: 420-437.
- Hopkins, S. A., S. Strasser, H. W. E. and J. R. Foster (1993). "Service Quality Gaps in the Transportation Industry. An empirical investigation." *Journal of Business Logistics* 14(1).
- Hunt, S. D. and R. M. Morgan (1996). "The Resource-Avantage Theory of Competition: Dynamics, Path Dependencies, and Evolutionary Dimensions." *Journal of Marketing* Vol. 60 (4): 107-114.
- Hutchinson, R. and K. Liao (2009). "Zen Accounting: How Japanese Management Accounting Practice Supports Lean Management." *Management Accounting Quarterly* 11(1): 27-35.
- Isacsson, S. (2001). Interview 29th Sept 2000 and telephone interview 8th Oct 2001. Göteborg. IVF (1989). 9000 goda råd. Att bygga kvalitetssystem i företaget.
- Jacobs, F. R. and R. B. Chase (2008). *Operations and Supply Management: The Core,* McGraw-Hill.
- Jahre, M., L. E. Gadde, H. Håkansson, D. Harrison and G. Persson (2006). *Resourcing in Business Logistics,* Liber and Copenhagen Business School Press.

- Jansson, C. (2012). *Företag med framgång – Hur resurser kan skapa varaktiga konkurrensfördelar*. Handelshögskolan vid Göteborgs universitet. Göteborg, BAS, School of Business, Economics and Law, University of Gothenburg. Ph.D. thesis.
- Jansson, C. and T. Polesie (2011). *En beskrivning och vidareutveckling av trekantsmodellen. Våra villkor i verkligheten – den beskrivande ekonomin*. E. Broniewicz and T. Polesie. Göteborg, BAS.
- Jonsson, P. (2008). *Logistics and Supply Chain Management*, McGraw-Hill Education.
- Keaveney, S. M. (1995). "Customer Switching Behavior in Service Industries: An Exploratory Study." *Journal of Marketing* 59(2): 71 - 82.
- Kleindorfer, P. R. and G. H. Saad (2005). "Managing Disruption Risks in Supply Chains." *Production and operations management* 14(1): 53-68.
- Knowledge@Wharton (2013). "Running Faster, Falling Behind: John Hagel III on How American Business Can Catch Up." Retrieved 21 April 2013, from <http://knowledge.wharton.upenn.edu/article.cfm?articleid=2523>.
- Konjunkturbarometern (2004). Konjunkturinstitutet. 040129.
- Konjunkturinstitutet (2011). *Road haulage companies and removal companies (SNI 49.4)*. Online database, Konjunkturinstitutet.
- Lambert, D. M., M. C. Cooper and J. D. Pagh (1998). "Supply Chain Management: Implementation Issues and Research Opportunities." *The International Journal of Logistics Management* 9(2): 1-19.
- Lammgård, C. (2007). *Environmental Perspectives on Marketing of Freight Transports. The Intermodal Road-Rail Case*, BAS, School of Business, Economics and Law, University of Gothenburg. Ph.D. thesis.
- Lammgård, C., B. Saxin and J. Flodén (2004). *Making an impersonal method personal – experiences from a telephone initiated mail survey among transport buyers*. WCTR, Istanbul, Turkey.
- Lampel, J. and H. Mintzberg (1996). "Customizing Customization." *Sloan Management Review* fall: 21-30.
- Lee, H., V. Padmanabhan and S. Whang (1997). "The Bullwhip Effect in Supply Chains." *Sloan Management Review*(spring): 93-102.
- Leitch, R. A. (2001). "Effect of stochasticity, capacity and lead time cost drivers on WIP and throughput in a pull production environment." *Management Accounting Research* 12(2): 167-196.
- Lovelock, C. H. (1983). "Classifying services to gain Strategic Marketing insights." *Journal of Marketing* 47(Summer): 9 - 20.
- Lundahl, U. and P.-H. Skärvad (1982). *Utredningsmetodik för samhällsvetare och ekonomer*, Studentlitteratur.
- Lundberg, J. (2001). *Euroute AB*, Interview 7th March 2001.
- Manuj, I. and J. T. Mentzer (2008). "Global supply chain risk management strategies." *International Journal of Physical Distribution & Logistics Management* 38(3): 192-223.
- Mason, R., C. Lalwani and R. Boughton (2007). "Combining vertical and horizontal collaboration for transport optimisation." *Supply Chain Management* 12(3): 187-199.
- Matzler, K. and E. Sauerwein (2002). "The factor structure of customer satisfaction: An empirical test of the importance grid and the penalty-reward-contrast analysis." *International Journal of Service Industry Management* 13(3/4): 314.
- Mentzer, J. T., W. deWitt, J. S. Keebler, S. Min, N. N. W., et al. (2001). "Defining Supply Chain Management." *Journal of Business Logistics* 22(2): 1 - 25.

