THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

Heavy Vehicle Maintenance in an Industrial Network Perspective:

Implications of Embeddedness and Interdependencies

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Gothenburg, Sweden, 2016

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ISSN 1654-9732
Report number L2016:081

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Chalmers Reproservice
Gothenburg, Sweden, 2016

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Abstract

Road transport solutions are often complex and involve numerous stakeholders. To secure that goods arrive in a timely and efficient manner, companies must cooperate and interact to define, implement and operate the transport solutions required. To support efficiency, reliability and robustness of the transport solutions, the trucks involved must be operational, and to achieve this, vehicle maintenance is imperative.

The aim of this thesis is to contribute to the understanding of heavy vehicle maintenance from an interorganizational perspective. The phenomenon in focus is the use and performance of heavy vehicle maintenance and the research underlying this thesis applies a holistic approach. As a result of this approach, the networks studied include Transport Buyers and Transport Providers (hauliers) together with other actors concerned by or influencing the focal phenomenon. The Industrial Network Approach (INA) has been applied as a starting point for the analytical framework of the thesis. In specific, the network model representing activities, resources and actors as three interdependent dimensions (the ARA model), is used for analysis of the maintenance activities.

Three cases involving Transport Buyers heavily dependent on freight transport form the empirical base of this qualitative case study. Data was collected using semi structured interviews and analysed using the ARA model. Specifically, maintenance activities are analysed with respect to interdependencies between activities, resources and actors embedded in the network.

The three cases demonstrate how demands on, and implications for, vehicle maintenance is conditioned by the characteristics of the context in which the haulier operates. Specifically, the embeddedness of the vehicle maintenance activity, and interdependencies involving the haulier and the workshop, strongly influence the conditions for vehicle maintenance. In addition, as the notion of efficiency of vehicle maintenance activities differs between stakeholders, a main conclusion is that an approach building on a holistic network-based perspective must be applied when improving overall efficiency of vehicle maintenance.

Keywords

Maintenance, Vehicle Maintenance, Trucks, Road Transports, Transport Solutions, Business Networks, Activities, ARA Model, Transport Service Triad, Interdependencies, Embeddedness

ACKNOWLEDGEMENTS

When I started to work on this licentiate thesis, I defined three personal targets, each of them important for my doctoral studies here at Chalmers University of Technology. Firstly, to prepare for, and write up, this thesis should help me develop my skills regarding research in general, and my knowledge regarding the Industrial Network Approach in specific. Secondly, the writing in itself should help me to develop my skills regarding academic writing. Thirdly, the thesis should contribute to research regarding heavy vehicle maintenance in transport solutions and establish a solid stepping stone for my continued research in the area. My hope, when putting the final touches to this thesis, is that I have been able to successfully reach all three targets.

However, none of my targets would ever have been possible to reach at all without the help, support and inspiration that I have received from my family and my colleagues and friends at Chalmers and AB Volvo. Specifically, I would like to thank my family for love and support, and my supervisors Professor Anna Dubois, Associate Professor Frida Lind and Dr Jan Ove Östensen for splendid and inspiring coaching.

This research has been carried out as part of the project "Efficient Maintenance for Sustainable Transport Solutions" (EMATS), a project co-financed by FFI, Strategic Vehicle Research and Innovation, in Sweden.

I hope that you will find the thesis interesting, and that I will succeed in my aspiration to pass on some of my enthusiasm and fascination regarding research on transport solutions and heavy vehicle maintenance!

Klas Hedvall

Chalmers University of Technology
Gothenburg, October 2016

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1. INTRODUCTION

"If you are only looking at maintenance as a way to prevent trucks from breaking down, you are missing out on a big piece of what it contributes to your operation and also on some real fuel savings. Maybe it is time to for you to rethink maintenance?"

(Michael Roeth, Executive Director, North American Council for Freight Efficiency, in Fleet Owner, 2016)

This thesis deals with the maintenance of heavy vehicles. Maintenance could seem as a task of trivial proportions, but planning and performing vehicle maintenance with efficiency as an objective is, as will be shown, a challenge for stakeholders involved.

Below, a discussion regarding heavy vehicle maintenance and the aim of this thesis is presented, but before this, let us start with an introduction to maintenance.

1.1 Maintenance - A necessary evil or a value-adding activity?

According to the European standardization body, maintenance is a "combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function" (EN 13306:2010, p. 5). This definition indicates that maintenance should be seen as an issue of both operational and strategical importance. However, maintenance has not always been perceived in this way.

About a century ago, a time influenced by the dawn of industrialization, maintenance was not an issue that attracted much attention. Pintelon and Parodi-Herz even argue that "at first maintenance was nothing more than an inevitable part of production; it simply was a necessary evil. Repairs and replacements were tackled when needed and no optimization questions were raised" (2008, p. 26). Hence, at this time the focus was on Corrective Maintenance (CM), i.e. maintenance performed after a breakdown or incident in order to repair or restore the system.

It was not until the second half of the twentieth century, as a reflection of the evolution of Operations Research (Murthy et al., 2002), that companies began to accept that maintenance could enable long-term cost savings and lead to some breakdowns being avoided. Hence, corrective maintenance was supplemented with Precautionary Maintenance, i.e. maintenance performed 'in advance' in order to ensure a system's performance or reduce the probability of a later failure or breakdown. As a result of this new awareness, Preventive Maintenance, a type of precautionary maintenance based on defined intervals, was adopted by many companies in the 1960s (Pintelon and Parodi-Herz, 2008; Murthy et al., 2002).

An important issue at this time was how to define the proper maintenance interval. To address this issue, concepts such as Reliability-Centred Maintenance (RCM) and Life Cycle Cost (LCC) were introduced and applied. RCM acknowledged the connection between the reliability of a system and the maintenance to which the system is subject, hence the reliability of the system and the possible consequences of failure are reflected in the way that the maintenance is performed (Murthy et al., 2002). LCC was based on the concept of life cycle costs and addresses the idea that the cost of precautionary maintenance (short term) has to be seen in relation to the long-term costs of a system's operation (Pintelon and Parodi-Herz, 2008).

Along the path of technological development, automation and advancements in Information and Communication Technology (ICT), a new perspective was applied by companies during the period from 1970 to 1990. As a result, Predictive Maintenance techniques, i.e. maintenance related to the condition of the system and not based on specific intervals, were introduced in the early 1980s (Pintelon and Parodi-Herz, 2008).

About a decade later, firms acknowledged that improvements with respect to maintenance could be gained by addressing opportunities in the early stages of product development (Pintelon and Parodi-Herz, 2008). Instead of applying a mainly reactive approach, companies developing products therefore started to apply a more proactive mind-set, addressing maintenance-related issues already during system design and development.

With the introduction of management principles like Just-in-time (JIT) and Total Quality Management (TQM), concepts such as LCC were further developed and new approaches such as Total Productive Maintenance (TPM) were introduced (Pintelon and Parodi-Herz, 2008). TPM, as opposed to the 'product-centric' RCM, is a concept that involves organizational aspects as well as processes (Tsang, 2002). With increased awareness that needs and conditions vary between different contexts, more customized maintenance concepts such as Value Driven Maintenance (VDM) and Kelly's Business-Centred Maintenance (BCM) (Kelly, 2006) were developed. VDM, for example, was proposed by

Haarman and Delahay in the first decade of the twenty-first century and reflects the growing awareness that maintenance should not only be seen as a burden or cost but also as an activity providing value through improved system reliability and productivity.

The growing interest in VDM is shared by practitioners and scholars, resulting in the field having attracted increasing attention over the last years. Tsang (2002), for example, argues that "With asset availability and reliability becoming critical issues in capital-intensive operations, the strategic importance of maintenance in such businesses should be recognized" (Tsang, 2002, p. 7).

However, Pintelon and Parodi-Herz (2008) argue that challenges and issues remain to be further addressed further. The authors specifically point to gaps between the tactical and operational perspectives of maintenance within companies. Pintelon and Parodi-Herz moreover argue that the links and interplay between the business and maintenance strategies of the company must be better understood and further strengthened (ibid, 2008). Or, in other words, from Pinjala et al: "lack of understanding this relationship [between business and maintenance strategies] and only cutting down the costs of maintenance can influence the company's competitive strength equation and its ability to compete in the market" (2006, p. 215, Text between brackets added)

1.2 Heavy vehicle maintenance in different perspectives

But – what about the transport industry and heavy vehicle maintenance? Is vehicle maintenance seen as a key strategic issue that influences the performance and efficiency of operations and business? Or, does the current situation reflect the perspective described by Murthy, Atrens, and Eccleston more? The authors argue that "The objectives of top-level management in most businesses have been more short-term as opposed to long-term and strategic. The focus has been on cost reduction and downsizing without proper evaluation of the long-term implications for the business. In most businesses, maintenance is viewed as being a non-core activity and the focus has been to outsource it completely" (Murthy et al., 2002, p. 297).

For the industry in general, the purpose of vehicle maintenance is to ensure that the equipment – in this case a truck – is fully operational and may be used for its intended purpose in a safe and efficient way.

Vehicle maintenance, a part of the Truck OEM's offerings, has by Tukker (2004) been defined as a "Product-oriented" service. The purpose of this service is to enable vehicle uptime, i.e. the time during which the vehicle is functional and may be used for its intended purpose, and improve vehicle utilization.

For a Truck OEM, vehicle maintenance is often related to the company's "after-market" operations. This operation, encompassing various, services, accessories and spare parts for instance, has over the years gained increasing attention from companies.

The idea of an aftermarket infrastructure servicing the customers is not new however; Already Henry Ford "toyed" with an idea of having a network of service centres as part of the conglomerate that constituted the Ford industries early in the 20th century (Drucker, 1990).

The focus on the after-market is gradually becoming stronger. Drivers for this are, e.g., the Truck OEM's ambition to strengthen customer relationships, as well as a growing interest in the so called "running population" or "installed base" (Araujo and Spring, 2006), i.e. the population of vehicles previously sold. To develop and strengthen the offerings, services based on Big Data is becoming a hot topic (See e.g. DI, 2016).

The challenges however remain the same, even when new and powerful technologies are introduced. For a customer operating heavy vehicles, efficiency and reliability of the operations is a must.

Demands for efficiency and reliability of operations in industry and retail are reflected in the demands on related logistics operations. Efficiency, reliability and robustness are therefore frequently required from transport involved in supply and distribution operations.

The conditions underpinning the demands for efficiency, reliability and robustness depend on the nature of the transport and vary between different contexts. The demands may originate in, for example, requirements grounded in the supply side, the receiving side or both. Moreover, the demands may originate in different settings such as JIT operations or Hub and Spoke operations (Fowkes et al., 2004).

If a transport provider fails to meet the demands for transport efficiency, reliability and delivery precision, this may lead to severe implications for the companies involved.

Hence, the transport buyer's expectations of the supplier's problem-solving abilities are often high, and any disruptions may lead to penalties for the supplier. As Fowkes et al. explain: "If delays start to occur, the first step is likely to involve discussions to find a mutually acceptable solution to the problem, but if such negotiations fail to resolve the problem the ultimate penalty facing the operator concerned is the loss of the contract" (Fowkes et al., 2004, p. 36).

Even if breakdowns or unplanned stops should occur less often, the impacts thereof may still be difficult to manage. As McKinnon and Ge state in an article related to a survey about road transport in the UK: "Delays caused by equipment breakdowns and the lack of a driver were the most disruptive …" (McKinnon and Ge, 2004, p. 235).

Moreover, the costs resulting from the absence of, or poorly performed, maintenance has to be seen in relation to the actual cost of performing maintenance. According to Murthy et al. (2002), the annual cost of maintenance (per cent of total operating cost) can be as high as 40-50 per cent in the mining industry and about 20-30 per cent for the transport industry. However, Murthy et al. argue that "… the indirect costs resulting from delay in delivery, customer dissatisfaction leading to loss of goodwill and customers is much higher" (ibid, p.288).

To allow for a discussion on the efficient use of vehicles in transport, Simons et al. (2004) introduce the concept of Overall Vehicle Efficiency (OVE). OVE as a concept is related to the ideas of Lean Thinking for manufacturing operations. According to Lean Thinking, three different types of activities are performed in a company: 1) activities adding value for the customer, 2) activities not providing value for the customer, i.e. 'waste', and, 3) activities that are required yet do not contribute value for the end customer (ibid.).

Simons et al. (2004) argue that OVE, which addresses the efficiency of vehicles, could be used as a tool when striving to improve the overall efficiency of transport. Improved efficiency would be achieved by addressing, and reducing, the non-value-adding activities. As a result, performance – and ultimately also profitability – could be improved.

If the ideas of Simons et al. are applied to the phenomenon on which this thesis focuses, i.e. vehicle maintenance, this allows for an analysis of maintenance in relation to efficient utilization of vehicles. In an analogy to the discussion above, the efficiency of vehicle utilization and transport would be improved if the ‘waste’ related to vehicle maintenance was reduced.

From the perspective of a transport buyer, vehicle maintenance belongs to either or both of the categories for non-value-adding activities discussed by Simons et al. (2004). For a transport buyer, vehicle maintenance as such does not add any value. The value for the customer, i.e. the transport buyer, is related to the actual transport of goods.

For a transport provider, however, vehicle maintenance is a necessity in order to ensure performance and reliability of the vehicles, a prerequisite for efficiency and robustness of transport. Hence, from the perspective of a transport provider, both preventive and corrective maintenance are required.

To address these two perspectives, that of the transport buyer and that of the transport provider, maintenance required for efficiency and reliability of transport therefore has to be performed but in a way that reduces the impact on the focal activity of the transport buyer, i.e. freight transport. In order to enable efficient and reliable transport, the efficiency aspects of vehicle maintenance should therefore also be addressed.

The efficiency of vehicle maintenance is hence a notion that is perceived differently by different stakeholders. Efficient maintenance from the perspective of a transport provider differs from that of the transport buyer. Moreover, maintenance efficiency from the perspective of the maintenance provider differs from that of the perspectives of the transport provider and the transport buyer.

In the context of this thesis, efficiency is seen as a question of efficient utilization of the resources available. Hence, improving efficiency will deal with how to gain more “output” with resources and “input” regarded as a given. With respect to vehicle utilization, for instance, efficiency will relate to the transport-work that a given number of vehicles will provide.

Efficiency of vehicle maintenance is also a concern for the Truck OEM, the company that designs and sells the vehicles and related services. For a Truck OEM, efficiency with respect to maintenance involves issues related to the design of products and services as well as the efficiency of the workshop part of the company. However, even if the concerns of a Truck OEM are implicitly reflected on in this thesis as part of the discussion related to workshops, the specific perspectives of the Truck OEM will not be elaborated on for now.

For a maintenance provider, i.e. a workshop, maintenance efficiency revolves around issues related to workshop efficiency, i.e. how to perform maintenance in an efficient way with respect to the resources available. Hence, maintenance efficiency from a workshop perspective mainly addresses areas such as workshop planning, staff planning, service and repair operations, and spare parts handling.

Maintenance efficiency from the perspective of the vehicle users, i.e. the transport providers, however, differs from the perspective of the workshop. For a transport provider, it is expected – and required – that the maintenance provider performs the maintenance tasks as efficiently as possible. Instead, maintenance efficiency for a transport provider relates to vehicle utilization, i.e. the transport provider's targets involving vehicle efficiency and reliability.

Moreover, as indicated above, the perspective of the transport buyer differs from those of the maintenance provider and the transport provider. For a transport buyer, efficiency relates to the overall transport and logistics operations. Efficiency of vehicle maintenance thus relates to the overall objectives, efficiency and reliability with respect to the transport services procured.

The concept and scope of efficiency of vehicle maintenance thus vary between the different stakeholders. Improving the efficiency of vehicle maintenance relates to different aspects for the three stakeholders discussed. To visualize this, maintenance efficiency can be imagined as three layers of an "onion"; see Figure 1.1. In the middle, or core, we find maintenance efficiency from a workshop perspective. This core is contained by the next layer, which relates to maintenance efficiency for the transport provider and, finally, the outmost layer relates to vehicle maintenance from a transport context perspective.

It would be possible to add another outer layer related to the customers or consumers that rely on the transport procured by the transport buyer. As this thesis mainly focuses on the two outer perspectives in Figure 1.1, this possible additional perspective is excluded for now however.

It is imperative to note that in order to improve the overall efficiency of vehicle maintenance, i.e. maintenance from a holistic perspective, the efficiency perspective of all three layers (or stakeholders) must be addressed. As the perspective and scope of each stakeholder differs, it is also important to note that some objectives may therefore be contradictory.

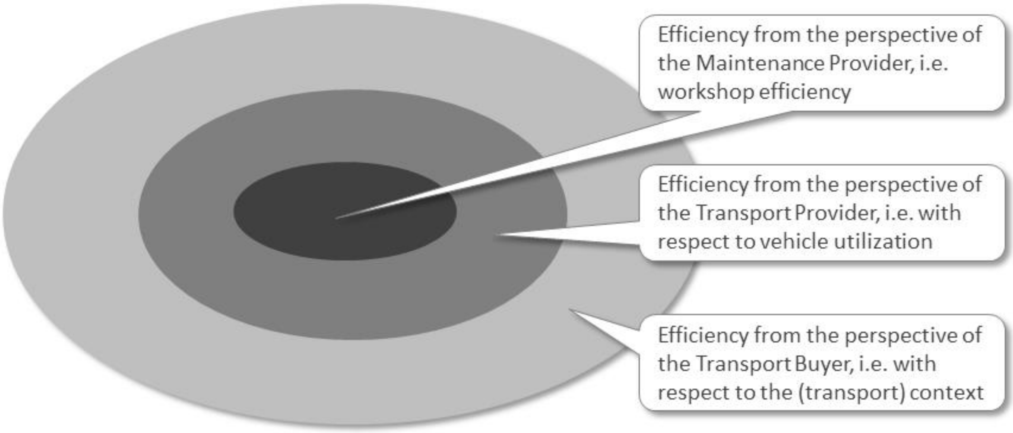

Figure 1.1 Efficiency from different perspectives.

From a managerial perspective, it is important for the present research to better understand how to improve maintenance efficiency from a holistic perspective. To achieve this, it is not enough with a company-centric view focusing only on the maintenance provider. Instead, a more extensive focus will be applied.

A dyadic perspective involving the maintenance provider and the transport provider, see Figure 1.2, opens up for an analysis of the potential for efficiency improvements with respect to the interaction and interplay between the two firms.

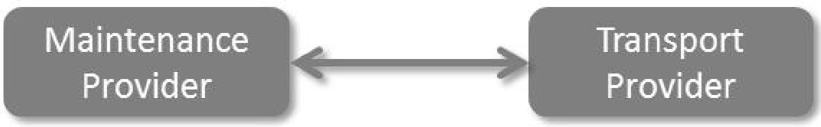

Figure 1.2 A dyad involving the maintenance provider and the transport provider.

However, the two companies involved in the dyad are also involved in other relationships. These relationships will influence and be influenced by what happens in the focal dyad; see Figure 1.3. The transport provider, for instance, interacts with one or several transport buyers. Similarly, the workshop most probably interacts with more than one transport provider. Hence, given that the perspective is highly applicable to firms involved in supply chains and transport solutions, a more holistic and network-based perspective is required.

Figure 1.3 provides an example of a network in which the maintenance provider(s), transport provider(s) and transport buyer(s) are embedded. Business relationships connect the transport provider with its customers, the transport buyers and the maintenance provider. Moreover, the maintenance provider depends on its relationship with the Truck OEM, e.g. for the supply of tools, knowledge and spare parts.

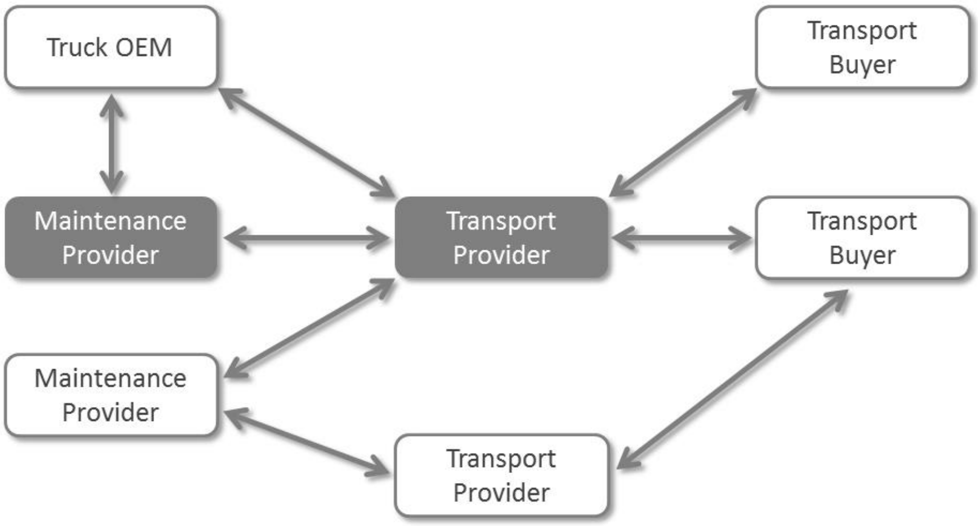

Figure 1.3 A network involving the dyad consisting of the maintenance provider and the transport provider.