- Mentzer, J. T., S. Min and L. M. Bobbitt (2004). "Toward a unified theory of logistics." *International Journal of Physical Distribution and Logistics Management* 34(8): 606 - 627.
- Mentzer, J. T., M. B. Myers and M.-S. Cheung (2004). "Global market segmentation for logistics services." *Industrial Marketing Management* 33: 15 - 20.
- Moore, R. and L. Scheinkopf (1998) *Theory of Constraints and Lean Manufacturing: Friends or Foes?* 2012-12-04
- Morash, E. A. and S. R. Clinton (1997). "The Role of Transportation Capabilities in International Supply Chain Management." *Transportation Journal* 36(3): 5 - 17.
- Morecroft, J. D. W. (1994). *Executive Knowledge, Models, and Learning. Modeling for Learning Organizations.* (Eds:) J. D. W. Morecroft and J. D. Sterman. Portland, Oregon, Productivity Press.
- Morgan, G. (1986). *Images of Organization*, Sage Publications.
- Neiberger, C. (2008). "The effects of deregulation, changed customer requirements and new technology on the organisation and spatial patterns of the air freight sector in Europe." *Journal of Transport Geography* 16: 247-256.
- Ng, I. C. L., J. Wirtz and K. S. Lee (1999). "The strategic role of unused service capacity." *International Journal of Service Industry Management* 10(2): 211-238.
- Oliva, R. (2001). "Tradeoffs in Responses to Work Pressure in the Service Indust." *California Management Review* 43(4): 26-43.
- Oliva, R. and J. Sterman (2001). "Cutting Corners and Working Overtime: Quality Erosion in the Service Industry." *Management Science* 47: 894 - 914.
- Oliva, R. and J. Sterman (2010). *Death Spirals and Virtuous Cycles. Human Resource Dynamics in Knowledge-Based Services.* *Handbook of Service Science*, Springer Science+Business Media.
- Oudhuis, M. and S. Tengblad (forthcoming). *BP och Deepwater Horizon - oljekatastrofen ur resiliensperspektiv. Organisatorisk resiliens — Vad är det som gör företag och organisationer uthålligt livskraftiga?* Eds:, S. Tengblad and M. Oudhuis.
- Parasuraman, A. (1998). "Customer service in business-tobusiness markets: an agenda for research." *Journal of Business & Industrial Marketing* 13(4/5): 309-321
- Parasuraman, A., V. A. Zeithaml and L. L. Berry (1985). "A Conceptual Model of Service Quality and Its Implications for Future Research." *Journal of Marketing* 49: 41-50.
- Peck, H. (2005). "Drivers of supply chain vulnerability: an integrated framework." *International Journal of Physical Distribution and Logistics Management* 35(4): 210 - 232.
- Penrose, E. (2003). *The Theory of the Growth of the Firm*, Oxford Scholarship.
- Perrow, C. (1999). "Organizing to Reduce the Vulnerabilities of Complexity." *Journal of Contingencies and Crisis Management* 7(3): 150 - 155.
- Pettit, T. J., J. Fiksel and K. L. Croxton (2010). "Ensuring supply chain resilience: Development of a conceptual framework." *Journal of Business Logistics* 31(1): 1-21.
- Polesie, T. (1991). *Continuity and Change. Corporate Identity in a Scandinavian Perspective.* Göteborg, BAS.
- Polesie, T. (1995). *Drift & Finans – aspekter på företags ekonomi*, Liber-Hermods.
- Ponomarov, S. Y. and M. C. Holcomb (2009). "Understanding the concept of supply chain resilience." *The International Journal of Logistics Management* 20(1): 124-143.
- Porter, M. E. (1980). *Competitive Strategy*. New York, Free Press.
- Porter, M. E. (1991). "Towards a Dynamic Theory of Strategy." *Strategic Management Journal* 12(Special issue, winter): 95-117.

- Reich, J. W. (2006). "Three psychological principles of resilience in natural disasters." *Disaster Prevention and Management* 15(5): 793-798.
- Repenning, N. P., P. Goncalves and L. J. Black (2001). "Past the Tipping Point: The persistence of firefighting in product development." *California Management Review* 43(4): 44-63.
- Repenning, N. P. and J. Sterman (2001). "Nobody Ever Gets Credit for Fixing Problems that Never Happened." *California Management Review* 43(4): 64 - 88.
- Repenning, N. P. and J. Sterman (2002). "Capability Traps and Self-Confirming Attribution Errors in the Dynamics of Process Improvement." *Administrative Science Quarterly* 47(2): 265-295.
- Rudolph, J. W., J. B. Morrison and J. S. Carroll (2009). "The dynamics of action-oriented problem solving: Linking interpretation and choice." *Academy of Management Review* 34(4): 733-756.
- Rudolph, J. W. and N. P. Repenning (2002). "Disaster Dynamics: Understanding the Role of Quantity in Organizational Collapse." *Administrative Science Quarterly* 47(1): 1-30.
- SAS (Institute Inc, 2010). *JMP® Modeling and Multivariate Methods..* Cary, NC, SAS Institute Inc.
- Sasser, W. E. (1976). "Match supply and demand in service industries." *Harvard Business Review* 54(6): 133-140.
- Saxin, B. (2002a). Förundersökning, enkät till transportköpare, delrapport (prestudy, transport buyers). Research report 1, available at: Företagsekonomiska institutionen, Handelshögskolan, Göteborgs universitet.
- Saxin, B. (2002b). Prestudy hauliers. Research report 2, available at: Företagsekonomiska institutionen, Handelshögskolan, Göteborgs universitet.
- Saxin, B. (2012). Data selection and analysis, transport buyer survey 2003. Research report 3, available at: Företagsekonomiska institutionen, Handelshögskolan, Göteborgs universitet.
- Saxin, B. (2013) Summary of the study: Resilience in transport services — focus on constraints. Research report 4, available at: Företagsekonomiska institutionen, Handelshögskolan, Göteborgs universitet.
- Saxin, B., C. Lammgård and J. Flodén (2005). Meeting the demand for goods transports – Identification of flows and needs among Swedish companies. Nofoma.
- SCB (2011). *Statistiska Centralbyrån.*
- Schmenner, R. W. (1986). "How Can Service Businesses Survive and Prosper?" *Sloan Management Review*(Spring): 21 - 32.
- Schmenner, R. W. (2004). "Service Businesses and Productivity." *Decision Sciences* 35(3): 333-347.
- Schmenner, R. W. and M. L. Swink (1998). "On theory in operations management." *Journal of Operations Management* 17(1): 97-113.
- Senge, P. (1990). *The Fifth Discipline: The Art and Practice of the Learning Organization.* New York, Doubleday.
- Simchi-Levi, D., P. Kaminsky and E. Simchi-Levi (2008). *Designing & Managing the Supply Chain. Concepts, Strategies, & Case Studies,* Mc Graw-Hill Companies Inc.
- Simon, H. A. (1979). "Rational Decision Making in Business Organization." *American Economic Review* 69(4): 493-513.
- Skarp, F. and L.-E. Gadde (2008). "Problem solving in the upgrading of product offerings — A case study from the steel industry." *Industrial Marketing Management* 37: 725-737.
- Sterman, J. D. (1989a). "Misperceptions of feedback in dynamic decision making." *Organizational Behavior and Human Decision Processes* 43(3): 301-335.
- Sterman, J. D. (1989b). "Modeling Managerial Behavior: Misperceptions of Feedback in a Dynamic Decision Making Experiment." *Management Science* 35(3): 321-339.