The firms in the network shown in Figure 1.3 are embedded in an even wider business network: a network involving other Truck OEMs, other maintenance providers, transport providers and transport buyers. With a wider network, the number of interdependencies between companies also increases, as does the complexity of the context in which the vehicle maintenance activity is embedded. With increased complexity, it becomes a challenge to improve the efficiency of vehicle maintenance from a holistic perspective.

Hence, acknowledging the challenge posed by a holistic perspective, how could these firms, embedded in a complex network of actors and interdependencies, improve the efficiency of vehicle maintenance? How do the organizational structures, processes and business objectives of the firms involved influence the conditions for vehicle maintenance and how do they influence the opportunities to improve maintenance efficiency?

To address these issues, detailed knowledge is required about vehicle maintenance from a holistic perspective.

1.3 Aim of the Thesis

The aim of this thesis is to contribute to the understanding of heavy vehicle maintenance in an interorganizational perspective.

A supplementary aim of the present work is to identify issues to address for further improvement with respect to the efficiency of vehicle maintenance.

The phenomenon in focus is the use and performance of heavy vehicle maintenance and the analysis is performed from a holistic and interorganizational perspective. The thesis is theoretically based on the Industrial Network Approach, reflecting the nature of the business network in which the companies involved operate. Specifically, maintenance activities are studied with respect to interdependencies between activities, resources and actors embedded in the network.

As stated above, this thesis concerns maintenance of heavy vehicles used for freight transports. Heavy Vehicles (Heavy-Duty Vehicles, Heavy Goods Vehicles) for freight transports are often defined as vehicles (Truck/Lorry) with a maximum mass exceeding 3.5 tonnes (See e.g. UNECE Classification and Definition of Vehicles). In this thesis, however, it is primarily the usage of the vehicles, and not a specific weight limitation, that is of importance.

1.4 Structure of the Thesis

Following this introduction, the analytical framework applied in this thesis is presented. The framework draws on concepts from the Industrial Network Approach, forming a toolbox applied to the case analysis. Chapter Two also involves a problem discussion, including the articulation of three research questions. Chapter Three discusses the methodological considerations of the qualitative case study. The chapter includes sections related to casing, data collection, data analysis, research quality and the overall research process. Next, Chapter Four provides a description of three cases: Dairy Products, Retail Corporate Group and Forest Products. In the same chapter the cases are analysed. Chapter Five is dedicated to a cross-case analysis, while Chapter Six involves a discussion on the findings. Chapter Seven, the final chapter, encompass the conclusions together with managerial and theoretical implications.

2. ANALYTICAL FRAMEWORK

Heavy vehicle maintenance is an activity performed by staff at a workshop or garage. The activity in itself encompasses a number of sub-activities that must be organized, planned and performed by technicians and other personnel. Vehicle maintenance, however, is also interconnected with other activities, within and outside the workshop. The vehicle subject for maintenance for instance, is utilized by the haulier for transports procured by the transport buyer.

To perform the activities, various resources are required. In the workshop, tools and spare parts are examples of resources that are needed. The vehicle itself is a resource utilized by the haulier for transports.

To manage the resources and perform the activities involved in heavy vehicle maintenance, personnel from various firms interact and cooperate. Maintenance planning, for instance, requires a dialogue between the workshop and the haulier concerned.

Hence, planning and performing heavy vehicle maintenance is not only an issue for a single company or actor; it becomes an issue with interorganizational aspects and must be managed jointly by the stakeholders concerned.

2.1 Introduction

Vehicle maintenance and the stakeholders concerned are embedded in a business landscape. In this landscape, business relationships between the companies result in interdependencies. These interdependencies increase the complexity of the context in which the vehicle maintenance activity is embedded. With increased complexity and numerous interdependencies, it becomes a challenge to improve the efficiency of vehicle maintenance from a holistic perspective.

To capture the antecedents with implications for vehicle maintenance, the analytical framework chosen must support an analysis of companies interacting in the business landscape. Moreover, as the maintenance activity and the firms concerned are all embedded in an industrial network, the analytical framework must support an analysis of the interorganizational aspects of the business landscape. To allow for this, the Industrial Network Approach (INA) forms the basis of my analytical framework for this thesis.

The Industrial Network Approach provides a perspective that support the holistic approach that I apply on the questions related to vehicle maintenance. Vehicle maintenance, embedded as an activity part of a wider context, hence forms part of an “open system” without a boundary.

This chapter presents the analytical framework. First, a general overview regarding the Industrial Network Approach is provided. Next, the three dimensions of the ARA model (i.e. Actors, Resources and Activities) are presented in three separate and consecutive sections. As part of each section, the aim of the thesis is problematized, and a Research Question related to each dimension is formulated. Finally, a section discussing Business Relationships and Business Networks concludes the chapter.

2.2 The Industrial Network Approach

The Industrial Network Approach (INA), also referred to as the IMP Approach, takes its starting point in seeing a business landscape as a business network involving companies interconnected through business relationships (Håkansson et al., 2009). What happens between two firms in a business relationship influences and is influenced by what happens in business relationships between other firms. This forms the basis for seeing a business landscape as a network. The Industrial Network Approach has attracted increased interest in the last two decades; however, the approach is not new but has resulted from research and discussions over a number of decades (Håkansson et al., 2009).

Drawing on results from extensive studies of industrial markets performed in Europe during the 1970s, the “IMP 1” study, a new view on markets and purchasing took form. The approach introduced by Håkansson et al. (1982) as the Interaction Approach challenged the traditional and more conventional streams of economic theory related to the transaction cost model, the marketing mix model and the atomistic view of markets. Unlike the traditional view of purchasing, the new approach emphasized the importance of the relationship, often long and close, interaction between buyers and sellers, and the stability of industrial market structures. As a result of the authors’ work a new research model, the Interaction Model, was introduced.

Building on the work and concepts introduced in 1982, Håkansson et al. (1987) refined and developed the new approach further. From being based on a dyadic perspective, which involves the buyer and seller of goods, the interaction approach develops into a Network

Approach. The Network Approach involves three dimensions that represent elements shaping the function, features and dynamics of the network. The dimensions, or elements, introduced were:

1) Actors, "those who perform activities and/or control resources" (Håkansson et al., 1987, p. 14)
2) Activities, "that are performed by the actors which means that resources are combined, developed, exchanged or created by use of other resources" (ibid., p. 15)
3) Resources, that "consist of physical assets (machinery, material, etc.), financial assets, and human assets (labour, knowledge and relationships)" (ibid., p. 16)

The new approach, i.e. the Network Approach, moved the focus from firms to the network; however, both firms and their relationships are key components of these networks. As illuminated by Easton (Axelsson and Easton, 1992), "The focus of the research is, ultimately, the network and not the firm or the individual relationship, although firms and relationships must be studied if networks are to be understood" (ibid, p. 3).

The network represents a specific type of structure, one described by Håkansson and Snehota (1995) as follows:

> "This kind of structure represents a form of organization that has a few distinctive properties that originate in the nature of the relationships between its components. It is not a structure imposed on the companies (actors). The relationships are not determined a priori but result from enactment, therefore they change and evolve over time. This form of organization is peculiar because it does not have a centre, nor does it have clear boundaries" (Håkansson and Snehota, 1995, p. 19).

Business relationships have specific features that shape the dynamics of the business network. Håkansson and Snehota (1995, p. 20) argue that "Business relationships have the components of mutual orientation, commitment, adaptations, trust-building and social exchange over time. There is mutual interdependence of outcomes since they cannot be controlled unilaterally." These features in turn influence the nature, characteristics and dynamics of the network.

The dynamic nature of the network relates to the continuous change and adaptation of relationships. Business relationships evolve and transform over time through different episodes, with each and every episode influenced by the history with respect to the experiences of previous interaction but also by expectations regarding future interactions (Håkansson et al., 2009).

To allow for a deeper understanding of the business relationships in a network, analysis involving both function and substance of the relationship is required. For this purpose, the three-layered ARA model is developed by Håkansson and Snehota (1995). The model involves three 'layers' representing various aspects of the relationship between two parties. The three layers relate to one and each of the three network elements discussed above, i.e. activities, actors and resources. Hence, in a relationship between two parties, we observe (see also Figure 2.1):

- An Activity Layer, interconnecting internal activities of the two parties through Activity Links
- An Actor Layer, interconnecting the two actors through Actor Bonds
- A Resource Layer, interconnecting resources of the two parties through Resource Ties

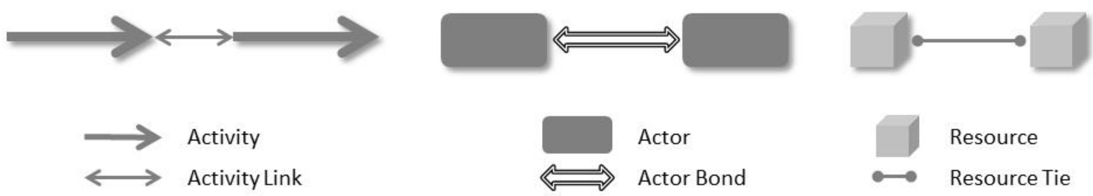

Figure 2.1 The three network elements and how they are mutually interconnected.

The activity links, resource ties and actor bonds reflect the status and nature of the business relationship. The business relationship evolves over time; hence the status and nature of the relationship will change over time. As every business relationship is unique, the substance and features of the three layers also vary between business relationships.

The layers of a business relationship are not independent. The substance and feature of each layer influences and is influenced by the relationship as a whole. Hence there is interaction between the links of the activity layer, the ties of the resource layer and the bonds of the actor layer. These interactions between the layers influence the development and dynamics of the business relationship (Håkansson and Snehota, 1995).

As a result of this, business relationships in a network are interconnected, as are the three layers of relationships on a network level. The business relationship between two actors in the network influences and is influenced by the development and dynamics of other relationships outside the dyad. Hence, an analysis from a network perspective requires a model encompassing the firm level, the dyad and the network. The model developed by Håkansson and Snehota (1995), depicted in Figure 2.1, provides the means for such an analysis.

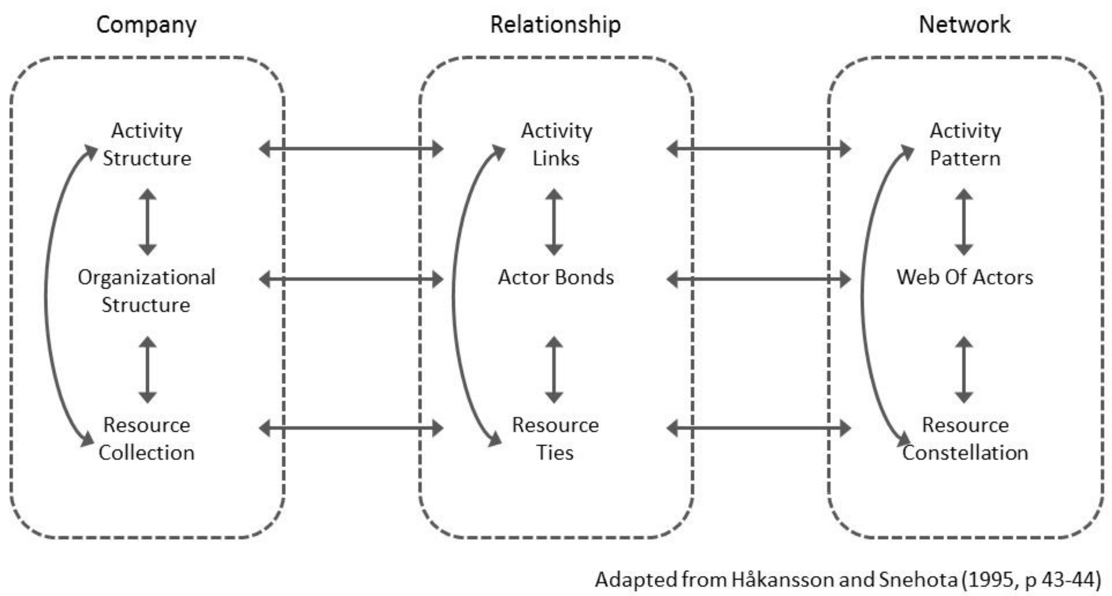

Figure 2.2 The ARA model, with the activity layer, the actor layer and the resource layer.

The model in Figure 2.2 encompasses three 'layers': the layer of activities, the layer of actors and the layer of resources. Within each layer, the interconnectedness of the elements is visualized as the activity links, the actor bonds and the resource ties. Moreover, the figure visualizes the interdependencies between the three layers.

Additionally, Figure 2.2 indicates that there are three different perspectives that could be applied for an analysis of the network, the firm level (the company), the relationship level (the dyad) and the network level.

In order to fully develop the analytical framework required for this thesis, more extensive concepts and models are required. For this reason, the next three sections focus on the three dimensions of the network: the actor dimension, the activity dimension and the resource dimension. The order of the three sections reflects the order in which the cases are analysed with respect to each network element.

2.3 The Actor Dimension

2.3.1 Theory and Concepts

The concept of actors relates to organizations and companies but is also applicable to individuals, groups and teams that are part of or represent a company or organization. A major difference between actors and the two other elements of the network, i.e. activities and resources, is that actors own a will and an intention. Hence, they are capable of managing activities and resources with a specific purpose (Håkansson et al., 2009). Actors are the ones that manage activities, own the resources and interact with others through business relationships embedded in the network.

The discussion often revolves around firms or organizations of the network; however, depending on the level of analysis, individuals are also important to the functionality and dynamics of the network. In fact, bonds between individuals are essential: “bonds between companies arise because of bonding between individuals” (Håkansson and Snehota, 1995, p. 194).

Even though the elements of the ARA model display different natures and features, there are interdependences between the elements that provide means to understanding the operations and products of companies. Cantù et al. (2012) discuss solutions as being resource combinations that develop through interaction between actors and hence argue that “… at the intersection of the actor and resource dimensions is the concept of a solution, defined as a combination of resources that has a meaning for an actor in the sense that the actor perceives it to serve some purposes. The solution is instrumental in solving a problem or achieving a desired goal.” (Cantù et al., 2012, p. 140)

A fundamental feature of actors is their ability to interact with counterparts within the organization itself as well as across firm boundaries, i.e. with other actors in the network. It is through this interaction that the actor is formed and its characteristics shaped. An actor has no meaning or purpose in isolation and interaction is thus a prerequisite for its existence (Håkansson et al., 2009).

Through interaction with others, and the development of business relationships, the actors involved develop actor bonds. The bonds enable the companies to channel direction, expectations and commitment, and to gain knowledge about the activities and resources of its counterparts (Håkansson et al., 2009). Together the actor bonds form a structure of actors interacting with each other, directly or indirectly. This structure, the web of actors, establishes the actor layer of the ARA model; see Figure 2.3.

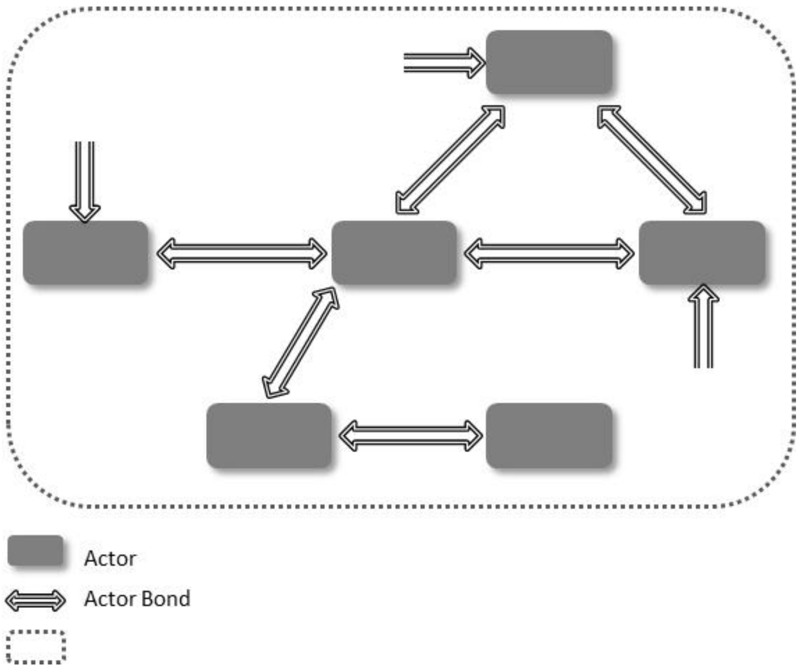

Figure 2.3 A web of actors interconnected with actor bonds.

Over time, the actors develop interdependencies through interaction. The interdependencies may involve resources that have been combined or activities linked and adjusted to each other, or relate to the actor bonds themselves. As interaction can be seen as a continuous process, the interdependencies change over time reflecting the dynamic character of the business network.

Within the realm of interaction between actors, the social, interpersonal, exchange plays a vital role (Håkansson et al., 2009). Even when looking at firms or organizations as a high abstract level, it is important to bear in mind that the interaction in itself is enacted by individuals at some level. The interaction between individuals results in opportunities or obstacles for cooperation, exchange of products, technical development and so forth. Moreover, interaction forms the identity of an actor (Håkansson et al., 2009). As an actor interacts with several counterparts, the identity of this specific actor varies from counterpart to counterpart and, most importantly, an actor will have all these different identities simultaneously.

The identity of an actor is formed by the perspectives of other actors in the network. The bonds established between actors in the network are thereby essential enablers for the process shaping the identity of a firm (Håkansson and Snehota, 1995). As the identity of a firm depends on the specific perspective of the counterpart, and a firm simultaneously may have several different counterparts in the network, a conclusion is that a firm may have more than one identity at the same time. This is the case when, for instance, a manufacturer simultaneously acts as buyer, a supplier, and an employer.

The bonds between actors are characterized by two related processes, one concerning the reciprocal construction of the identities of the actors involved and the other related to the commitment and trust resulting from the business relationship that has developed (Håkansson and Snehota, 1995). Moreover, trust is a prerequisite for commitment as well as business relationships. Trust is gradually earned by actors through interaction over time, i.e. as a result of the business relationship developing between them. Hence, the business relationship, including commitment and trust, is formed by history as well as expectations about the future.

Due to the complexity of the business network, no actor can have a complete overview. It is not possible for a sole actor to have a clear picture encompassing all the other actors, their business relationships and the interdependencies between them. The reality shaped by the company, as well as the decisions made, will thus be based on knowledge about and influences from a limited part of the network (Håkansson and Snehota, 1995).

For a firm, the bonds established with other actors have an influence on the firms' activities and resources. Firstly, the bonds influence how the resources and activities of the firm are oriented towards other actors. That is, the bonds guide which resources and activities are involved in which business relationships and how. Moreover, the bonds influence the firm’s possibilities to mobilize external resources and influence the activities of other actors. As a business relationship cannot be established by a company alone but requires mutual interest and investment, this process cannot be controlled by a single actor.

2.3.2 A Research Question Related to the Actor Dimension

Actors play a crucial role with respect to the organization of activities and resources. In interaction, actors manage the coordination of activities and resource combinations. When the interdependencies between activities and resources of the network are strong and numerous, the role of the actors becomes especially important.

Logistics operations and supply chains feature complex networks of actors involved in various activities (see, e.g., Dubois et al., 2004; Sternberg et al., 2013). To ensure that goods are delivered according to expectations in an efficient manner, several companies often need to cooperate. Activities involved in the transport operations, directly or indirectly, must be coordinated by the actors in cooperation. Similarly, the actors concerned have to manage a variety of resources involving interdependencies spanning firm boundaries.

Actors of the network, interconnected via actor bonds, will strive to manage interdependencies and business relationships in a way that enables efficiency and productivity. This also applies to vehicle maintenance, an activity performed by a maintenance provider embedded in the network. Hence, the efficiency of vehicle maintenance will not only depend on the actions and will of the maintenance provider alone. Due to the interdependencies in the network, vehicle maintenance will influence and be influenced by other actors in the network.

As discussed in Chapter One, a maintenance provider forms part of a wider network of companies. These companies have different roles and provide different output but all relate directly or indirectly to the transport operations. Vehicle maintenance, an activity performed by the maintenance provider, is thereby subject to interdependencies conditioning its performance.

Hence, the first research question strive to clarify which categories of actors that influence the conditions for vehicle maintenance, and how.

RQ 1: How do actors and their interconnections influence the conditions of vehicle maintenance?

Actors manage activities and resources. For vehicle maintenance, encompassing a number of activities and resources, a number of actors at different levels will be involved. For an informed discussion regarding efficiency of vehicle maintenance, knowledge regarding which actors that influence the conditions for vehicle maintenance, and how, is key.

2.4 The Activity Dimension

2.4.1 Theory and Concepts

Activities establish the second key dimension in the network of companies. It is through the activities that products and services are formed and exchanged. Activities embedded in the network belong to one of two categories: transformation activities or transaction activities (Håkansson et.al, 1987). In a transformation activity, resources are combined in various ways to form new resources, i.e. goods or services. A transaction activity links transformation activities, resulting in activity chains and relationships. While activities are performed by actors and both use, produce and exchange resources, it is apparent that activities are closely related to the two other key elements of the network, i.e. actors and resources.

The activities within a company are organized in an activity structure (Håkansson and Snehota, 1995). An activity structure, see Figure 2.4, thus consists of activities managed by the company itself.

When a company establishes a business relationship with another company, links develop between activities belonging to the two companies. These links "… regard technical, administrative, commercial and other activities of a company that can be connected in different ways to those of another company as a relationship develops" (Håkansson and Snehota, 1995, p. 26). Activity links thus contribute to the content of the relationship, and through the links an activity pattern is formed (ibid). An activity pattern hence spans organizational boundaries and encompasses the activity structures of the companies involved.

An activity pattern incorporates all activities of the companies concerned but can be divided into activity subsets that are involved in producing a specific product or service. Such activity subsets, defined as activity configurations (Håkansson et.al, 2009), can be found in, for example, a company or group of companies that produces several products that differ due to variation in specification or customer needs. Thus, an activity configuration involves the activities in an activity pattern “that are involved in the creation of a particular product or service” (ibid, p. 100).

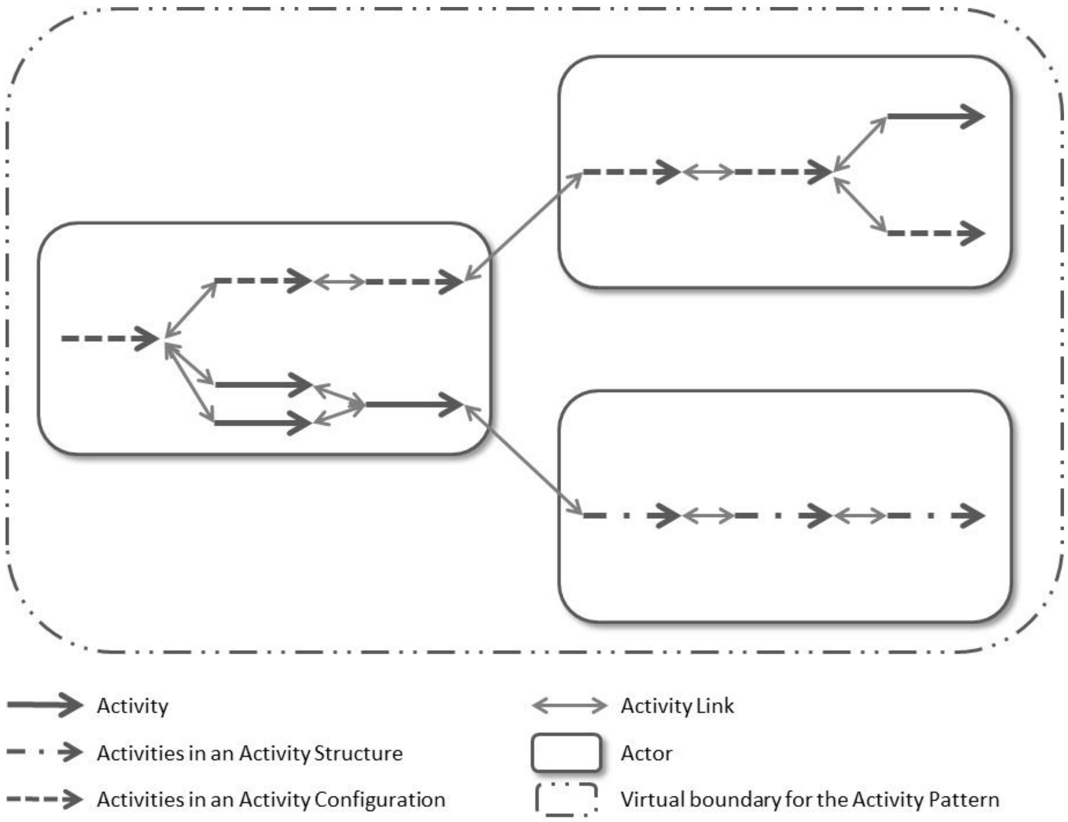

Figure 2.4 Organization and linking of activities in a network.

Over time, the activity structures of two companies interconnected in a dyad tend to become interdependent. The interdependencies part of a relationship drives the necessity for both inter- and intra-company coordination. As a result of these interdependencies, changes within a company’s activity structure also effects the activity pattern involving the other company of the dyad. Hence, also activities in the activity pattern outside the firm’s boundary may need to be adjusted. As a dyad is embedded in a wider network of companies with interdependencies both within and between dyads, a change within the activity structure of a company may also cause effects in other parts of the wider activity pattern of the network.

To understand the mechanisms of a business network, one of the primary tasks is to investigate how activities are organized among the companies involved. Activity patterns, activity structures and activity configurations will provide valuable information about the various features of the network. It is however equally important to clarify how activities, through interdependencies, are linked to other activities. Every activity in the network is dependent on other activities in the activity pattern stretching within and across company boundaries (Håkansson et al. 2009).

According to Thompson (1967), one of the authors providing inspiration to scholars involved in the development of the concepts part of the IMP Approach, a discussion about structures in organizations must also address issues related to interdependencies and coordination. To allow for such a discussion, Thompson (ibid.) defines three forms of interdependencies with respect to technological requirements within companies: pooled interdependence, sequential interdependence and reciprocal interdependence.

The first form of interdependence, pooled interdependence, occurs when each part separately contributes to and at the same time is supported by the whole. In cases of pooled interdependence, each part needs to be functional in order to guarantee the functionality of the whole. As an example of pooled interdependence, we can look at a company developing and selling a product. Within this company, each department of the organization contributes to – and is supported by – the whole. Moreover, the company's ability, i.e. the functionality of the whole, relies on the functionality of each department, e.g. the research department, the production facility and the marketing department.

While pooled interdependence may seem quite broad, the two supplementary categories of interdependencies provide more specific tools for analysis.

If an activity needs to be completed before the next one can start, these two activities are subject to sequential interdependence according to the ideas of Thompson (1967); see Figure 2.5. Sequential interdependences, for instance, are frequently observed in assembly processes or the flow of goods through a supply chain.

The third form of interdependence defined by Thompson (ibid.) is reciprocal interdependence. This form occurs when the output from each part becomes the input for the other. To illustrate reciprocal interdependence, Thompson describes two main operations within an airline: the regular operation involved in the transport of passengers and the maintenance operations. In this case, the passenger transport activity results in an aircraft in need of maintenance, an output that becomes the input for the maintenance activity.

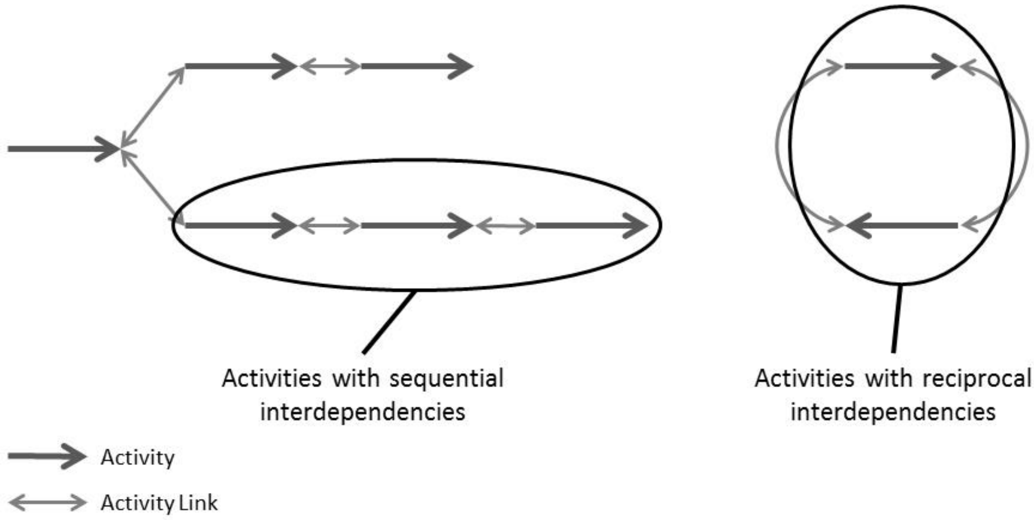

Figure 2.5 Activities with sequential and reciprocal interdependencies (Thomson, 1967).

The interdependencies defined by Thompson are not exclusive, and parts of an organization may be subject to all three classes of interdependencies simultaneously. For the airline described above, the two main operations simultaneously display pooled, serial and reciprocal interdependencies. According to Thompson (ibid., p. 55), “all organizations have pooled interdependence; more complicated organizations have sequential as well as pooled; and the most complex have reciprocal, sequential and pooled”.

Thompson furthermore argues that the three forms of interdependency, in the order discussed above, are gradually more difficult to coordinate and with an increasing level of difficulty also more costly to coordinate. For pooled interdependence, Thompson argues that coordination by standardization of routines and rules is appropriate. Sequential interdependence, the second level of complexity, requires coordination by plan, while reciprocal interdependence requires coordination by mutual adjustment according to Thompson (1967).

Inspired by the interdependencies discussed by Thompson in 1967, Håkansson et al. (2009) define three concepts for analysis of interdependencies in activity patterns: Serial, Dyadic and Joint Interdependencies. Serial interdependence, see Figure 2.6, occurs when an activity needs to be completed before the next activity can start. Joint interdependence occurs in cases when an activity is influenced by another due to both being related to a third activity; see Figure 2.6. Joint interdependence is observed when, for example, two components resulting from the production of different production lines in a subsequent step are assembled into a common system or product. The third category of interdependence discussed by Håkansson et al. (ibid.) is Dyadic interdependence. This category relates to cases in which activities are specifically adjusted to each other or the output from one is the input to the other.

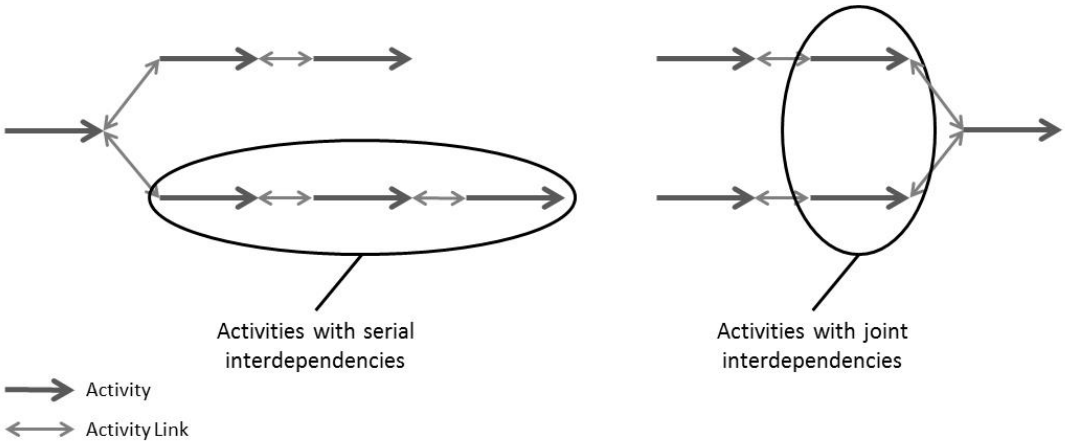

Figure 2.6 Activities with serial and joint interdependencies (Håkansson et al., 2009).

To allow for a more exhaustive investigation on serial, joint and dyadic interdependencies, Håkansson et al. (2009) introduce three supplementary concepts drawing on the work of Richardson (1972). The first of the concepts, sequentiality, relates to serial interdependence while the concepts of similarity and diversity regard the dyadic and joint interdependencies discussed previously.

For serial interdependence among activities, Håkansson et al. (ibid.) define two subcategories, sequential activities and tightly sequential activities. Activities with serial interdependence display the properties of sequential activities if they also need to be performed in a specific order. Apart from the fact that the activities have to be undertaken in a specific order, the interdependence between the two activities does not necessarily need to be strong.

Activities with serial interdependencies may also display interdependences with respect to the characteristics of the resources being used or produced. Hence, if the activities are mutually dependent with respect to the characteristics of the joint result, e.g. regarding specification or functionality, they are defined as tightly sequential activities. Activities involved in the production of customized products ordered with a unique specification, for example a passenger car or a PC, are characterized as being tightly sequential. Activities with tightly sequential interdependence have to be adjusted to each other.

Diversity in the activity configuration is a result of companies managing the specific and unique requirements observed in dyadic relationships (Håkansson et al., 2009). The result is diversity when companies, through a mutual adjustment of activities, strive to improve efficiency and produce customized products or services. However, as Håkansson et al. (ibid.) argue, diversity costs and makes it more difficult to manage joint interdependencies. For an activity adjusted to meet the specific demands of a dyadic interdependency, the diversity may cause problems in other activity configurations of which this activity forms part. This diversity may thus limit the firm's possibilities to manage joint interdependencies in an efficient way. Moreover, the diversity resulting from dyadic interdependencies reduces the possibilities to draw cost benefits from economies of scale. To balance the negative effects of diversity, the companies involved also need to set targets regarding similarity in the activity pattern. Similarity, achieved through standardization, improves the possibility of benefitting from economies of scale.

Efficiency with respect to heavy vehicle maintenance was initially discussed in Chapter One, the Introduction. For the present thesis, efficiency relates to the outcome of the utilization of resources, i.e. the outcome when an activity activates a resource. Improving efficiency thus becomes an issue of improving, or increasing, the outcome of an activity with resources remaining the same.

2.4.2 A Research Question Related to the Activity Dimension

Vehicle maintenance, the activity this thesis focuses on, encompasses both preventive and corrective maintenance. Maintenance is performed in order to ensure functionality of the vehicle and that it can be used efficiently for its intended purpose. Either maintenance is performed *ex ante*, i.e. as preventive maintenance, in order to avoid unplanned stops or *ex post* in order to repair the vehicle, i.e. as corrective maintenance.

Hence, on a higher abstraction level, there are two different states for the vehicle: subject to maintenance or being utilized for transport. According to Thompson (1967), this is what signifies activities having reciprocal interdependence, i.e. activities for which the output from each part becomes the input for the other. In this context, see Figure 2.7, the output from the activity called 'transport of goods' is a vehicle requiring maintenance. This vehicle in need of maintenance then becomes the input to the activity called 'vehicle maintenance'. When maintenance has been performed, the vehicle is once more available for its intended purpose, i.e. transportation.

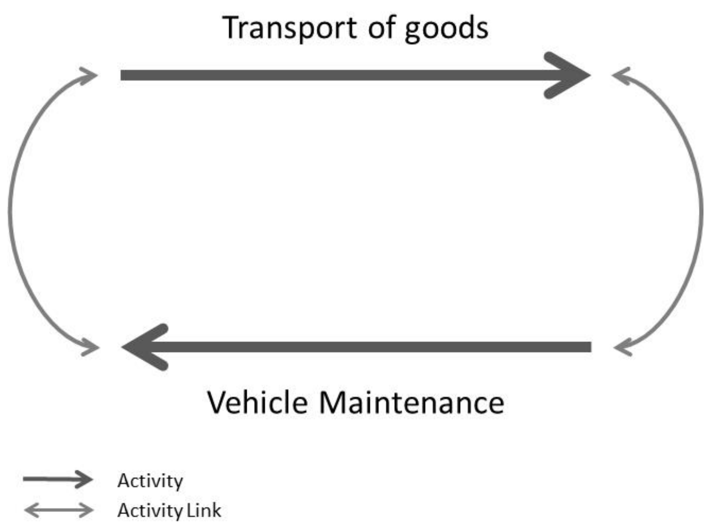

Figure 2.7 Vehicle Maintenance and Transport of Goods, activities with reciprocal interdependence.

However, if we leave this abstraction level and take a closer look at the network in which these two activities, 'transport of goods' and 'vehicle maintenance', are embedded, the level of complexity will increase. Both activities in Figure 2.7 consist of sub-activities that are but part of a wider activity pattern spanning firm boundaries. An abstraction level like the one in Figure 2.7 above does not enable a more thorough and advanced analysis of the activity pattern, its links and interdependencies.

Vehicle maintenance, either preventive or corrective, encompasses a number of activities displaying various types of interdependencies. As an example of corrective maintenance, activities related to diagnostics and fault-tracing must be completed before the actual repair can be performed. Similarly, spare parts must be ordered and delivered before maintenance can be completed.

Vehicle maintenance should thus be seen as an activity embedded in an activity pattern spanning several actors. Vehicle maintenance is part of the maintenance provider's activity structure but also involves links to activities in the wider activity pattern. In order to improve efficiency in an activity pattern spanning more than one firm, interaction across company boundaries becomes a necessity.

Hence the objective for the second research question is to uncover how vehicle maintenance is embedded in the activity pattern of the network, and expose the links and interdependencies that influence.

RQ 2: How is vehicle maintenance interconnected to, and influenced by, other activities in the network?

Heavy vehicle maintenance is an activity encompassing several sub-activities organised within, and outside, the firm boundary of the maintenance provider. These sub-activities are moreover interconnected to other activities performed by the actors of the network. To address the question regarding efficiency of vehicle maintenance, knowledge regarding links and interdependencies in the activity layer is important.

2.5 The Resource Dimension

2.5.1 Theory and Concepts

Resources establish the third key dimension of the business network, a dimension closely related to the other two, i.e. activities and actors. While activities are managed and performed by actors they use, produce and exchange resources.

Resources embedded in a business network exist in numerous, not to say endless, forms, sizes and shapes, tangible as well as intangible. Some are durable while others have a shorter lifespan. At a production facility, for example, we find physical and tangible resources such as machinery, raw material and end products, as well as intangible resources in the form of human resources and know-how (Penrose, 1959; Håkansson and Snehota, 1995).

Independent of their form and nature, a company's resources contribute strongly to the character and performance of the firm. In the work 'The theory of the growth of the firm' (1959), Penrose argues that "*Thus, a firm is more than an administrative unit; it is also a collection of productive resources …*" (ibid, p. 24).

Penrose moreover claims that:

> "Strictly speaking, it is never *resources* themselves that are the 'inputs ' in the production process, but only the *services* that the resources can render. The services yielded by resources are a function of the way in which they are used--exactly the same resource when used for different purposes or in different ways and in combination with different types or amounts of other resources provides a different service or set of services. The important distinction between resources and services is not their relative durability; rather it lies in the fact that resources consist of a bundle of potential services and can, for the most part, be defined independently of their use, while services cannot be so defined, the very word 'service' implying a function, an activity. As we shall see, it is largely in this distinction that we find the source of the uniqueness of each individual firm." (ibid, p. 25, italics in original)

In this claim, Penrose (1959) captures several key characteristics of resources. One of the characteristics discussed relates to the inherent multifaceted nature of a resource. Due to this characteristic, the same resource in different resource combinations may result in different outcomes. This possibility is an important asset for the company as well as the network.

A second characteristic discussed regards the interplay between activities and resources. In order to expose the result, product or produce involving a resource, i.e. the specific ‘service’ generated by the resource, the resource must be activated by the means of an activity.

Finally, and possibly most important, Penrose highlights the heterogeneous nature of resources. For a firm, the heterogeneity of a resource or group of resources provides possibilities for value creation in interaction with other firms.

Due to the heterogeneous nature of resources, the value of a resource is not a given, nor is it constant. The value of a resource depends on its features and lies in its potential use (Håkansson and Snehota, 1995). Hence, without a known use, an element should not be seen as a resource in this context. Moreover, as a result, the value of a resource depends on its potential use, the value not a constant. The value of a given resource differs between users and the various resource combinations of which the resource forms part (Håkansson et al., 2009).

Over time, resources combined with each other establish ties, so-called Resource Ties (Håkansson and Snehota, 1995). Resource ties exist among resources within a company, for example between machines in a production process. However, resource ties also span company boundaries. Such ties exist between, for instance, the resources of a sub-supplier and those within the buying company. The ties between resources belonging to different companies form part of the substance of the business relationship.

As a result of resource combining and re-combining, over time resources become adapted to each other. Hence, the companies involved gradually become mutually and increasingly interdependent (Håkansson and Snehota, 1995). This mutual adaptation has an effect on the features of the resources combined as well as the interface between them. This is also related to how specific a resource is to a certain combination, referred to as resource versatility by Holmen (2001).

Resource heterogeneity, providing a firm with the possibility of creating value and improving efficiency by combining the resource with others, is also related to economic concerns however. To manage the resource interface of every resource combination uniquely imposes a burden on the company. To address this downside of resource heterogeneity, the company may decide to standardize a resource and its interfaces. Standardization, or the use of intermediaries, provides cost benefits for the company by changing the resource heterogeneity to homogeneity (Håkansson et al., 2009). Even if standardization provides benefits for the company managing the resource, it may have negative effects on other resource combinations in which the resource is involved. As a resource and its resource interface are embedded in a network, both the resources and their interfaces are interconnected with other resources and their interfaces, i.e. it is not only resources in the network that are interdependent but also the related resource interfaces.

Within a company, resources tied together form a Resource Collection. The resource collection of a company reflects its specific purpose, i.e. what the company may achieve or produce and also sets the limitations for what the company may accomplish in isolation (Håkansson and Snehota, 1995). To improve the performance of a given resource collection, companies may cooperate and tie their resources together, as shown in Figure 2.8. These resource structures, which span company boundaries, are defined as Resource Constellations (ibid.).