- Sterman, J. D. (2000). *Business Dynamics - Systems Thinking and Modeling for a Complex World*, McGraw-Hill.
- Strandvik, T. (1994). *Tolerance zones in perceived service quality*. Helsinki, Svenska Handelshögskolan. Ph.D. thesis.
- Stratton, R. and R. D. H. Warburton (2003). "The strategic integration of agile and lean supply." *Int. J. Production Economics* 85: 183-198.
- Stratton, R. and R. D. H. Warburton (2006). "Managing the trade-off implications of global supply." *International Journal of Production Economics* 103(2): 667-679.
- Svensson, G. (2002). "Vulnerability scenarios in marketing channels." *Supply Chain Management* 7(5): 322-333.
- Teece, D. J., G. Pisano and A. Shuen (1997). "Dynamic Capabilities and Strategic Management." *Strategic Management Journal* 18(7): 509 - 533.
- Tengblad, S. (forthcoming). *Mästarföretaget som försvann: En resiliensanalys av detaljhandelsjätten Circuit City. Organisatorisk resiliens — Vad är det som gör företag och organisationer uthålligt livskraftiga?* Eds: S. Tengblad and M. Oudhuis.
- Tengblad, S. and M. Oudhuis, eds. (forthcoming). *Organisatorisk resiliens — Vad är det som gör företag och organisationer uthålligt livskraftiga?*
- Towil, D. R. (1996). "Time compression and supply chain management – a guided tour." 1(1): 15-27.
- Tversky, A. and E. Shafir (1992). "The disjunction effect in choice under uncertainty." *Psychological Science* 3(5): 305-309.
- Vargo, S. L., K. Nagao, Y. He and F. W. Morgan (2007). "Satisfiers, Dissatisfiers, Criticals, and Neutrals: A Review of Their Relative Effects on Consumer (Dis)Satisfaction." *Academy of Marketing Science Review* 11(2): 1-19.
- Vennix, J. A. M. and J. W. Gubbels (1994). *Knowledge Elicitation in Conceptual Model Building: a Case Study in Modeling a Regional Dutch Health Care System*. Modeling for Learning Organizations. J. D. W. Morecroft and J. D. Sterman. Portland, Oregon, Productivity Press.
- Weele, A. J. v. (2010). *Purchasing and Supply Chain Management*, Cengage Learning.
- Weick, K. E. (1995). *Sensemaking in Organizations*. Thousand Oaks, CA, Sage.
- Weick, K. E. and K. M. Sutcliffe (2007). *Managing the Unexpected. Resilient Performance in an Age of Uncertainty*, Jossey-Bass.
- Williams, M. (2011). *A gathering tornado. Finished Vehicle Logistics*, Automotive Logistics group: 16-23.
- Wold, S., J. Trygg, A. Berglund and H. Antti (2001). "Some recent developments in PLS modeling." *Chemometrics and Intelligent Laboratory Systems* 58: 131–150.
- Wolstenholme, E. F. (1990). *System Enquiry- A System Dynamics Approach*, John Wiley & Sons.
- Wolstenholme, E. F. (2003). "Towards the definition and use of a core set of archetypal structures in system dynamics." *System Dynamics Review* 19(1): 7-26.
- Womack, J. P. and D. T. Jones (1996). *Lean Thinking: banish waste and create wealth in your corporation*. New York, Simon & Schuster.
- Womack, J. P. and D. T. Jones (2005). "Lean Consumption." *Harvard Business Review* 83(3): 58-68.
- Yin, R. K. (1994). *Case study research: design and methods*, Thousand Oaks: SAGE Publications.
- Zanuy, A. C. (2009). *Unbalances in European Container and Intermodal Transportation*, Chair of Track and Railway Operations. Berlin Institute of Technology.
- Zeithaml, V. A., L. L. Berry and A. Parasuraman (1988). "Communication and Control Processes in the Delivery of Service Quality." *Journal of Marketing* 52(April): 35 - 48.