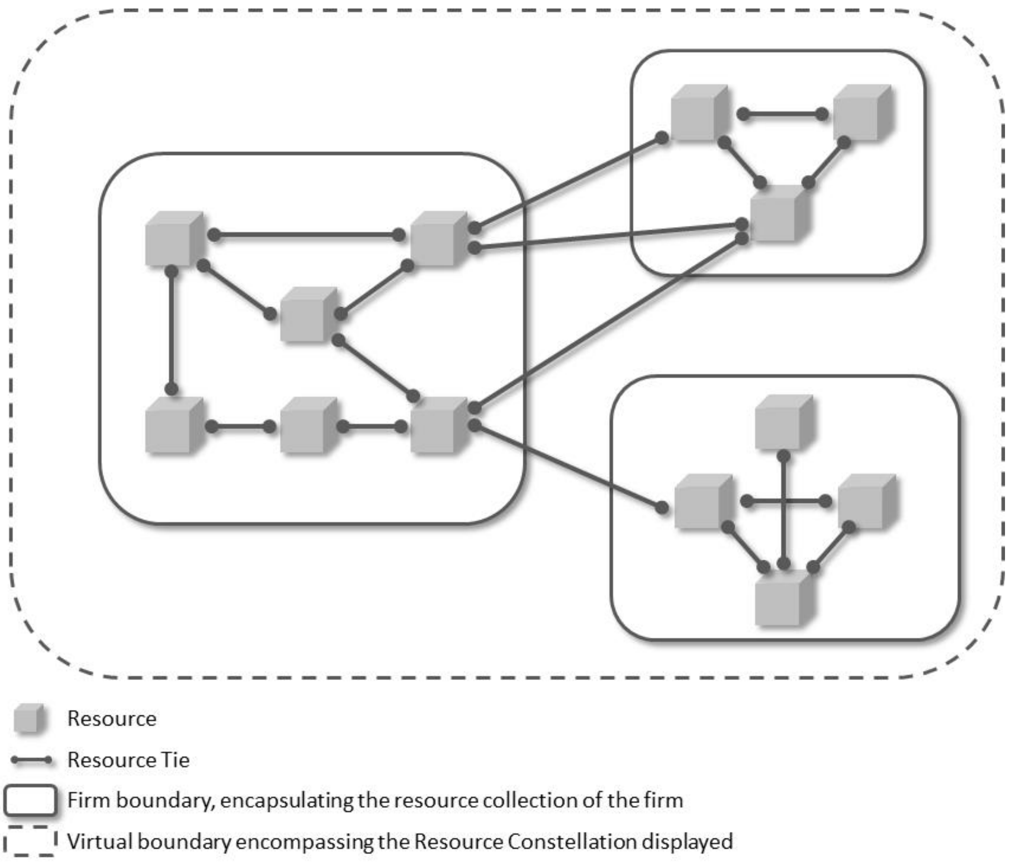

Figure 2.8 Organization and interconnection of resources in a network.

From a network perspective, resource ties among companies form an important part of the business relationships and are imperative and a result of cooperation. Combining and re-combining resources becomes part of the development dynamics of the firms involved. As a result of the resource ties developed over time, the resources managed by a firm may become influenced by other companies in the network. Hence, the performance of a company not only depends on the resource part of its resource collection but also on the resource part of the resource constellation outside the firm's boundary. Through the process of combining and re-combining resources, knowledge about the usage and value of the resources is gained and the firms involved are able to evaluate means for improving utilization of the resources.

For the phenomenon in focus for this thesis, heavy vehicle maintenance, planning and plans are important prerequisites. To meet the needs of the transport buyer, transport planning is a focal activity. Similarly, planning of vehicle maintenance is required for both the maintenance provider and the transport provider. The outcomes of planning activities as these are plans, resources with an inherent value, possible to combine with other resources embedded in the network. For preparation of vehicle maintenance, the maintenance plan of the haulier must be combined with the maintenance plan of the workshop.

2.5.2 A Research Question Related to the Resource Dimension

The resource dimension also plays an important role in vehicle maintenance. The specification and equipment of the truck influence which maintenance operations to perform as well as when and how. Moreover, replacements and spare parts must be available and the facility and technicians properly prepared for the tasks.

In the case of vehicle maintenance for trucks used for goods transport, the transport buyer, the transport provider and the maintenance provider are key actors. In Figure 2.9, some typical resources are mapped in relation to these key actors. The figure display the resource collection formed by the resources of these actors, and also involve business relationships between the transport buyer and the transport provider, and between the transport provider and the maintenance provider. The function and content of business relationships will be further discussed in 2.6 below.

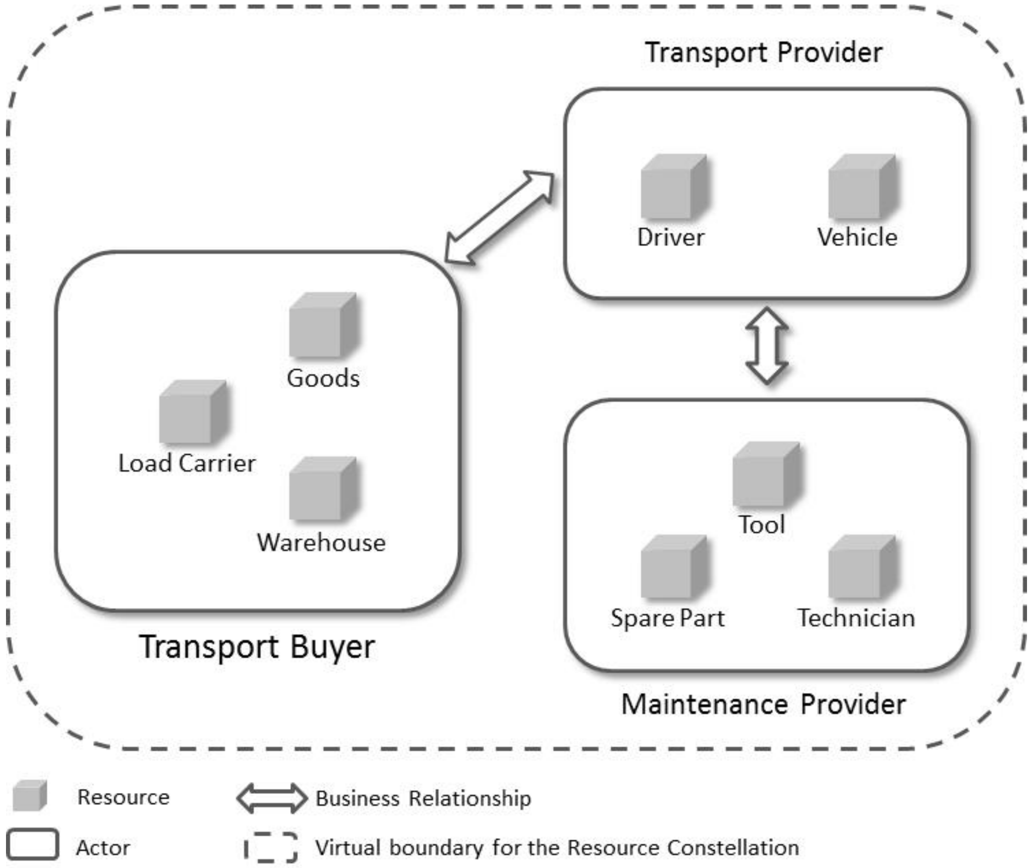

Figure 2.9 Organization of some typical resources embedded in a network involved in freight transports.

A single resource in isolation should be seen as passive and without value. Its actual nature and value do not become evident until it is combined and interacts with other resources (Penrose, 1959; Håkansson et al., 2009). In a workshop, a tool in itself would not provide any value. It is not until the tool is put in the hands of a skilled and experienced technician and used according to the manuals that the value of the resource can be exploited.

Hence, interdependencies between activities, resources and actors strongly influence performance and efficiency in the networks. This also applies to the focal activity of this thesis: vehicle maintenance. To ensure that correct, timely and efficient maintenance is performed in a network of companies, a number of interrelated resources need to be activated and combined properly by the actors.

To capture the implications for vehicle maintenance with respect to resources, a number of questions should be addressed. To guide a systematic investigation, Baraldi et al. (2012, p.

126) suggest a focus on inquiries such as “Which resources are essential for a particular purpose or activity?”, “Which other resources indirectly influence those central resources?”, “Where are these other resources located in the external network?”, “How do the effects of these indirect resources become visible and transmit to the focal resources?” and “How can a firm influence the direct and indirect interactions involving the resources it is concerned with?”

With reference to the focus of this thesis, the purpose of the third and last research question is to expose which resources that influence the conditions for vehicle maintenance, and how.

RQ 3: How do resources and resource ties of the network influence the conditions for vehicle maintenance?

Heavy vehicle maintenance involves numerous resources that are organized and combined by actors of the network. The vehicle itself, as well as workshop tools and spare parts, are all examples of resources that are required when performing vehicle maintenance. Hence, a better understanding about how resources and resource ties influence the conditions for vehicle maintenance becomes important.

2.6 Business Networks and Relationships: Implications for Strategizing

Actors in interaction develop relationships that connect the organizations or firms involved. As the relationships influence and are influenced by other relationships, interdependencies develop between the companies involved. The firms and their business relationships hence form a network of actors interconnected through business relationships. The network does not have a specific centre and, due to the interconnectedness of relationships, nor does it have a clear boundary (Håkansson and Snehota, 1995).

For a firm embedded in a network, business relationships are an integral part of the environment and strongly influence its operations. Relationships develop over time with suppliers, customers, competitors and other stakeholders. A firm may have numerous relationships with other companies in the network. However, research indicates that only a limited number of these relationships actually have a strong influence on the company’s performance (Håkansson and Snehota, 1995). Hence, for a firm it becomes essential to identify the relationships that most strongly influence its operations and performance.

Moreover, relationships are influenced by the dynamic nature of the network, and the structure formed by the network and its business relationships will evolve over time.

A network has a history, and the current state of the network elements and interdependencies is a result of the past (Håkansson et al., 2009). The activity layer, for instance, has evolved over time through interactions and mutual influence. In the activity layer, the companies strive to improve the efficiency of the activity pattern through their business relationships. As activities in the network become mutually adjusted and adapted over time, the activity pattern becomes more specialized.

Similarly, the features and interfaces of a resource at any given time will be a reflection of previous interactions and its development along the resource path (Håkansson et al., 2009). The more interactions result in new resource interfaces the better the abilities to develop new interfaces for new combinations. The change in itself, however, is also related to costs, not only for the owner of the resource being changed but also for the owners of resources to which it is related. A resource adaptation aimed at improving the value of one resource combination could thus cause negative side effects in other resource combinations. Furthermore, the more that has been invested in development and adaptation of a resource previously, the more difficult it will be to implement new changes and new interfaces. To reduce possible costs and negative effects resulting from the change of a resource, companies could decide to introduce a new resource as an 'interface' to other resources in the network.

The future also influences the current state of a network. As expectations about the future influence how companies act and interact, this will be reflected in the state of the activity layer. As the network is dynamic, activity patterns are in constant development and interdependencies develop over time as a result of interactions between companies. Due to the nature of the network, with an ever on-going process of adjustments and changes, no equilibrium or optimal activity pattern is possible (Håkansson et al., 2009).

A dyadic business relationship connecting two actors in the network is the result of investments from both parties over time. The business relationship in itself, however, features a paradox: it provides opportunities for the two parties while at the same time limiting the parties from acting freely (Håkansson and Ford, 2002). Using the business relationships, a company may mobilize resources that stimulate development or improved efficiency. The same business relationship may at the same time restrict the company's possibilities due to adaptations and adjustments previously implemented as a result of the relationship. As a result, "… a network is both the source of life for a company and the cage that imprisons it" (Håkansson et al., 2009, p. 190).

Relationships are also related to a second paradox of business networks: relationships provide possibilities for the company to influence other actors but, at the same time, enable influences from other actors in the network (Håkansson and Ford, 2002). As a result of this mutual flow of influences, the business relationships of a network fuel development and change of the company itself as well as its counterparts.

A third paradox involves the issue of influence on other actors in the network. Companies tend to aim to influence the network in which they are embedded. However, the more and stronger the influence becomes, the less the effectiveness and innovation capabilities of the network (Håkansson and Ford, 2002).

For a firm embedded in a network, a major strategic undertaking is to manage the three paradoxes discussed above (Håkansson and Ford, 2002). This strategically oriented task, "strategizing" (Gadde et al., 2003), hence involves how to manage the business relationships of the company, balance the mutually opposing forces of influencing versus being influenced, and find an appropriate level of influence over counterparts in the network.

Strategizing in industrial networks is thus an issue of how to manage business relationships, resources and activities embedded in the network in a way that enables efficiency. As business relationships, as well as resource ties and activity links, are interconnected, it is not only the focal relationship that must be considered but also other business relationships that are influenced or influencing through interdependencies in the network.

In the resource dimension, strategizing is an issue of prioritization among counterparts in order to determine how the business relationships will support or hinder resource combining. Furthermore, strategizing with respect to resources will involve analysis of internal investments in resources in relation to how these will influence and be influenced by the business relationships of the firm. A third issue related to strategizing with respect to resources is the question of possible lock-in effects. When combining resources with a counterpart, there is a possibility, or risk, of a lock-in. This possibility, or risk, is something that the company has to evaluate and address.

Activities in the network are interlinked and form structures spanning company boundaries. Hence, for the activity dimension, strategizing is about the way the company manages cross-boundary activity interdependencies when striving for efficiency. A company that strategizes in the activity dimension will thus seek to influence the activities of other actors through interaction with its counterparts and attempt to improve efficiency by re-organizing the activity structures.

To strategize in a network context, an actor must apply an extrovert perspective as opposed to an introvert perspective focusing on the company itself. For a firm, it is not only the resources and activities they possess and control that are important but also the resources mobilized in the network and the activities part of the structure outside the firm boundary. Hence, for improved efficiency, the firm may use the capabilities of its counterparts as leverage and strive for an appropriate level of external control.

3. RESEARCH METHOD

This chapter discusses the methodological approach applied in the research presented in this thesis. The chapter starts with an introduction aiming at providing a background for the research performed. Following this, the research strategy and the casing process are discussed. Thereafter, the methods applied for data collection and data analysis are presented. A discussion about specific aspects related to the role as Industrial Doctoral Student follows upon this, and, finally, the chapter ends with a discussion on research quality.

3.1 Introduction

The journey resulting in this thesis started many years ago in the mind of a concerned Product Planner at Volvo Group Trucks Technology. Working as a global Maintainability Specialist provided ample opportunities to discuss uptime and maintenance with internal experts and engineers as well as market organizations and customers. However, there was a growing pile of unanswered questions and concerns without obvious solutions. When trying to address this troublesome situation the organization seemed to lack time, tools and data. As a result of this dilemma, the ideas for a PhD research project started to grow in my mind.

The research presented in this thesis was thus initiated and motivated by questions shaped within the organization of Volvo Group Trucks Technology (Volvo). A research proposal addressing the main issues and concerns was formed and an industrial doctoral position was created in cooperation between Volvo and Chalmers University of Technology (Chalmers). This Licentiate Thesis marks the midterm milestone of the on-going research.

Vehicle maintenance solutions are solidly grounded in the design and specifications of the vehicle, a fact well known by the industry. However, from the perspective of the vehicle users, the solutions should not only address the needs formed on technical grounds but also address the demands shaped by the transport operations of the transport provider, i.e. the antecedents underpinning demands for solutions for vehicle maintenance originate in the context in which the firms involved are embedded.

This fundamental assumption guided me to design the empirical study with an approach in which the demands and needs of transport providers are traced from 'the origin', i.e. the operations and requirements of the transport buyers. Hence, in an initial step, I have studied the operations and demands of the transport buyers in order to analyse their requirements for transport in general and maintenance specifically. Assuming that the requirements of buyers should be reflected in the operations of the transport providers I thereafter expanded the study to include hauliers. By applying this approach I opened up the possibility of gaining new knowledge to supplement, alternatively question and contrast, knowledge and presumptions I have gained over time through my work in the industry.

3.2 A Qualitative Multiple Case Study

Motivated by the scope and purpose of the study as well as the choice of the Industrial Network Approach as a foundation for my analytical framework, my research is based on a qualitative research strategy. To improve my understanding of vehicle users' needs and demands and how these are formed in a specific context through interaction and interdependencies, a qualitative research strategy fits well (Maxwell, 2013). Moreover, given the complexity of the business networks at hand and striving to answer the research questions articulated, a case study design is preferable (Yin, 2014).

As argued above, an ex-ante assumption was that the vehicle users' needs and demands are context related and vary between different transport operations. Hence, in the interest of being able to reveal not only more general requirements but also needs and demands that depend on the specific context studied, a multiple case design (Yin, 2014) has been applied.

3.3 Cases and Casing

Dubois and Araujo (2004) argue that case studies can have a notion of being open-ended with neither the phenomenon nor its context necessarily being known from the beginning and thus an arbitrary starting point may guide the initial phase of research. In my research, with assumptions and an approach as discussed above, the transport buyer established my empirical starting point for each case.

Departing from the position that needs and demands may be specific and unique for each context, transport buyers were selected in order to reflect assumed instances of variety. The sampling process was thus purposive (Bryman and Bell, 2011) with the aim of identifying possible differences with respect to context, operations and needs. Moreover, the transport buyers selected were known beforehand to manage operations heavily reliant on transport.

Having completed a number of interviews with transport buyers active in different industries and with different types of transport needs, three cases were identified as being of specific interest and having the potential to provide data relevant for the purpose of my research. The industries of the three cases were all dependent on transport as part of their core operations and, furthermore, the cases were assumed to reveal variety with respect to relationships, cooperation and influence from external companies. In the continued casing process (Ragin, 1992), the boundaries for each of the three selected cases were expanded in order to encompass additional companies with relevance to the research.

As a result of further data collection, the number of stakeholders in each case continued to grow, reflecting the main business relationships observed for transport buyers and transport providers. Figure 3.1 provides an overview of a generic case involving some of the main stakeholders observed.

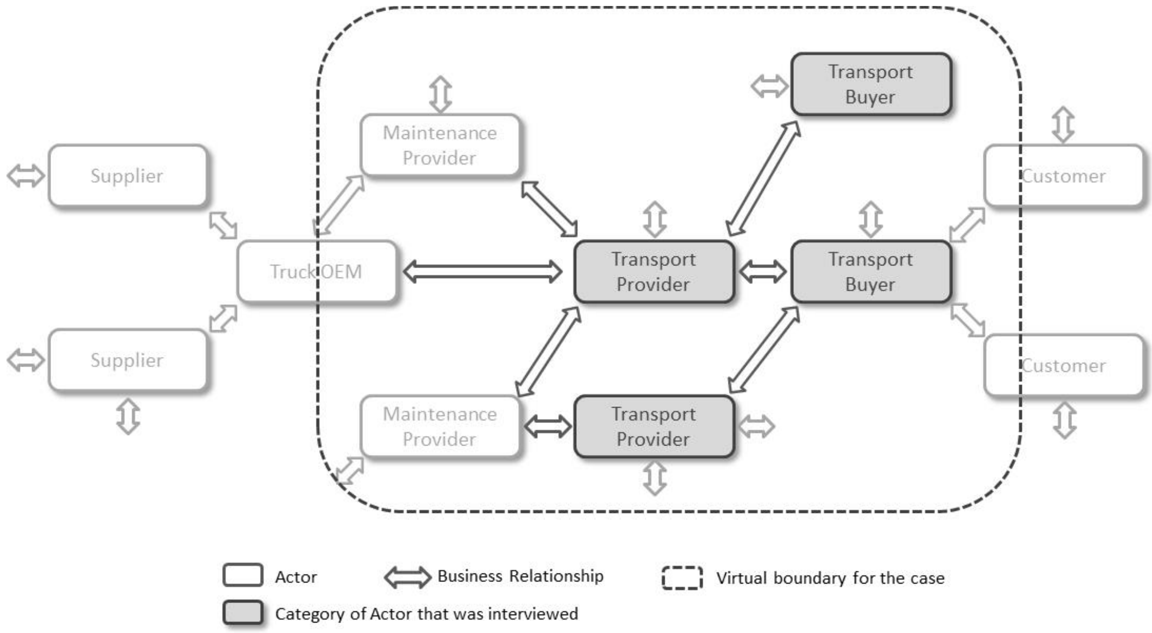

Figure 3.1 A generic overview of the main actors of a case typical for this thesis.

With the particular focus of my research, it became important to improve the understanding of vehicle users' needs and demands for vehicle maintenance and how these were formed in a specific context through interaction and interdependencies. Hence, the transport providers and their business relationships in the business network were of specific interest. However, even with the transport buyers used as empirical starting points, the firms with the main focus in my cases were the transport providers. Moreover, with a specific focus on vehicle utilization and maintenance, not all activities and business relationships of the companies involved required the same attention. For these reasons, the boundaries resulting from the casing process encompass the transport providers as well as business relationships and actors of relevance. In Figure 3.1, the "dotted line" symbolizes a typical example of a case boundary applicable to my research.

The decision of where to draw the boundary of a case depends on the progress and results of the casing process. For the three cases presented in this thesis, the decision about case boundaries was not made until late into the data collection phase, and the final boundaries were not set until during the thesis writing phase. As my focus has been on the antecedents underpinning demands for solutions for vehicle maintenance and how these demands relate to the specific context in which the firms involved are embedded, the boundaries of each case encompass transport buyers and transport providers. Moreover, firms that are part of the business network common to transport buyers and transport providers – and with possibilities to influence the maintenance activity – were included in the network of each case.

In this thesis, Chapter Four involves a description and (within-) analysis of each case. The case description and case analysis are divided in two separate sub-chapters.

The first section of the sub-chapter related to the case description aims at providing an introduction to the case and the main parts of the operations. Section two discusses the transport operations in detail while section three focuses on issues related to vehicle maintenance. The transport operation of each case strongly influences how vehicle maintenance may be planned and performed. In section four, an overview regarding the business network discussed is provided.