Zeithaml, V. A., L. L. Berry and A. Parasuraman (1993). "The Nature and Determinants of Customer Expectations of Service." *Journal of the Academy of Marketing Science* 21(1): 1 - 12.

Zeithaml, V. A., L. L. Berry and A. Parasuraman (1996). "The Behavioral Consequences of Service Quality." *Journal of Marketing* 60(April): 31 - 46.

Zsidisin, G. A., G. L. Ragatz and S. A. Melnyk (2005). "The DARK SIDE of Supply Chain Management." *Supply Chain Management Review* 9(2): 46-52.

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# Appendices

## Appendix 1: Some central concepts

Concept	Short explanation
Agility	Short-term capability, “the ability to respond rapidly to unpredictable changes in demand or supply” (Christopher and Peck, 2004:10)
Bottleneck	A “bad” constraint, usually an unintended “side effect” of a policy or strategy changes to deal with another problem. See constraint.
Bullwhip effect	Information distorting effect travelling up the supply chain due to uncertainties (changes) in demand.
Capability	“...complex bundles of skills and accumulated knowledge, exercised through organizational processes, that enable firms to coordinate activities and make use of their assets.” (Day, 1994)
Coherence	This is the “knowledge factory” of the system. Coherence is a deeply embedded need in people, “the drive to know, the desire to remove uncertainty” (Reich, 2006) by enhancing meaning, direction, and understanding when something happens.
Connectedness	“Banding together” in order to create more transparency, trust, better communication, relationship, and thus better information quality, which favour stability, quality and efficiency. Connectivity is a synonym.
Constraint	The limitation of a resource, the conditions, rules, laws, or anything limiting the flow of an activity, e.g. in production, information. The maximum capacity use of a resource.
Control	The ability to take action, to have a direction, to be able to coordinate, and follow up, and to make regulations, adjustments.
Enterprise Resource Planning (ERP)	Computerized information system used in businesses, to keep a track of production flows, planning production, material supply, etc. Usually connected to business transaction data.
Just-In-Time delivery (JIT)	Delivery of goods when it is needed, i.e. delivery in small quantities, but more frequently, rather than a big batch.
Lean thinking / production / management	Production philosophy developed in the automobile industry to eliminate waste; based on Just-In-Time production why inventory buffers are minimized; focus on productivity and costs.



Logistics management	“Logistics management is 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 customer requirements.” (CSCMP 2007)
Requisite variety	The diversity or variety there has to be in the solving resource to be able to solve a problem. Only “variety can destroy variety.” (Ashby, 2011 (1968))
Resilience	The system’s capacity to recover from disturbances (Gallopín, 2006; Bhamra et al., 2011), A property of bouncing back in face of adversity, “the capacity for an enterprise to survive, adapt, and grow in the face of turbulent change” (Fiksel, Pettit et al., 2010).
Resource-based competition	Firm-level strategic theory, that it is the firm’s available resources or assets coupled with its capability that is the foundation for growth, innovation, and development.
Supply chain	“... a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.” (Mentzer et al., 2001) A supply chain starts upstream (supplier), the customer is downstream.
Supply network	Complex web of different supply chains.
Theory of constraints (TOC)	Goldratt’s theory, see section 2.4. and 9.2.
Time precision, time window	Time precision means delivery within a certain time window, e.g. 12 o’clock $\pm$ 1 hour.
Transport Buyer	The industry, in this thesis the manufacturer, the wholesaler, which has goods to ship. In this study it is only outgoing shipments that has been studied.
Transport Provider	Bigger forwarders often subcontract hauliers to perform the actual transport, in other words the forwarders sell the transport to the Transport Buyer, then hauliers carry out the shipment. More about this in section 8.2. In this study it is the company that does the business transaction with the Transport Buyer that is called Transport Provider. In some cases Transport Buyers have their own transport department or transport company. In this study they still are in the category of Providers.
Vulnerability	The capacity to preserve the structure of a system (Gallopín, 2006; Bhamra et al., 2011). Includes sensitivity to external stress, pressures, disruptions, response capacity, and exposure to disruptions (risk aspects).