The subchapter for the case analysis is divided in three sections, one each for the three dimensions of the ARA model, i.e. activities, resources and actors.

3.4 Data Collection

To map and describe how transport providers operate, interact and address issues such as vehicle uptime and maintenance, in-depth empirical data regarding the focal firm and its business relationships with the main actors are required. To collect this rich data (Dubois and Araujo, 2007; Dyer and Wilkins, 1991), and simultaneously gain access to the specific viewpoints and knowledge of the actors in the business network, interviewing was chosen as the main data collection method (Yin, 2014; Bryman and Bell, 2011). To ensure the focus was on the phenomenon of interest and simultaneously be able to reflect on the specific characteristics of the case, the interviews were performed as Semi-Structured Interviews (Bryman and Bell, 2011).

Based on my previous experiences from the transport industry, in combination with knowledge gained through PhD courses and dialogue with supervisors and colleagues at the department, an interview guide was developed (Maxwell, 2013). By developing an interview guide, I could better ensure a proper fit between the purpose, research questions, theory and method. The generic guide that was developed could be adapted to both transport buyers and transport providers and covered a wide scope of topics related to the companies' operations, business relationships and issues of utilization and maintenance of vehicles (see Appendix 1 for further information regarding the interview guide).

To initiate the process of collecting empirical data and evaluate the interview guide that was developed, a pilot study was performed. Within the scope of the pilot study, three companies representing transport providers and transport buyers were interviewed. The objective of the pilot study was to gather data informing the casing process and the development of the interview guide. Having completed the pilot study, a revised Interview Guide was developed and later used for data collection. Of the three initial interviews that were part of the pilot study, only one is included in the three cases described in this thesis (see Tables 1 and 2).

Based on the results of the interviews performed, additional companies and interviewees were identified in a purposive approach (Bryman and Bell, 2011). In the early phase of the interview process, three cases of specific interest were identified. From this point, data collection was limited to these three cases and their main stakeholders. All in all, 13 interviews were performed as part of this first phase leading up to the Licentiate Thesis, see Table 1, whereof 8 are related to the three cases discussed in this thesis. The five additional interviews, see Table 1, were all part of the initial data collection phase during which the three cases were selected.

Table 1 Interviews performed for this thesis. Transport operation types marked with * were part of the initial pilot study.

Context	Interviews for Data for Licentiate Thesis	Additional Interviews Performed	Reference in Licentiate Thesis
Transport Operations			
Food Industry (Milk)	3		Dairy Products (DP)
Grocery Retail Industry *	2		Retail Corporate Group (RCG)
Forest/Timber Industry	3		Forest Products (FP)
General Cargo Transport *		2	
Medical Supplies *		1	
Refuse/Garbage Collection		1	
Infrastructure Construction		1	

The interviews, which lasted from one to two hours, were recorded using a voice recorder and then transcribed. For all but the initial interviews, the NVivo tool was used for transcription. The transcriptions, which provided a synthesis summarizing the dialogue, were then sent to the interviewees for review and feedback. The majority of the interviewees responded with feedback. The feedback received resulted in minor corrections or clarifications.

To ensure access to relevant and valuable data, the interviewees were selected based on their specific roles and responsibilities. In the case of a firm representing a transport buyer, the interviewee should not only have knowledge of the daily operations of the company but also specific knowledge about topics such as transport planning, transport purchase and relations with transport providers. For a company selling and performing transport, a transport provider, the interviewee must be well acquainted with the operations of the company, relations with its customers as well as how the vehicles were used and maintained. All the interviews where performed at the site of the particular company, thus also providing opportunities for observations. Table 2 provides an overview of the interviewees for the three cases presented.

Table 2 Overview of the interviewees providing data for this thesis. The interviewee marked with * was part of the initial pilot study.

Case	Role of Interviewees	Comments
Transport Operations		
Dairy Products (DP)	DP Transport Manager (Inbound)	Transport procurement and transport planning
	DP Transport Manager (Outbound)	Transport procurement, internal fleet and transport planning
	Contracted Haulier (Inbound)	Owner/Manager of a haulier contracted by DP for inbound transport
Retail Corporate Group (RCG)	RCG Transport Manager *	Transport procurement, SCM development and transport planning
	RT Business Area Manager	Management of business relations with RCG and contracted hauliers
Forest Products (FP)	FP Transport Planner	Timber transport planning and orders to haulier
	FP Haulage Manager	Manager of the FP internal haulier
	Timber Haulier	Owner/Manager of a timber haulier

To supplement the data gathered through the interviews, web pages of the companies concerned have been used as complementary sources of information when available. This supplementary data have been used to cross-check information from the interviews and to add further details regarding operations and organization.

3.5 Data Analysis

The data collected, mainly through the interviews performed, are presented in Chapter Four, which consists of three case descriptions and related (within-) case analysis. The analysis of the data is based on these case descriptions and divided into three main steps.

1) The first step, an initial analysis, was performed during the transcription of the interviews and write-up of the case descriptions. This analysis resulted in the figures included in each of the three case descriptions and ideas informing the two subsequent steps.

2) In the second step, the within-case analysis, the focus was on the three dimensions of the ARA model. For the purpose of the analysis, the data collected through interviews were structured and presented in figures. The figures, each related to one of the three ARA dimensions, provided a visual overview that facilitated analysis of interdependencies and organizational aspects. In the second step, related to the analysis within each case, three different types of figures have been compiled.

Firstly, for the actor dimension, the concept of network pictures (see, e.g., Holmen et al., 2013, and Roseira et al., 2013) provides inspiration for the figures identifying the main actors and their relationships. The figures for each case encompass the main actors involved in the focal transport operations as well as vehicle management and maintenance. For the activities, the second dimension analysed, parts of the activity pattern for each case were presented in a figure. For obvious reasons, not all activities managed by the firms involved have been included: the focus remains on transport operations, vehicle management and vehicle maintenance. Finally, the resources embedded in the network are mapped and organized in a figure for each of the three cases. As for the activity dimension, only selected resources that are part of the collection of each firm have been included.

3) In the third and last step of the analysis, the cross-case analysis, the focus was on similarities and variety. Here, the Transport Service Triad (Andersson et al., 2014, Hedvall et al., 2016) forms a generic element by which structures and interdependencies were analysed. The triad was used to analyse actors, activities and resources.

For a more comprehensive discussion on similarities and variety among the cases, a primary objective of the cross-case analysis, tables were compiled to structure and organize the collected data. Tables were also used as a tool in the concluding analysis.

3.6 Being an Industrial PhD Student

Being an Industrial PhD student with experience and knowledge gained from the industry offers ample opportunities. Knowledge about the products, context and terminology of the transport industry became valuable when formulating interview questions, sampling companies and interviewees, performing interviews and during the data analysis.

However, there are other sides to the role as an Industrial PhD student that require attention. Among the issues related to research ethics, two specifically concern my role as an Industrial PhD student. The first relates to the fact that AB Volvo provides the funding for my research and PhD studies, and the second is that I am an employee of Volvo Group Trucks Technology, a department that is part of AB Volvo – a main supplier of trucks and transport solutions.

If not properly addressed, circumstances like these could have a negative influence on my interaction with the companies in focus and the interviews performed. As the purpose of my research is to study the phenomenon in a neutral way from the perspectives of the transport buyers and transport providers, this becomes even more important.

Thus, as an Industrial PhD student it becomes essential to balance the positive aspects with the possible risks, drawing on the benefits the circumstances provide and addressing the potential threats of being seen as a representative of a major Truck OEM and not a ‘neutral’ researcher from a University. To strive for this balance, different approaches have been applied. In the case of the interviews, I was very clear about my connection with Volvo Trucks but at the same time strongly underlined that I was performing the interviews in the role of a researcher from the University. Furthermore, to open up a wider transport industry perspective, transport buyers and transport providers have been selected based on grounds that are valid for the research framework and not because they may possibly purchase trucks from Volvo. Hence, the companies selected operate with and have experience of various truck makes.

3.7 Research Quality

With respect to research quality and, specifically, validity, there is a link to my role as an Industrial PhD student from a company closely related to the focus of my research. According to Maxwell (2013), validity refers to “the correctness or credibility of a description, conclusion, explanation or interpretation, or other sort of account” (ibid., p. 122). Maxwell (ibid.) argues that this definition does not suggest that there is an objective truth and thus it fits well with the ideas underpinning my research and this thesis.

As an Industrial PhD student, I have addressed two specific issues to strengthen the validity and reduce the possible threats. The first issue is Research Bias, i.e. researcher subjectivity, and the second is Researcher Reactivity, the way I as a researcher may influence the setting or individuals.

To address possible threats caused by Research Bias, it was essential for me to recognize how previous knowledge and preconceptions could jeopardize my research and to understand how to avoid such risks during, for example, interviews and analysis.

Research Reactivity, a concern also discussed above in this chapter, became an issue of how to actively balance the opportunities provided through my role in the industry with the risk of negative influence on the interview situation through the same role.

Moreover, to further address possible threats regarding validity it has been my ambition to present a comprehensive description of the context and mechanisms of each case through rich data (Maxwell, 2013) from interviews. Conducting interviews with at least two interviewees related to the same case made it possible to compare, combine and contrast the information and data gathered. To enable this, as previously discussed, the interviewees were chosen based on their knowledge and experience. Additionally, as described above, the Interview Guide was tested and evaluated in a pilot survey involving interviewees from the industry. Thirdly, through respondent validation I have been able to address possible issues regarding the correctness of interview transcriptions as well as Researcher Bias.

Research quality, however, is not only about concerns and considerations related to data collection and analysis but also an issue that deal with the interplay between, and matching of, theory, method and empirical context, see Figure 3.2.

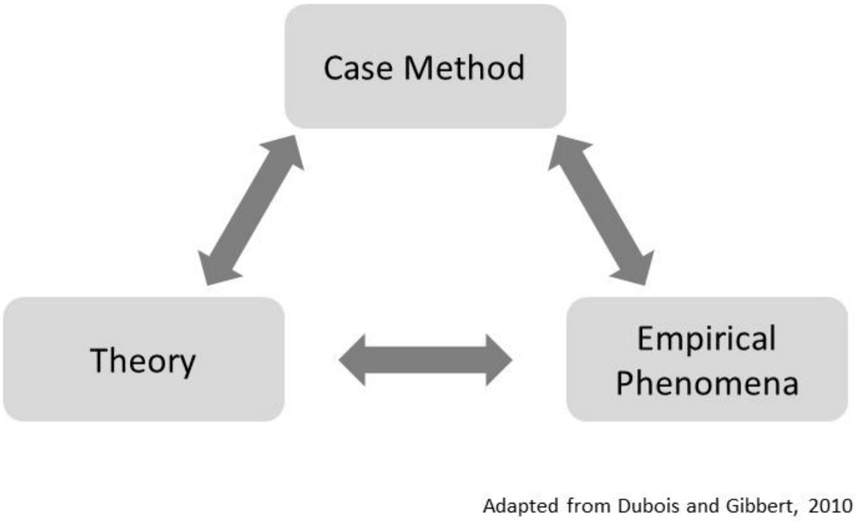

Figure 3.2 A figure describing the interplay between three dimensions of research.

Dubois and Gibbert (2010, p. 135) argue that "…the main point is to provide a transparent approach to the interplay between theory, empirical phenomenon and method". This thesis has therefore been written with intent on transparency, both regarding choice of analytical framework and methods, the context of each case presented, and the interplay between these three areas. I have, as far as possible, described and motivated the choices that I have made.

4. CASE DESCRIPTIONS AND CASE ANALYSIS

Chapter four presents the three (sub-) cases. Each case description starts with a general introduction, which is followed by a section on the transport operations related to the case. The third section covers vehicle maintenance, and section four provides a graphical overview of the main actors in the case.

Immediately after each case description, as a separate sub-chapter, a (within-) case analysis is presented. The analysis is structured in three sections according to the three dimensions of the ARA model. The case analysis starts with a discussion regarding the activity dimension and is followed by a discussion related to the activity dimension. Finally, the resource dimension of the case will be discussed.

4.1 Case Description of Dairy Products (DP)

4.1.1 Introduction

Dairy Products (DP) is an international corporation with a presence in six countries, including Sweden. The group has a cooperative ownership structure of milk-producing farmers, which currently number about 13,000, more than 3000 of which are in Sweden. DP’s operations in Sweden involve production, marketing and retail sales of fresh milk, and fermented and other dairy-based products. DP operates twelve dairies in Sweden whereof three are milk dairies that produce products such as milk, cream and soured milk. The remaining nine dairies, called special product dairies, produce milk-based products such as cheese and butter.

DP’s transport and logistics operations in Sweden have been divided into two parts; see Figure 4.1. One part is responsible for inbound transport from the farmers and transport of unpacked products between dairies. The other part is responsible for outbound transport and transport of packed products between dairies.

The three milk dairies manage all outbound transport: to industrial customers as well as shops and retailers for the consumer market. For the major retail chains, DP provides transport to the warehouses operated by the customers or direct to their shops, depending on the type of products. For the outbound operations, transport is provided either by DP’s own vehicles or by contracted hauliers. All transport to DP’s regional distribution terminals and of packaged products between dairies is undertaken by external hauliers. In areas where DP’s sales volumes are low, the distribution of its products is carried out together with other transport buyers through co-distribution arrangements.

For the inbound transport operations, the part on which this thesis focuses, DP contracts external hauliers: it does not use any of its own trucks. About 70 vehicles from some 30 hauliers are currently used in the inbound transport operations in Sweden. Most of the contracted hauliers are small companies and only operate between one and seven vehicles. DP prefers to contract small hauliers as it considers them more flexible and efficient than big hauliers. The transport operations rely on the drivers being familiar with the routes, farms and receiving dairies. The hauliers contracted for inbound transport own and manage the trucks that are used, while DP owns and manages the bulk tanks and most of the bulk tank trailers.

The capacity DP requires in the inbound flow is continuously being monitored by its logistics team. When deviations are observed, the capacity provided by the contracted hauliers is adjusted accordingly. DP aims to keep the hauliers that work in the inbound flow fully occupied, and they are thus not engaged in other transport assignments. The contracts between DP and its external hauliers last eight months, though the turnover of hauliers is very limited. DP demands continuous efficiency improvements in the inbound transport operations and, as a result, the number of contracted hauliers has decreased over the years. The number of milk-producing farms has also fallen, but due to greater stocks and improved efficiency, the volume of collected milk has remained almost the same.

The hauliers’ vehicles may be positioned in different locations according to directives from DP. This is to improve efficiency, as each vehicle is located in or close to the area from which milk is collected. DP only sets a few requirements for the trucks to be used, and the hauliers may decide, for example, the make and type of cab. In view of its focus on sustainability, DP does, however, require hauliers to use biodiesel where available.

To support its contracted hauliers and help improve efficiency, DP allows the hauliers to fuel their vehicles using the biodiesel infrastructure at its dairies. Additionally, DP leverages its purchasing size to offer external hauliers the chance to buy tyres through its framework agreement with a contracted supplier.

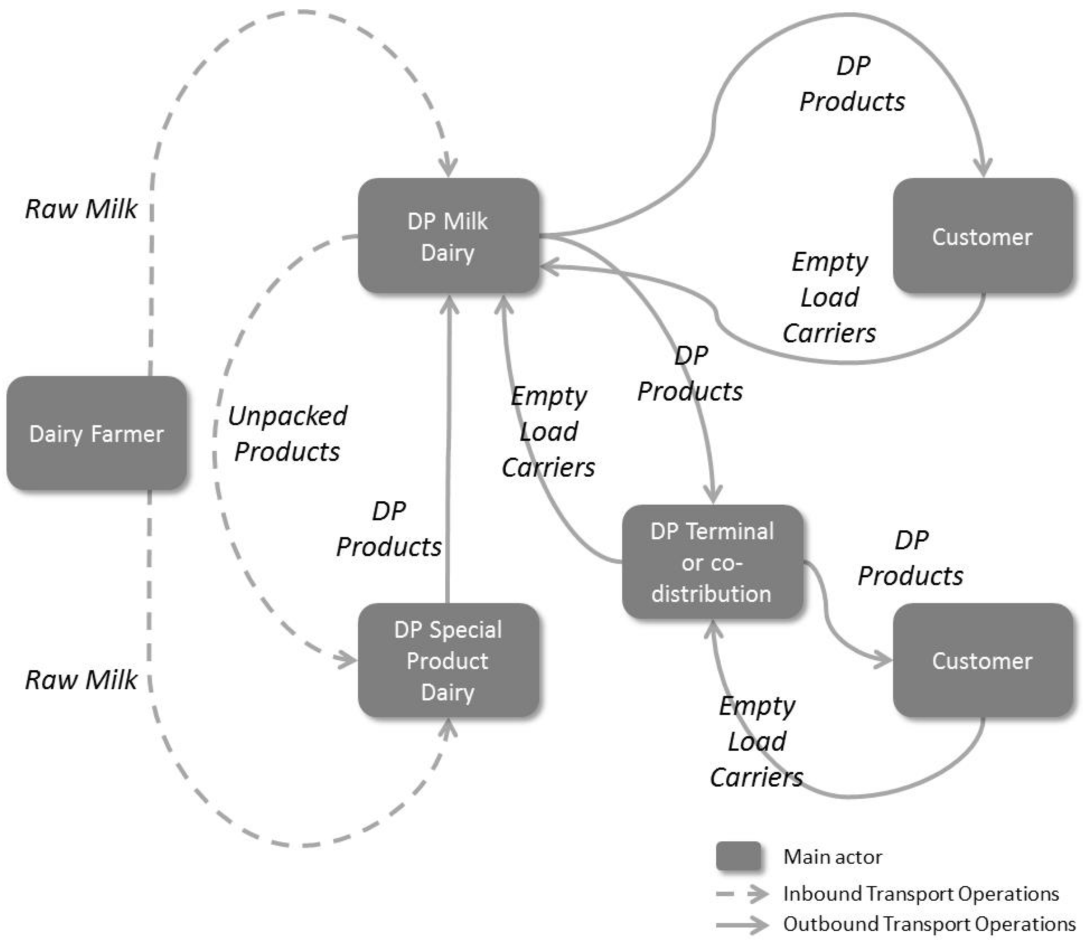

Figure 4.1 Overview of the inbound and outbound transport flows of DP.

4.1.2 Transport Operations

A logistics team at DP manages the purchasing and planning of the inbound transport operations. The team is also responsible for managing DP's bulk tanks and bulk tank trailers.

The transport plans managed by DP aim to address the requirements stipulated by the two main stakeholders: the milk farms and the dairies. The demands of the milk farmers are related to the biological 'clock' of the milking the cows, while the demands of the dairies are based on customer orders and production plans. The plan is optimized to minimize the number of trucks being used. The plans have fairly fixed 48-hour cycles. While the farms in a specific collection cycle are fixed, the receiving dairy varies. The consumer and customer demand for products and deliveries determines which dairy requires fresh milk, and the receiving dairy will thereby vary from day to day to reflect the demand.

Orders from industrial customers, shops and retailers are collected centrally on the day before distribution. The production at the milk dairies is adjusted based on the orders to meet the demand. Inbound transport and DP's production have to be well synchronized, and the time-critical processes with short lead times are in continuous operation. Milk has to be processed on the day it is collected and packaged no later than the day after.

The transport plan, which is revised annually, defines the time allocated for each activity in the collection cycle, e.g. loading, driving, unloading and cleaning. When establishing or revising a transport plan, DP discusses it with the haulier concerned. This allows DP to make use of the hauliers' extensive knowledge of the farms involved and the road network used. As the milk volumes produced by the farms vary during the year, the plan is continuously monitored and minor adjustments are frequent.

Milk is collected from a farm every 48 hours, and the transport process is in operation 24/7. Of Every 24 hours, approximately 23 are scheduled for milk collection or related activities. The contracted hauliers therefore clearly do not have time for other transport assignments. A collection cycle has a start and an end time defined in the transport plan. The number of stops, however, depends on how much milk the farms in question produce and varies from 1 to 20 farms, with an average of 12 farms for a vehicle with a trailer. Most farmers milk their cows twice every 24 hours: once in the morning and once late in the afternoon. The transport plan has to be adapted to the schedules of the different farms and address any restrictions due to limitations on the storage capacity at the farms. During a collection cycle, milk from different farms is mixed, unless part of the collection is organic milk. For the collection of organically produced milk, which currently represents about 25% of the total volume, separate bulk tanks must be used. During a collection cycle, a vehicle with a trailer may load up to 40,000 litres, whereof 26,000 on the trailer.

When the driver arrives at a farm, he inspects the quality of the milk stored by the farmer. If the quality level is approved, the driver starts loading. During the loading process, the pump equipment automatically takes a sample of the milk being collected. The sample is later sent to a laboratory for analysis. The results of the analysis are then transmitted to the pump equipment via the 3G network. When loading is complete, the pump equipment prints a receipt that includes information about the milk collected (e.g. time, location, volume, temperature) and laboratory analysis results for the previous collection. The laboratory results are an important source of information for the farmer as his remuneration is related to the measured parameters. The pump equipment is capable of loading 800 litres per minute, hence limiting the duration of the stop. Before leaving the farm, the driver hands over the receipt and prepares for tank cleaning, which the farmer completes later.

When the collection cycle is complete, the vehicle is driven to the receiving dairy. The dairy may differ depending on DP's production plans. When it arrives at the dairy, the vehicle is cleaned and its weight measured. The weight provides information about the volume of milk collected during the last cycle. Having unloaded the milk, the driver may fuel the vehicle before leaving the dairy to start the next collection cycle. The bulk tanks of the truck and trailer must be cleaned on the inside once every 24 hours, and when it is time the contracted haulier does this at the dairy after unloading.

Four drivers are assigned to each vehicle. The drivers work in shifts to keep the vehicles running round the clock. The driver changeover is usually performed just before or after the trip to the receiving dairy. The hauliers themselves are responsible for vehicle planning and driver scheduling.

Figure 4.2 provides an overview of the main activities in a milk collection cycle. The activities, repeated every 48 hours, are performed in sequence and follow the transport plan defined for each assignment.

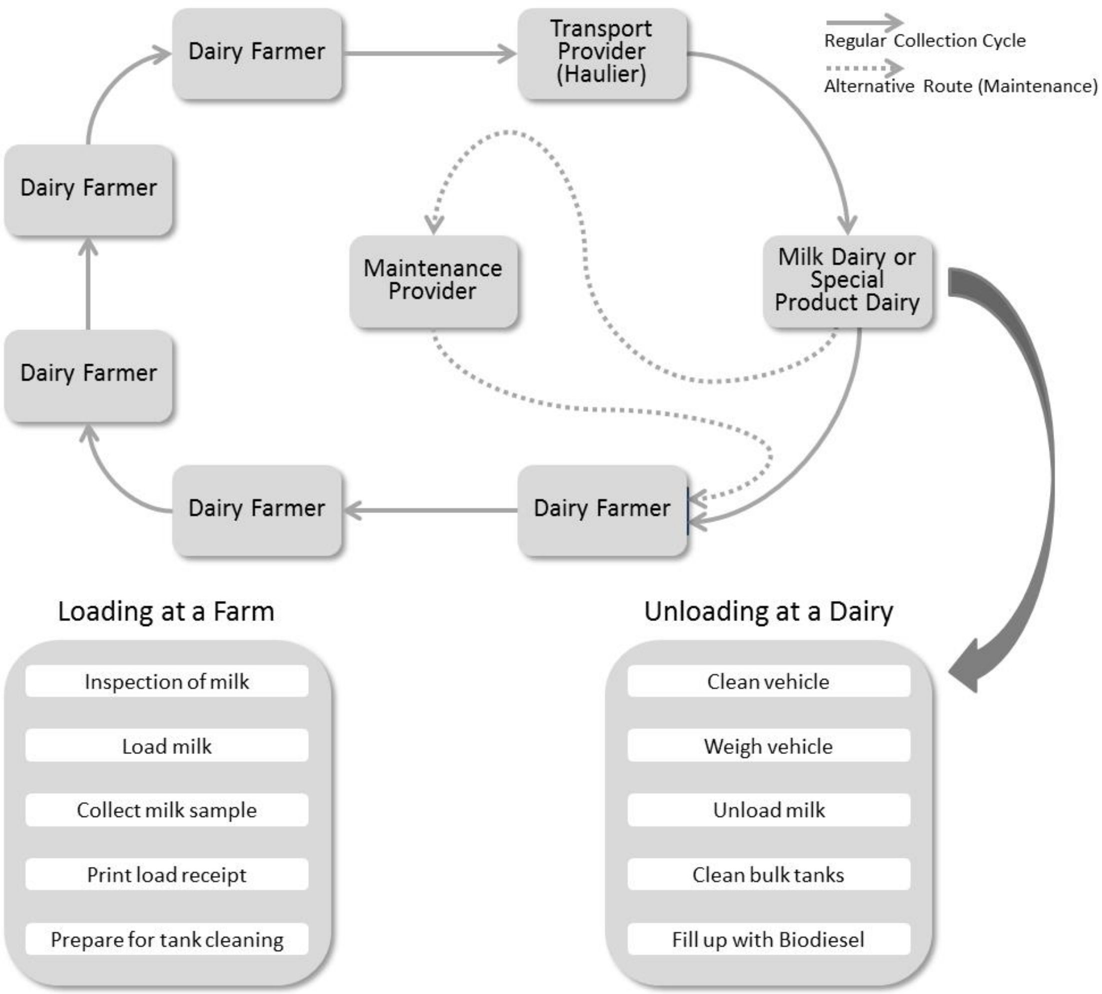

Figure 4.2 Overview of the main activities in a milk collection cycle as well as a cycle involving a visit to the workshop.

4.1.3 Vehicle Maintenance

The transport operations of the inbound flow should never stop, and disruptions must be resolved immediately. Milk production is ruled by biological processes, and cows continuously produce fresh milk. Even though the reliability and robustness of the inbound transport flow are crucial, DP's contracts do not include any specific requirements related to vehicle maintenance. Instead, DP leaves these matters to the contracted hauliers themselves. The reliability of the vehicle is thus important for the haulier. Hence, if the haulier, for some reason, does not have confidence in the vehicle he is using, he may replace the vehicle earlier than planned.

As the trucks are used 24/7, they cover more than 300,000 kilometres per year. With a service interval of 20,000 to 30,000 kilometres, vehicle service (preventive maintenance) is performed frequently. Unlike in the past, the trailers are now connected throughout the collection cycle, and they cover great distances in a year. The vehicles are kept by the haulier until they clock about 800,000 kilometres, after which they are replaced.

The hauliers are responsible for the maintenance of the vehicles while DP is responsible for the maintenance of the trailers, bulk tanks and related equipment. Once a year, a major overhaul is performed on each trailer. At this overhaul, which is performed by DP or a contracted workshop, all pipes and valves are demounted and the gaskets replaced. When a trailer is scheduled for maintenance, DP provides a replacement trailer for the haulier.

When vehicle maintenance is due, the haulier calls the workshop to agree a date. As transport plans are more or less fixed, a haulier can predict the monthly distance covered by a vehicle. In theory, it would thus be possible to establish a long-term maintenance plan. However, in order to safeguard flexibility, the haulier may prefer a shorter planning horizon of about a week. For minor service activities, often performed during the trip to or from the dairy, the driver stays with the vehicle. A haulier may also opt to perform minor maintenance activities itself.

For more extensive maintenance activities, the haulier may have to rent a replacement vehicle. However, to avoid renting a spare vehicle, a haulier may divide the maintenance into several parts that are performed separately on different occasions and timed in accordance with the transport plans. Flexible solutions like this are very valuable for a haulier. Hence some hauliers prefer a workshop that offers maintenance during evenings and weekends.

The workshop is one of the most important business partners for a haulier. Flexibility, quick response and service-minded personnel are hallmarks of the kind of workshop preferred by hauliers. The mind-set of the workshop personnel is important to the haulier, and it is highly valuable if repeated workshop visits or roadside stops are avoided through a proactive approach by the contracted workshop. All these qualities, as well as the geographical location of the workshop, are so important that they may guide the haulier's choice of make when purchasing a new truck. The haulier will also try to choose a tyre workshop with flexibility and quick response time.

To ensure reliability and robustness of the inbound flow and support its hauliers, DP owns about 20 vehicles that are kept as spares and are available for the contracted hauliers to rent if required. When, for example, a vehicle is due for a major service overhaul, the haulier may reserve one of DP's spare vehicles and adjust the vehicle and driver planning to enable efficient pick-up and return of DP's vehicle.

To ensure a better overview of the monthly maintenance costs, a haulier may sign a maintenance contract for the truck. The haulier then pays a fixed sum every month and relies on the workshop to manage all maintenance covered by the contract. Hauliers that have a maintenance contract for their trucks are also given high priority at the workshop when maintenance is required.

The trend for increased demands on uptime, reliability and efficiency is expected to continue. Even if vehicle maintenance is a key factor in meeting these demands, DP will continue to focus on its core business. DP therefore does not see itself taking a leading role with respect to vehicle management and maintenance.

4.1.4 Overview Regarding Main Actors in the DP Case

Figure 4.3 provides an overview of the main actors in the DP case. The network shows actors related to the inbound as well as the outbound transport. The diagram shows the many actors involved and the complexity of their relationships. Actors in the inbound transport operations, which are the focus of the case description, are shown in the left part of the diagram and actors in the outbound transport operations in the right part.

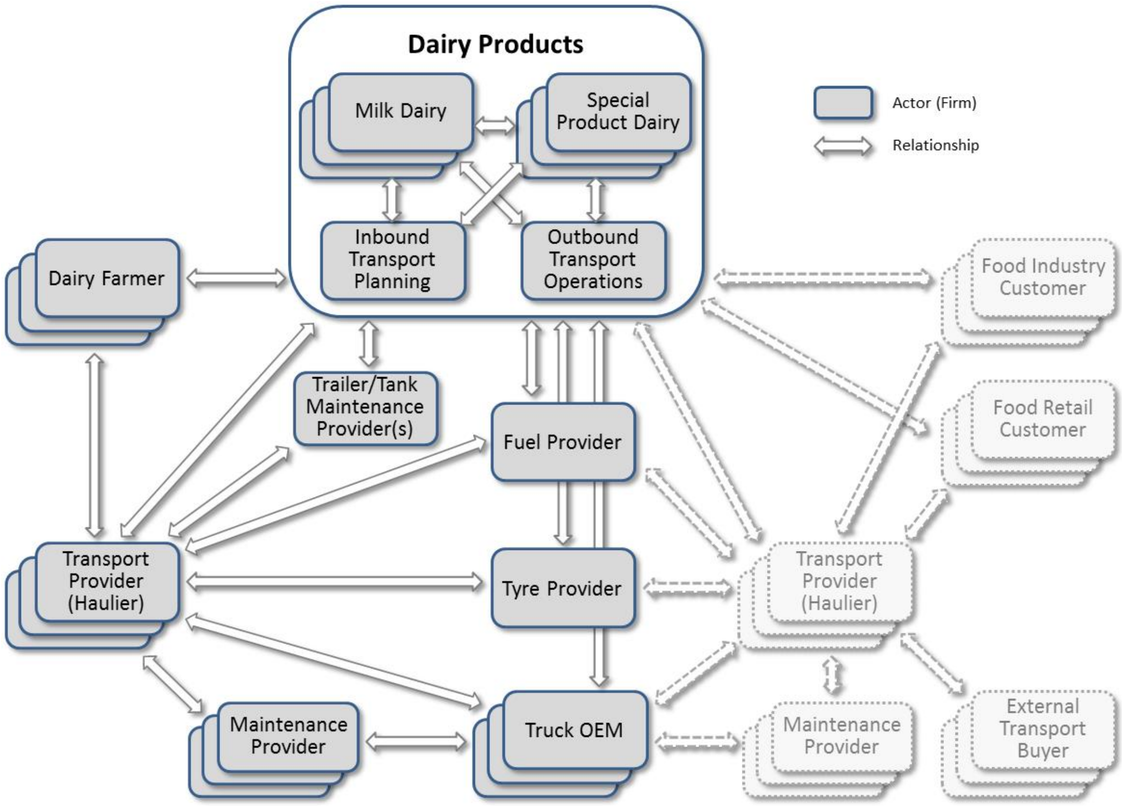

Figure 4.3 Main actors and their relationships in the DP case.

4.2 Analysis of Case Dairy Products

4.2.1 The Actor Dimension

DP's inbound transport operations relate to fresh milk, a product that is sensitive with respect to handling and quality. The processes involved, from the milking of the cows to the processing performed in a DP dairy, are directed by demands on handling times and regulations regarding quality and hygiene.

The network picture representing the DP case, see Figure 4.3, displays a multitude of actors and relationships. The web of actors in Figure 4.3 provides an indication that the companies must find means to interact and cooperate in order to secure functionality and efficiency in the transport flows.

The inbound transport operations involve three main actors: DP, the farmers and the hauliers. In this specific case, the farmers have two parallel roles, or identities, in relation to DP: the farmers are the owners of DP and at the same time suppliers of fresh milk to be further processed by DP. The business relationships between the farmers and DP are long term, and over time the two actors develop strong bonds and interdependencies. The transport providers are contracted as external suppliers of transport capacity. The hauliers contracted are normally small companies that do not carry out transport for any other customer. This results in the hauliers more or less becoming an integrated part of DP's operations. Even though the contracts are fairly short, about eight months, the relationships between DP and the hauliers tend to be long term, resulting in a limited turnover of hauliers. The hauliers, and their drivers, develop strong bonds with the farmers as well as DP, which makes the transport operations more efficient. All three actors are involved in, for instance, transport planning, more or less on a daily basis.

Figure 4.3 shows two additional actors indirectly involved in the transport operations. DP has negotiated agreements with a fuel supplier and a supplier of tyres, and it makes these agreements available to the hauliers.

Vehicle maintenance is performed by the maintenance provider, the workshop, contracted by the haulier. Irrespective of whether the haulier signs a maintenance contract, the business relationship with the workshop is one of the most important for the transport operator. The business and operations of the haulier contracted by DP rely on the vehicles being functional and usable for their intended purpose: the collection of fresh milk. In this context, the services of the workshop play a crucial role. The Truck OEM also has an important role with respect to vehicle maintenance. The Truck OEM is responsible for the design and manufacturing of the product itself and also provides knowledge, tools and the parts required for maintenance. The relationships between the haulier, workshop and Truck OEM are critical when planning and performing vehicle maintenance. As the targets for each firm may differ with respect to efficiency and productivity, the actors involved must engage in interaction in order to address possible obstacles and pave the way for efficient solutions.

To plan and perform maintenance efficiently, additional interdependencies must be considered. For the farmers and DP, the collection of fresh milk is the key issue. DP processes the milk to produce products ordered by its customers. As the hauliers have been contracted to collect the fresh milk, interdependencies between DP and its customer also influence the inbound transport operations.

4.2.2 The Activity Dimension

The activity pattern of the inbound transport operations involves activities related to DP's primary concern, i.e. the collection of milk from the farmers. The milk collection cycles are repeated every 48 hours, i.e. each and every farm is visited on a regular basis every 48 hours.

The activities involved in a milk collection cycle are performed in sequence and follow the defined transport plan. A cycle contains activities linked in a chain and displays serial interdependencies of a sequential nature; see Figure 5.2. Transport from the dairy must be completed before the loading process at the first farmer in the cycle can commence and, similarly, the transport from the first to the second farmer has to be completed before the milk loading process can be repeated. When milk has been collected from all the farms in the cycle, the milk is transported to the dairy where the unloading process starts.

To collect organic milk from farmers specializing in organic farming, the hauliers use separate bulk tanks dedicated to organic milk. Hence, when collecting organic milk, the activities of the chain display serial interdependencies of a tightly sequential nature. The milk is unloaded separately from regular milk at the dairy and also kept apart from regular milk in the subsequent processing.

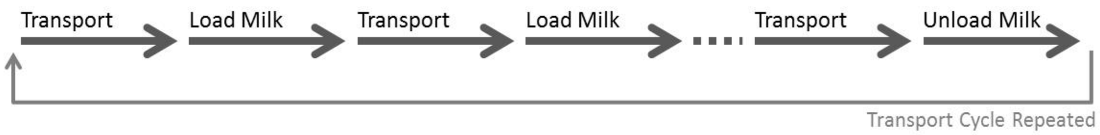

Figure 4.4 Main activities of the transport cycle for milk collection in the DP case.

The activities in the chain in Figure 4.4 are performed by the haulier or, more precisely, the driver of the vehicle. Two of the activities, however, are managed jointly with other actors: the loading activity and the unloading activity; see Figure 4.5. (N.B. in reality, the loading activity and the unloading activity both encompass a number of sub-activities with sequential interdependencies; see Figure 4.2.)

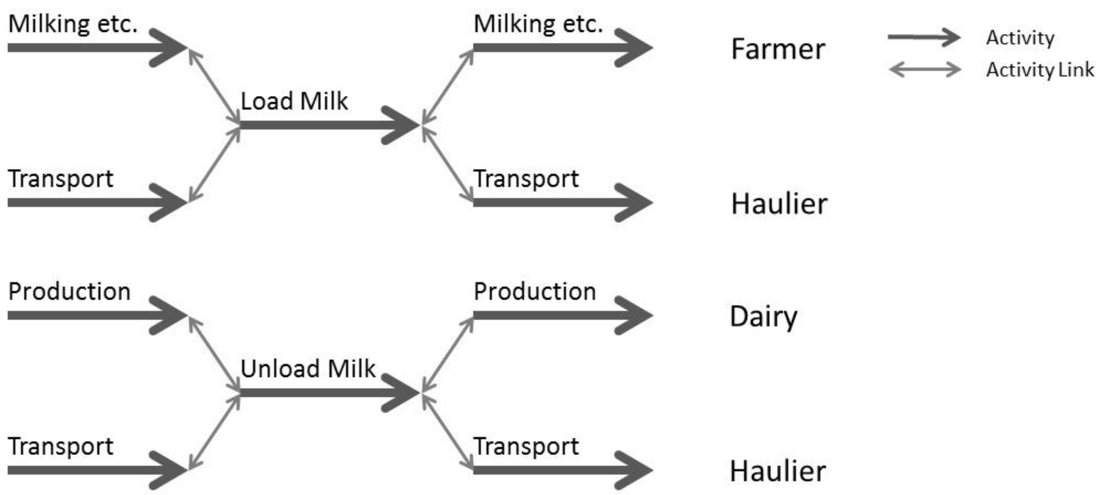

Figure 4.5 The load and un-load activities link the activity structures of the actors involved.

For loading and unloading, the activity structures of the two actors become linked through joint interdependencies. The interdependencies observed indicate that the activities in the two ‘parallel’ activity chains, which belong to each of the actors involved, have to be properly coordinated for functionality and efficiency of the operations managed by each of the actors.

The joint interdependencies, resulting in the activity structures of the actors concerned being linked, lead to the activity pattern also featuring pooled interdependence. In this activity pattern, each activity forms part of, and supports, the functionality of the wider activity pattern. Moreover, the activity pattern supports each of the activities involved. The result is that activities such as loading and transport are interrelated to other activities that are part of the activity structures of, for instance, the haulier and the farmer. This interdependence also results in an issue such as efficiency becoming more difficult to address.

The transport operation is governed with the focus on three main factors: 1) the milking process ruled by the ‘biological clock’ of the cows, 2) the production plans of the DP dairies, reflecting the customer orders received, and, 3) the aim of minimizing the number of trucks required for transport. This results in a transport operation with very little slack for activities other than milk collection and transport. Moreover, to meet the demands for quality, time is critical and the transport chain is governed by rigid and tight deadlines. All in all, the contracted hauliers face challenges when it comes to managing and coordinating the plans for transport, vehicles, drivers and vehicle maintenance.

Demands on the inbound transport operations result in the hauliers' vehicles being utilized round the clock, seven days a week. The vehicles are scheduled for transport or transport-related activities about 23 of every 24 hours. Not only does all this lead to the vehicles covering long distances over time but also to preventive maintenance having to be performed frequently.

As discussed in the analytical framework, the two activities of transport and maintenance can be seen as activities with reciprocal interdependence. The output from one becomes the input to the other, and vice versa. This 'high-level' perspective does not support a more detailed analysis of the interdependencies in the network however. In the eyes of a haulier, the maintenance activity may look like 'one' activity, but for a workshop, this 'one' activity consist of several interlinked sub-activities. Hence, a more detailed analysis than the one supported by the 'high-level' reciprocal perspective is required.

To allow for the time required for maintenance, the haulier must coordinate maintenance planning with the plans for the transport cycles. This results in interdependencies between the maintenance activity and the activities of the transport chain. If, as in Figure 4.2, vehicle maintenance is performed when the vehicle has left the dairy and before the next collection cycle starts, vehicle maintenance will be subject to serial interdependencies. The interdependencies involving vehicle maintenance and the milk collection cycles result in the activity structures of the firms involved becoming interdependent; see Figure 4.6.

Unless the maintenance provider is an 'in-house' workshop serving only the vehicles of the transport provider, the workshop will also have other customers, i.e. other hauliers. As a result, interdependencies between the transport provider and the workshop's other customers will develop. As the companies involved, i.e. the haulier, the workshop and the workshop's other customers, may have different objectives, the interdependencies observed may become a challenge and adjustments have to be considered.

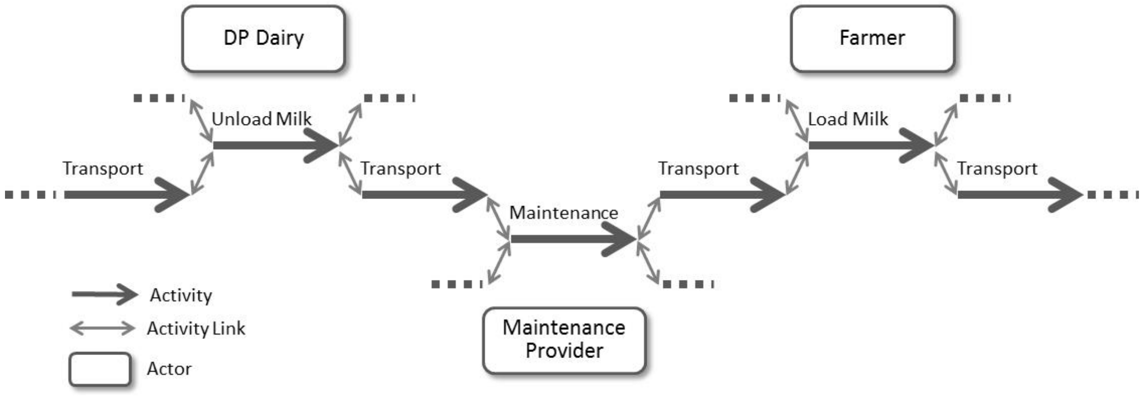

Figure 4.6 The load, un-load, and maintenance activities link the activity structures of the actors involved.