## Appendix 2: Interview guide

Interview questions	Pre-study industrial Transport Buyers		
Datum:	Företag:	Transportchef:	Bransch / produkter:
ORT	Tel	Omsättning / ant anst	
Kundkategorier?	Industri	partihandel / grossist mot industri / mot konsument?	detaljhandel
Tillverkning	• Kundorderstyrd?	•Tillv. Mot lager?	HUR STORT ÅR LAGRET?
SÄNDNINGSTYP?	Styckegods	Partigods	DIREKTLEVERANS eller via linjenät?
Transportsätt?	Landtransporter genom Sverige	Lastbil, tåg, kombi, fartyg, flyg?	
VART?	Inom Sverige	Export	
VOLYMER?	Inom Sverige	Export	
LASTBÄRARE?			
HUR?	Förmedlare	Egna transporter	
BESLUT	VEM ställer villkor för utlev kvalitet?	Ni eller er kund?	Vem i organisationen?
	... för transportsätt?	Ni eller er kund?	Vem i organisationen?
		IHOP MED TRANSPORTÖR?	
	Vilka kriterier på service och kvalitet är viktiga eller avgörande när ni gör transportupplägg för era sändningar?	/ olika typer av gods (om de har flera godstyper).	<ul style="list-style-type: none"> <li>• pålitlighet</li> <li>• punktlighet / tidsprecision</li> <li>• transporttid</li> <li>• flexibilitet</li> <li>• proffsigt uppträdande?</li> <li>• hantering av godset</li> <li>• pappersarbetet</li> <li>• helhetssyn, logistiktjänster?</li> </ul>
PÅLITLIGHET	• Vad lägger ni för betydelse i begreppet "pålitlighet" beträffande en transportör?		(t.ex. punktlighet ? / i rätt tid ? / ser till att godset kommer till rätt ställe ? / godset kommer fram oskadat?)
HUR MÄTER ni pålitlighet?	Endast avsändningen, från egna lastbryggan		Ankomsten till kund?
Mäter INTE	TRANSPORTÖREN MÄTER?		
TIDSFÖNSTER?	Vecka                      Dag                      Tim		
	TIDSFÖNSTER I FÖRHÅLLANDE till HÄMTNINGSTILLFÄLLET?		
	• TID - avvikelse i min /tim		
	• ANTAL sena hämtningar / inlev	HUR definieras isåfall en avvikelse?	
NIVÅ?	Vilken nivå av pålitligheten är acceptabel?		
FÖRÄNDRING?	Hur stor förändring av detta är tänkbart?	Bättre / sämre	
	UTBYTE isåfall mot vad?		
TRANSPORTTID	Är transportererna tidsstyrda?	Ledtid av totala ledtiden?	
MILJÖ	• Vilka miljöfrågor är viktigast kopplat till era transporter?		(låt dom föreslå! Tex koldioxidutsläpp, emissioner, energilätgång etc)
	• Hur skulle man kunna mäta transporters miljöpåverkan bäst?		Säger % något?
	• Om ska tänka dig en förändring av transportsätt och upplägg.		Vad är en realistisk förändring av miljöpåverkan? (%)
PRIS	Pris i förhållande till varuvärde?		
	• Tror ni det finns förhandlingsutrymme om priset med er transportör?		(t.ex. pga ökad effektivitet?
	• Isåfall hur mycket (%)		

### Appendix 3: Survey questions

Two questions (total of 30 main questions) from the survey are used in the study and shown here. In question 9 the respondents were to describe the mix of pressures they were under in choosing a transport solution.

#### Question 9 Description of pressure mix

**Distribute 100 percent among the properties below, in accordance with their importance for your local unit when selecting transport solutions for your outgoing transport.**

*Attribute of the transport solution    Weight of attribute*

Price	.....%
Transport time door to door	.....%
Time precision <sup>1</sup> door to door	.....%
Environmental efficiency (represented by carbon dioxide emissions)	.....%

*Total* *100 %*

1 Pick-up and delivery within agreed time-window



## Attribute

Item #	The transport provider...
1	...covers our market area geographically in a sufficient manner.
2	...has a good IT support system for receiving our orders (e.g. EDI, internet orders)
3	...has a good IT support system for tracking the goods (e.g. track and trace)
4	...has a wide variety of complementary logistics services
5	...knows how to handle our goods in order to avoid damage
6	...is quality certified e.g. ISO 9000
7	...has good routines for handling documents
8	...has safety routines against theft and loss
9	...can offer custom-made transport solutions
10	...is easily accessible regarding enquiries and bookings
11	...is easily accessible regarding follow-up of transport
12	...has many scheduled dispatches
13	...can adjust to large variations in volume
14	...can perform deliveries at short notice
15	... performs transport in upon agreed time
16	...fulfills its commitments
17	...has well functioning routines for reporting deviations
18	...has good manners at pick-up and delivery of goods
19	...maintains an even quality level
20	...has worked for us previously
21	...has a good reputation
22	...offers one of the lowest prices
23	...gives us access to detachable load-carriers (e.g. swap-bodies and semi-trailers)
24	...can offer the modes of transport (truck, train, boat, aircraft or a combination of these) we desire
25	...can coordinate our inbound and outbound transport
26	...offers coordinated shared deliveries with other companies in order to reduce empty load transport
27	...can offer goods transport on rail
28	...has a high loading factor of goods
29	...uses other fuels than diesel. e.g. bi-fuel and gas
30	...uses trucks with low emission standards
31	...can offer combined transport truck-train
32	...has implemented an Environmental Management System e.g. ISO 14001
33	...has environmentally efficient transport

## Appendix 4: Table 4 Principal Component Factors, in detail

*How to read Table 4, next page:*

In Table 4, the items or attributes<sup>192</sup> are the rows, and the nine factors are shown in the columns. Those items that give high enough “factor loadings” form each factor. The factor loadings are the framed-in numbers shown in the matrix. These numbers are the correlations (the strength of the linear association) between each item and the factor.

The factor loading is a number between -1 and 1. 1 means there is total correlation (attribute and the factor co-vary in the exact same direction), -1 (item and factor have exact opposite directions). If there is no correlation, i.e. no association between them, the correlation is near 0. This happens mostly when variations are random, i.e. there is no indication of possible association.

Hair, Anderson *et al.*, 1992, mean that factor loadings greater than 0.30 can be considered significant, and loadings of at least 0.40 are more important, 0.50 and up is highly significant, but this varies somewhat with the number of variables and sample size (p. 239). As can be seen in Table 4 most of the loadings in the survey are over 0.50. All loadings under 0.30 have been excluded for clarity.

In the bottom of the matrix, data for each factor is summarized. It gives among others how much (in %) uncertainty is reduced<sup>193</sup> by respective factor. The whole model thus reduces the uncertainty in the data by 62% (sum of “Uncertainty reduced (%)” for all the factors).

Cronbach’s alpha gives the internal reliability for each factor, i.e. it is a test that the variables are measuring the same thing. Should be at least 0.70, but in some cases could be lower.

The mean values for importance and performance respectively are the answers by the respondents (see Appendix 3, question 24).

Column furthest to the right shows communalities (variance explanation for each item). They are high, except for two items (item # 1 and # 4). This extraction followed the criteria of the latent root of eigenvalues and a scree tail test to extract the “best number” of factors (Hair et al 1992, p 236f).<sup>194</sup>

<sup>192</sup> Same questions as in Appendix 3, question 24.