It becomes obvious that an unplanned maintenance stop, e.g. a repair due to a malfunction or accident, is difficult to manage. In such cases, the haulier must address short-term issues related to the milk collection cycle having to be completed in due time and more long-term issues related to a replacement vehicle having to be arranged. To prevent unplanned stops, it thus becomes critical that preventive maintenance is performed as required and is of high quality.

As some of the key resources, i.e. the vehicles, bulk tanks and trailers, are owned by different actors, complexity with respect to maintenance is increased. The hauliers manage the maintenance of their vehicles while DP is responsible for the maintenance of the tanks and trailers. From an efficiency perspective, it is preferable to coordinate the planning with respect to maintenance of the vehicles, trailers and tanks.

4.2.3 The Resource Dimension

The resources are closely related to the activities embedded in the network of actors. While the activities are managed and performed by actors, the activities use, produce and exchange resources. The resources exist in numerous forms, tangible as well as intangible.

Figure 4.7 provides an overview of important resources of the main actors in the DP case. The resources selected for this figure are related to the key process of the case studied, i.e. the collection of fresh milk for further processing at a DP dairy.

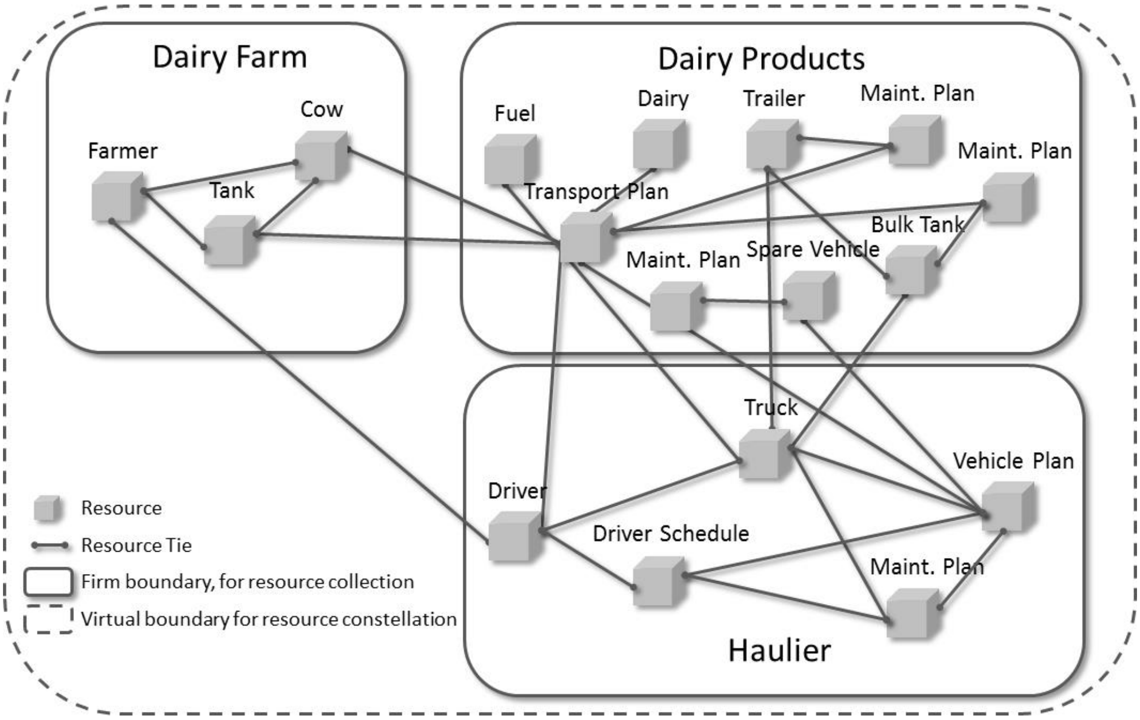

Figure 4.7 Resource ties interconnecting the resource collections of the actors involved.

Within each firm's boundaries, the resources form a resource collection, a structure in which the separate resources are connected through resource ties. For the dairy farm, three main resources are included in the figure: the farmer, the cows and the tank for fresh milk storage. The operations of the haulier involved in transport for DP include two tangible resources tied to each other: the truck (tractor) and the drivers. The haulier also manages three intangible resources: the vehicle plan, the driver schedule and the (truck) maintenance plan. The maintenance plan is tied to the truck, reflecting that the technical specification of the truck influences the maintenance plan established by the haulier. DP, the receiver of the fresh milk collected at the farms, manages five main tangible resources and four intangible resources. The trailers, bulk tanks, fuel infrastructure, spare vehicles and dairies themselves represent the tangible resources. The intangible resources encompass the transport plan and the maintenance plans for the trailers, bulk tanks and spare vehicles. For DP, the transport plan is related to the production plans of each of the dairies.

The resource ties, however, stretch over firm boundaries and, as a result, the resource collections of the separate stakeholders form a resource constellation. In the DP case, numerous ties connecting the resources of the three stakeholders are observed. The haulier’s trucks are tied to DP’s trailers and bulk tanks as well as to DP’s fuel infrastructure, due to the interplay between the vehicle specification and the type of fuel used. The drivers’ knowledge is used by DP when compiling the transport plan, hence introducing a tie between these two resources. The drivers also establish a relation with the farmers, a relationship resulting in yet another resource tie. Finally, the (production of the) cows and the (size of the) tank owned by the farmer both interrelate with DP’s transport plan.

Over time, the stakeholders’ resources become adapted to each other, resulting in the companies involved gradually becoming increasingly mutually interdependent. In the DP case, the long-term business relationships established between DP and the contracted hauliers provide a clear example of this.

The discussion above relates to the example of regular milk transport. If, instead, the collection cycle is for organic milk, additional interdependencies are introduced, e.g. for bulk tanks, dairies and cows, resulting in new and supplementary resource ties. This example also shows the importance of resource heterogeneity and the aspect that the value of a resource is not a given but differs between different resource combinations. If, for instance, a farmer produces organic milk but the milk is mixed with regular milk in a common tank, then the additional value of the organically produced milk will be very limited. If, instead, the organic milk is collected by the haulier in a separate and dedicated tank, then DP will be able to add the extra value for organic milk.

When it comes to vehicle maintenance, the resource constellation discussed above indicates a complexity to be addressed by the parties involved. The haulier’s maintenance plan depends on the specification and usage of a specific truck, and the plan must be adjusted to the haulier’s vehicle and driver plans, and thus also to DP’s transport plan.

To consider the maintenance provider, i.e. a workshop, part of the business network discussed so far, a mapping for the related resources and ties is required. In Figure 4.8, the workshop and its main resources have therefore been added to the previous network in Figure 4.7.

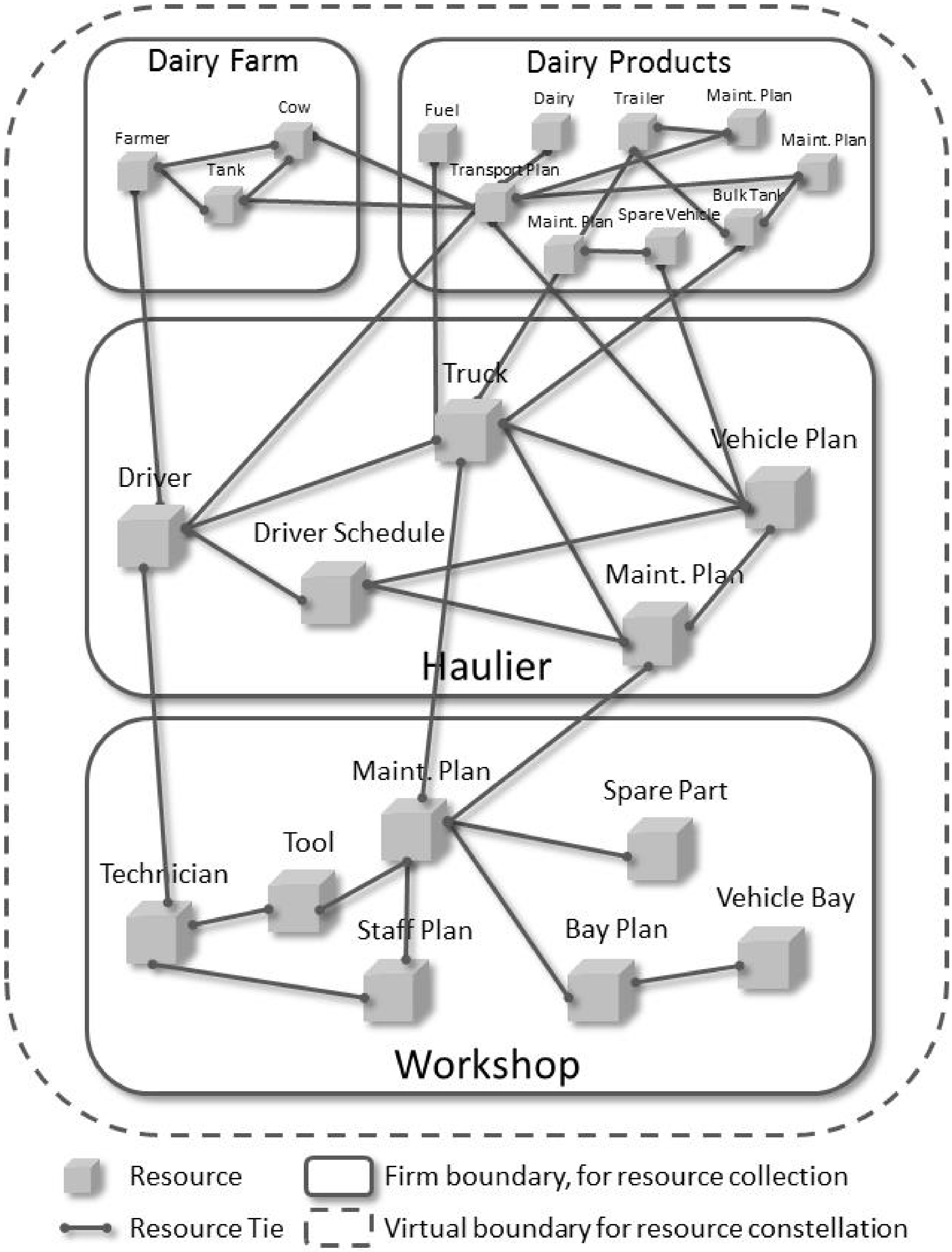

Figure 4.8 Resource ties involving the workshop and the haulier.

In Figure 4.8, four tangible and three intangible resources are identified for the workshop. The technicians, workshop tools, and replacement parts and consumables (spare parts) are all tangible resources required for vehicle maintenance. Furthermore, a vehicle bay (also tangible) must be assigned and available for the truck due for maintenance. The overall maintenance plan of the workshop includes all the maintenance activities scheduled for its customers, the hauliers. This plan is also tied to the workshop's plans for staff and vehicle bays. The spare parts and tools to be used for each instance of maintenance depend on the type of maintenance that is planned; hence these three resources are tied to each other. As specialist skills may be required, there could also be ties between the tools and the technicians.

The workshop’s maintenance plan not only reflects the availability of internal resources but must also be adjusted to the maintenance plan of the haulier concerned. Moreover, the plan must reflect the specification and usage of a vehicle.

To reduce the complexity and number of variants of solutions offered, Truck OEMs and workshops tend to strive for standardized maintenance solutions. In this way, challenges related to resource heterogeneity may be reduced for the Truck OEM and workshop. In reality, however, the uniqueness of the vehicle specification, usage and operational context may make it difficult for all the stakeholders involved to benefit from standardized solutions.

4.3 Case Description of the Retail Corporate Group (RCG)

4.3.1 Introduction

The Retail Corporate Group is a major player in retail in the Nordic countries. The group is also involved in operations related to, for example, banking and pharmaceutical products. The Retail Corporate Group supports more than 2000 retailers in the Nordic countries, of which over 1300 are in Sweden, where it is responsible for sourcing groceries and other products required by the stores, logistics and distribution, and marketing.

With the aim to centralize company functions and improve efficiency in Region South-West of the Retail Corporate Group, a decision to reorganize the warehouses and logistics operations of the region was taken. After the reorganization, Retail Corporate Group South-West (hereafter RCG) had reduced the number of warehouses in the region from four to two. The reorganization of warehouses and logistics also resulted in the need to restructure inbound and outbound transport as well as transport between the two warehouses.

RCG does not operate with any vehicles owned by the company itself and therefore relies fully on external transport capacity. Until the reorganization, the transport was undertaken by a number of contracted hauliers, which varied between the four warehouses in the region.

In conjunction with the reorganization, however, RCG decided to revise the strategy for procuring transport capacity. Instead of using several suppliers, the new approach was based on the idea of having only one supplier for the whole region. As a result of the new strategy, the company Rapid Transports (hereafter RT) won the contract related to transport for RCG in the region.

The main drivers for the change in strategy were to simplify the transport operations by having only one interface and to improve flexibility. For example, by having only one speaking partner, redistributing capacity to reflect fluctuating needs, e.g. during the summer and winter holidays, could be negotiated more easily.

With the new strategy for transport operations, which has five-year contracts instead of the previous three-year ones, RCG will be able to invest more in the relationship with the supplier RT. RCG and RT both hope that the new relationship will provide possibilities for mutual learning, higher efficiency and continuous improvement. Both stakeholders aim to open up their internal processes and hope that this transparency will enable improvements through mutual adjustments of systems and routines.

With the new contractual arrangement, RCG also strives to support productivity and profitability for the hauliers contracted through RT. For RCG, it is seen as a mutual gain if the hauliers’ vehicles can be used for other assignments when not required for the RCG logistics operations. Hence, RCG and RT approve and support the contracted hauliers also selling their services to other customers.

Environmental sustainability is another important issue in the dialogue between RCG, RT and the hauliers. RCG has drawn up an internal plan for sustainable transport and a reduction of CO2 emissions. The plan results in contractual requirements for the technical specifications of the vehicles to be used by the hauliers operating for RCG. In order to prepare for future solutions, RCG and RT have a continuous dialogue with Truck OEMs as well as the fuel suppliers.

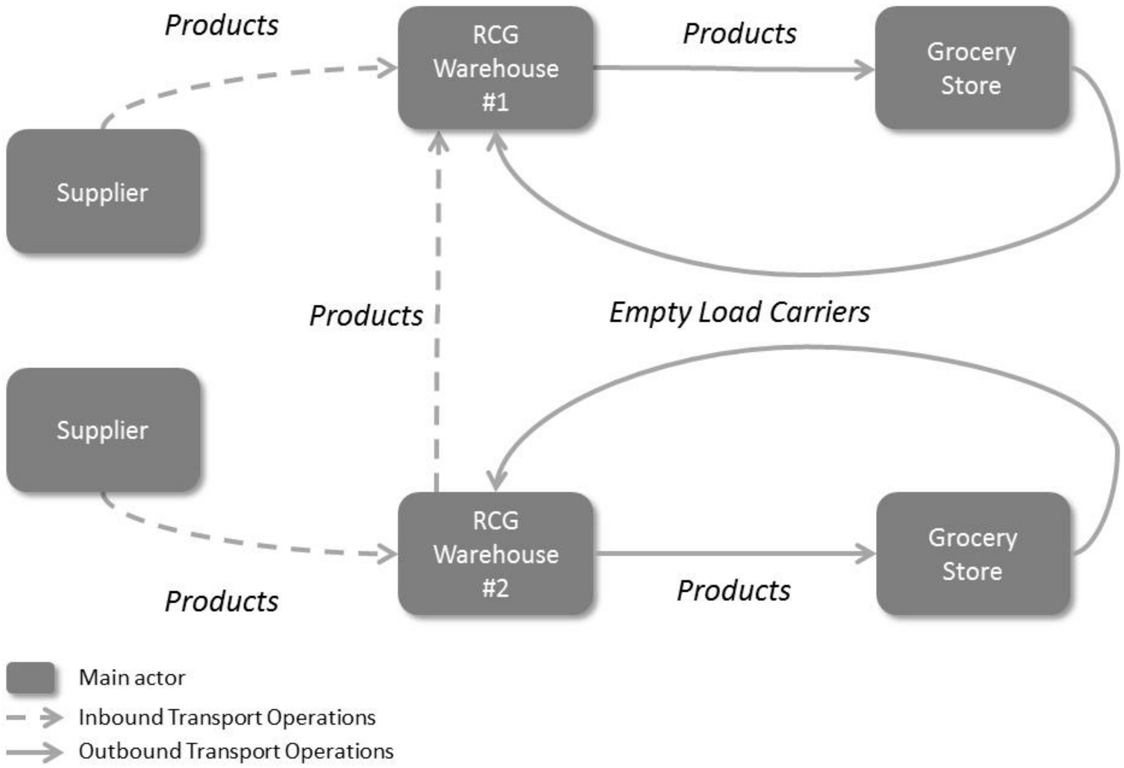

Figure 4.9 Overview of the inbound and outbound transport flows for DP.

4.3.2 Transport Operations

The outbound transport in region South-West involves the two warehouses and almost 600 grocery stores scattered around the region. RT does not operate any of its own vehicles; hence all transport is carried out by (sub-) contracted hauliers. To meet the demands, RT operates with about 100 vehicles from a number of hauliers in the region. The vehicles provided by the hauliers encompass trucks, ‘tractors’ and trailers.

RCG has defined two main types of distribution: one for cases in which the load of a vehicle only has one receiving grocery store and one for when the load of the vehicle is to be distributed to several stores. When the vehicle load is to be delivered to a single store, RCG is responsible for the transport planning while RT provides the vehicle and its driver. In cases when there are several stops on the route, RT and the hauliers involved are responsible for the transport plan. In both cases, however, the loading times set by RCG and the delivery times agreed by RCG and the receiving stores must be met.

Loading takes place at an RCG warehouse, a location that is fixed and remains the same independent of the route and day of the week. The location of each store is also well known in advance, though the list of stores on the distribution plan varies over the weekdays.

In contrast to the locations for loading and unloading, the amount and type of goods ordered by the stores vary over time. The needs of each store reflect the projected buying patterns of the store's customers, i.e. the consumers. As the buying patterns of the consumers vary over time, so do the groceries required by the store.

The challenge for RCG is to satisfy the needs of each individual store, big or small. Each store aims to optimize its sales, and to do so it needs the goods it has ordered at the time it specifies. To address the needs of each store, all the stakeholders involved, i.e. RCG, RT and the hauliers, cooperate to identify suitable solutions.

The receiving stores usually have limited space for intermediate storage of goods received. Moreover, the stores normally work with lean organizations and only have a limited number of staff working at a given time. Hence it becomes important for the ordered goods to be delivered at a predefined time agreed between the store and RCG.

To address the need for well-defined delivery times, RCG and the store agree on a specific time for delivery of the goods. To allow some flexibility, a window is defined around the specific delivery time. The window is one and a half hours, with 30 minutes before and one hour after the agreed time. Delivery precision is crucial for the operations, and the actual performance of the hauliers is measured continuously and followed up on a weekly basis.

The driver plays a vital role in the distribution chain. Over time, the driver becomes familiar with the route as well as any specific demands of the receiving stores. Hence, more than one driver is usually assigned to each distribution district. This allows flexibility and redundancy if one of the drivers should be absent.

At the store, the drivers distributing groceries for RCG are responsible for unloading the goods at the loading bay. In contrast, drivers involved in the distribution of beverages and bread are normally also responsible for moving the delivered goods from the unloading area to the shelves and display areas in the shop.

In addition to the requirements for delivery times, the defined loading times are of high importance to the efficiency of the transport operations. If a haulier fails to provide a vehicle with the right specification at the right time, the space in the warehouse inside the loading bay will be blocked until a replacement vehicle arrives. This disrupts the logistics operations of the warehouse, resulting in re-scheduling and extra, unplanned, work.

As well as transport and vehicle planning, driver scheduling is important for the hauliers. When scheduling drivers, the haulier tries to assign drivers to routes with which they are familiar. Moreover, considering the impact of driver salaries, the hauliers strive to minimize gaps and waiting times. As the hauliers contracted by RT are allowed to sell transport services also to other customers, this adds complexity to the planning process for the vehicles and drivers.

The infrastructure for loading and unloading, as well as demands related to the goods and load carriers, results in RCG making strict demands on the vehicle specification. Standardized vehicle specifications are also required for efficient transport planning. Knowing the loading capacity of each vehicle in advance makes planning of loading and routes more efficient.

The contracts that RT signs with its sub-hauliers reflect the overarching contract between RCG and RT. The contracts thus have the same requirements and mirror the contract length of five years applied by RCG. RT's contracts also define demands for the hauliers' standard and spare capacity. The spare capacity is used during peaks, such as at Christmas and New Year.

To support the contracted hauliers, RT offers them the chance to use the contract that RT has signed with its fuel supplier. The hauliers are thus able to benefit from RT's purchasing negotiation power.