<sup>193</sup> The same as variance explained.

<sup>194</sup> The latent-root-rule is to choose factors with eigenvalues (factor variance) of at least 1, since that is considered to be the limit for factor significance (Hair et al p 237).

Table 4 in detail

Item #	Transport provider attribute	F1 Standards	F2 Reliability of Service	F3 ICT	F4 Modal	F5 Relationship	F6 Load Factor	F7 Network capability	F8 Skill	F9 Price	Communalities
32	Environmental mgmt system	0.88									0.83
33	Environmentally efficient transport	0.85									0.81
30	Low emission standards	0.80									0.78
6	Quality certified (e.g. ISO 9000)	0.70									0.64
29	Other fuels than diesel	0.58									0.58
10	Accessible for bookings		0.78								0.66
15	Transport on time		0.69								0.59
11	Accessible for follow-up		0.67								0.58
17	Routines, disruption report		0.56								0.56
3	IT system, track & trace			0.83							0.74
2	IT system for ordering			0.75							0.64
4	Complementary logistics services			0.47							0.38
31	Offers intermodal R/R				0.79						0.73
27	Offers Rail transport				0.77						0.71
23	Access to detachable load-carriers				0.58						0.54
24	Different transport modes				0.49						0.59
21	Has good reputation					0.80					0.73
20	Has worked for us before					0.76					0.63
18	Good manners					0.53					0.59
26	Coordinated deliveries with other companies						0.74				0.61
28	High loading factor						0.63				0.65
25	Can coordinate our in- and outbound transport						0.44				0.59
12	Many scheduled dispatches							0.68			0.56
13	Can adjust to large variations in volume							0.61			0.58
14	Deliveries at short notice							0.60			0.61
1	Geographic coverage							0.33			0.44
5	Can handle our goods								0.66		0.61
9	Customized transport								0.51		0.51
7	Routines document handling								0.37		0.49
8	Has safety routines								0.35		0.55
22	One of the lowest prices									0.88	0.81
	Uncertainty reduced	3.5	3.2	2.4	2.2	1.8	1.8	1.7	1.6	1.1	
	Total uncertainty reduced %	11.4	10.4	7.6	7.2	5.8	5.7	5.3	5.3	3.6	
	Cum %	11.4	21.7	29.4	36.6	42.4	48.2	53.5	58.8	62.3	
	Cronbach's (Std) Importance	0.74	0.73	0.76	0.75	0.75	0.74	0.74	0.72	0.79	0.77
	Cronbach's (Std), perform.	0.80	0.79	0.82	0.81	0.80	0.80	0.79	0.79	0.84	0.82
	Performance, mean, total pop	4.99	5.50	4.09	3.93	5.72	4.64	5.44	5.45	5.21	
	Importance, mean, total pop	5.12	6.24	3.80	3.44	5.40	4.61	5.63	5.68	5.83	







# RESILIENCE IN TRANSPORT SERVICES — FOCUS ON CONSTRAINTS

Findings from transport buying companies are analyzed to assess if Transport Providers are able to keep up with the Buyers' demands of on-time service. Global competition is a driver of the "leaning" of resources in organizations, both for Transport Buyers and Providers.

Complex service businesses are particularly sensitive to fluctuating demand, since it takes time to adjust capacity, and it affects quality. An option is to use the available capacity more, which, however, can lead to "bottlenecks".

The purpose of this study is to discuss such unwanted constraints in the light of a somewhat, for services, misapplied management trend that is likely to affect the long-term resilience and ability to compete negatively.

Resilience, or response capacity, is the ability to bounce back in the face of adversity and severe disturbances, and is necessary for long-term adaptation to change. However, resilience can only be developed through learning, skill and capability training.

The main conclusion from the findings indicates that constraints in the information and communication systems affect people's ability to solve problems, and their customers' satisfaction. This finding is significant. It suggests that some companies might have a lack of resilience, which could cost them the ability to compete and survive in the long term.

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