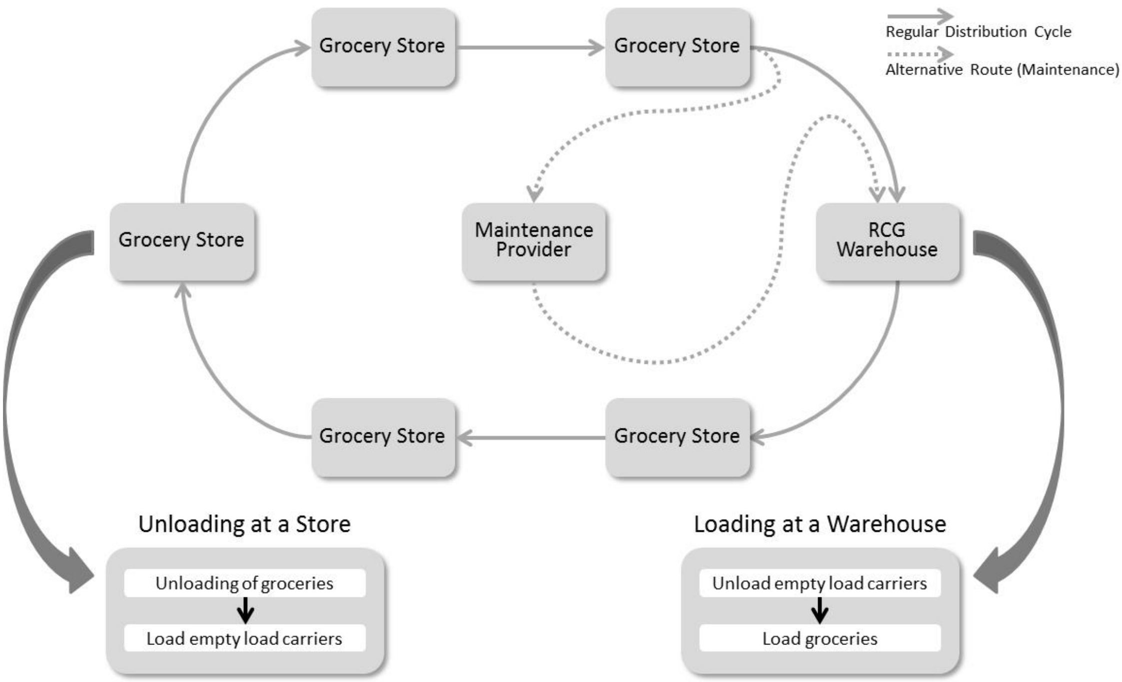

Figure 4.10 Overview of the main activities of goods distribution in the RCG case as well as a cycle involving a visit to the workshop.

4.3.3 Vehicle Maintenance

RCG has evaluated the possibility of including demands for vehicle maintenance in its contracts with external hauliers. However, based on RCG purchasing transport service, the conclusion was that vehicle maintenance is an issue for the hauliers themselves. Hence, neither RCG nor RT includes any specific requirements for maintenance in the contracts. It is seen as positive, however, if the hauliers without an in-house workshop sign maintenance contracts for their vehicles.

Today, an increasing number of the hauliers are signing maintenance contracts for their vehicles. A main driver is that the hauliers want a clear view of the monthly costs of vehicle maintenance, an important part of the vehicle operating costs. Another reason for signing maintenance contracts is that the hauliers want a guarantee that the workshop will provide service when it is required.

With regard to the demands for transport reliability and delivery precision, the contracted hauliers are required to prepare contingency plans in case of vehicle failure. For this, the hauliers may have an in-house replacement vehicle or arrange to rent or lease a vehicle when required.

The hauliers' vehicles are used in the daytime; hence, vehicle maintenance has to be carried out in the evenings or at weekends. In the past, big hauliers used to have their own workshops. Running an in-house workshop had benefits with respect to availability of personnel, as the priorities and opening hours were purely internal matters. However, it has been difficult to get a clear picture of the actual costs of an in-house workshop operation.

Even if outsourcing of vehicle maintenance tends to be more commonplace today, hauliers often employ a person who is responsible for the vehicles and their status. This person may perform a variety of repairs, for example involving hydraulics or the cooling system.

4.3.4 Overview Regarding Main Actors in the RCG Case

Figure 4.11 provides an overview of the main actors in the RCG case. The diagram shows the actors involved in the distribution of groceries to the stores related to RCG. It also includes actors indirectly related to the transport operations, e.g. the truck OEMs and external transport buyers.

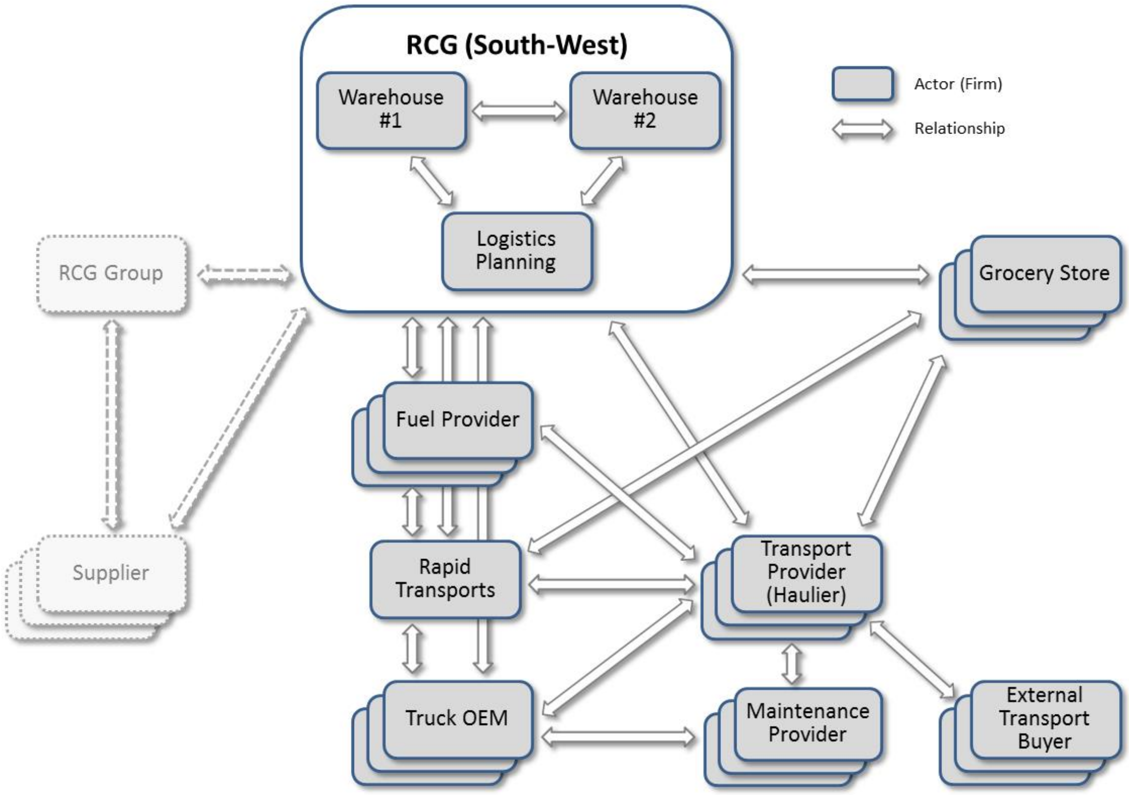

Figure 4.11 Main actors and their relationships in the RCG case.

4.4 Analysis of Case Retail Corporate Group

4.4.1 The Actor Dimension

For RCG, the outbound transport, on which this case focuses, relates to the distribution of groceries and other products ordered by the receiving stores. As the transport relates to groceries, some of which require a cold environment, the demands for quality and timeliness of transport are high. The hauliers must adhere to requirements regarding time slots for loading and unloading.

Figure 4.11 shows a network picture of the RCG case with the main actors involved in the outbound transport operations. The complexity of the web of actors is further increased by the hauliers contracted by RT being free to offer transport services also to other customers than RT and RCG.

Four actors are directly involved in the outbound transport of the case: RCG, the grocery store(s), RT and the contracted haulier(s). RCG is responsible for sourcing groceries and other products required by the stores, logistics and distribution related to the goods, and marketing. The relationship between RCG and a grocery store hence involves several different areas and actor bonds. The relationships between RCG and the stores are long term.

Until the recent reorganization, RCG contracted several different hauliers for the transport in the region. From here on, however, only one primary supplier of transport has been selected, i.e. RT. The new relationship is intended to be long term and enable deeper cooperation between the two companies in order to improve efficiency. The relationship involves several bonds between different functions of the two companies. As RT takes part in the transport planning process managed by RCG, the company also establishes relationships with the receiving stores.

RT does not use any of its own vehicles for RCG-related transport; instead it has contracted a number of transport sub-suppliers. RT aims to reflect the concept applied to the contract with RCG also in the contracts with each separate sub-supplier. Hence these contracts are also longer, and deeper cooperation is expected. Like DP in the previous case, RT offers the hauliers the possibility to use the company’s framework agreement with its fuel supplier.

The contracted hauliers are involved in the distribution cycles serving the stores and, over time, the transport providers establish relationships with the receiving stores. Specifically, the drivers of the hauliers gain knowledge about the specific demands of each store in the district.

In contrast to the DP case, the sub-contracted hauliers are allowed and able to sell their services also to other customers than RCG and RT. This results in the hauliers establishing business relationships with other transport buyers, companies that will have an impact on the haulier’s operations and thus influence the operations of RCG.

As for the hauliers involved in transport for DP, the maintenance provider is a key actor and represents one of the most important business relationships for the haulier. The challenges related to planning and performing vehicle maintenance in an efficient way remain the same. However, as the hauliers provide transport services to several customers, this leads to an increase in the complexity of the planning. The transport operations of the haulier’s external transport buyers hence influence the operations of RT and RCG. As the hauliers own both the truck and the trailer, some of the challenges seen in the DP case are avoided.

4.4.2 The Activity Dimension

In the outbound transport operations, the activity structures of RCG, RT and the contracted hauliers are connected in a common activity pattern. The main purpose of this activity pattern is the distribution of groceries and other products ordered by the stores and provided by RCG.

The activities in a distribution cycle are performed in sequence according to the transport plan. The activities included display serial interdependencies; see Figure 4.12. Even though the sequence of the receiving stores may be changed during the delivery cycle, the shipment is most probably loaded on the vehicle in a way that reflects the original distribution plan. Having completed the deliveries included on the specific route, the empty load carrier needs to be unloaded at the warehouse before it can be loaded with a new shipment.

The groceries and products included in a specific shipment will have been ordered by one or more specific stores. Even though some orders may contain some of the same types of products, each order and thereby each shipment is unique and irreplaceable. The activities included in a specific milk run hence feature tightly sequential interdependencies.

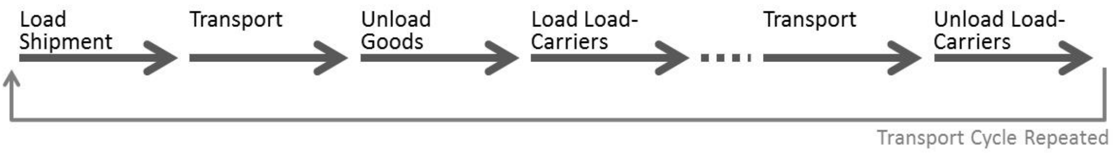

Figure 4.12 Main activities of the transport cycle for distribution in the RCG case.

Each distribution cycle reflects a plan defined and agreed by RCG, RT and the receiving stores. The cycle starts with the loading activity in which the shipment prepared by RCG is loaded onto the vehicle. A specific time has been allocated to each loading activity and the haulier must ensure that a vehicle of the right specification is available at the warehouse in due time for loading. Through the loading activity, the activity structures of the haulier and RCG become interdependent; see Figure 4.13. The same reasoning also applies to the activity of unloading the empty load carriers.

Figure 4.13 also shows how the activities at each stop interconnect the activity structure of the haulier with that of each of the stores. The activities for unloading of goods and loading of load-carriers hence introduce interdependencies between the two activity structures. For the unloading activity, a well-defined time slot has also been defined and agreed. The time slot relates to the internal processes of the store and its capacity to receive and handle the goods delivered by the haulier.

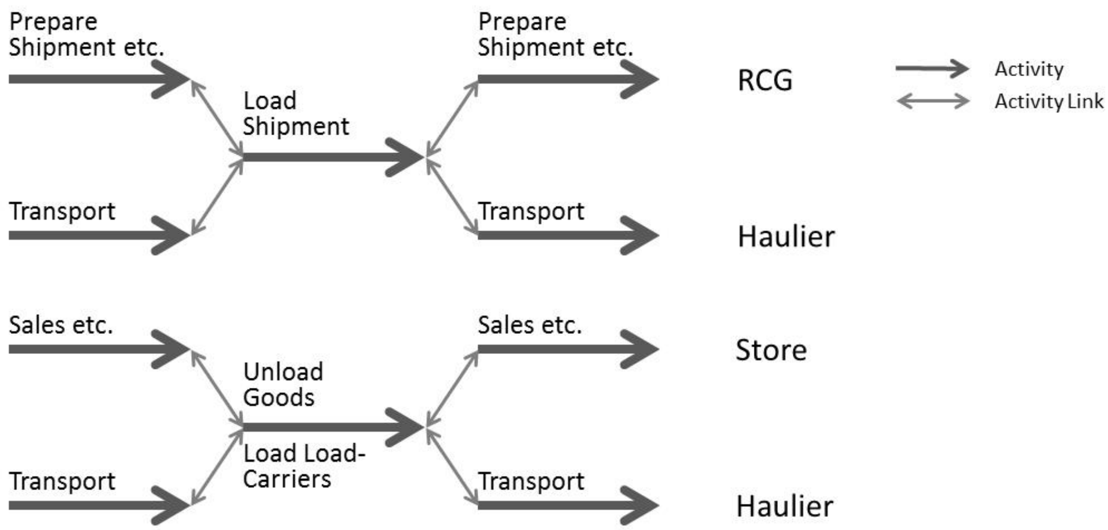

Figure 4.13 The load and un-load activities link the activity structures of the actors involved.

Together, the loading activity, performed at the RCG warehouse, and the unloading activity, performed at each specific store, introduces interdependencies between the activity structures of RCG, the contracted haulier and the stores concerned. The transport planning must therefore be well coordinated with and adjusted to the planning processes of the RCG warehouse and each of the stores concerned.

Planning and transport operations are further complicated by the fact that the hauliers concerned may sell their services to other transport buyers. In order to improve vehicle utilization and thereby efficiency of the transport operation, the haulier must address and manage the interdependencies between the RCG shipments and the transports for other customers. As in the case of DP, the pooled interdependencies in the activity pattern make it more difficult to achieve efficiency of vehicle utilization and transports.

Vehicle maintenance, a prerequisite for vehicle uptime and utilization, therefore has to be planned with consideration for transport performed for RCG as well as other customers. Hence, to manage the transport ordered by RCG, and possibly other customers, the haulier may have to arrange for a replacement vehicle to use when a vehicle part of the fleet is subject to vehicle maintenance.

Through the maintenance activity, the activities of the workshop become interconnected to the overall activity pattern; see Figure 4.14. To perform vehicle maintenance with minimum negative impact on transport efficiency, the interdependencies between the activities of the haulier and those of its clients must be addressed. In this process, the maintenance workshop also becomes an important stakeholder.

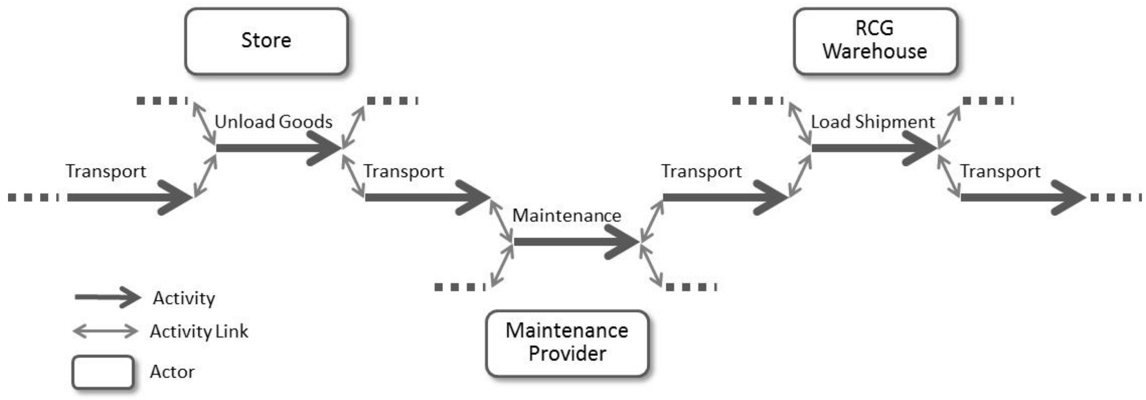

Figure 4.14 The load, un-load, and maintenance activities link the activity structures of the actors involved.

4.4.3 The Resource Dimension

Similarly to the DP case, numerous types of resources are embedded in the network of outbound transport for RCG, intangible as well as tangible. However, the complexity of the RCG case is higher due to the involvement of an additional 'intermediate' actor, i.e. RT. Figure 4.15 identifies key resources involved in the transport process of the studied case. (For the sake of simplicity, the return flow of empty load carriers has been excluded from the figure and further discussion.)

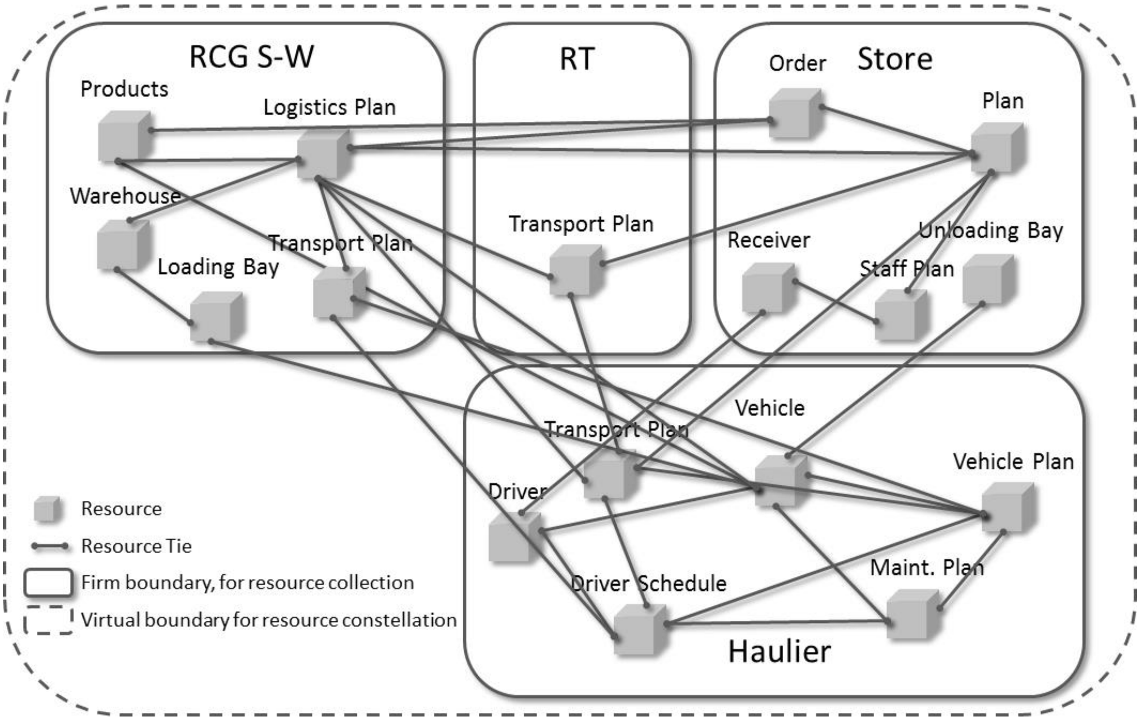

Figure 4.15 Resource ties interconnecting the resource collections of the actors involved.

Each of the four actors in the picture features a resource collection organized within the boundaries of the respective firm. The number of resources within each firm, and the complexity of the structure, varies. For RT, the main resource is represented by the transport plan. For RCG, several resources are involved: the overall logistics plan of the operations, the transport plan(s), the (two) warehouse(s), the loading bays, and the groceries (and other products) to be loaded and distributed to the stores. The stores also manage a number of resources related to the transport operations. The overall 'plan' for the store relates to the plan for staff and is also tied to the order sent to RCG. At the unloading bay, a 'receiver' directs the unloading of goods. For the haulier, the situation is similar to that of the haulier in the DP case, with two important exceptions. The first exception regards transport planning. In contrast to the DP case, the hauliers (together with RT) are responsible for transport planning of some of the shipments. The second exception regards the vehicles and, in contrast to the DP case, the contracted hauliers are responsible for the complete vehicle combination, i.e. the trucks (tractors) as well as the trailers.

In addition to the boundary-spanning resource ties already discussed above, a few other resource interdependencies influence the case. The haulier’s vehicles are tied to the loading bays with respect to the interface between the vehicle and the infrastructure of the bays. The vehicle specification and the related structures for the loading and unloading bays provide an example of standardized resource interfaces. Additionally, the vehicle (specification) is tied to the logistics plan. With standardized vehicles, the capacity is well known in advance and planning for loading and transport is facilitated. The vehicle specification is also tied to the groceries or, more specifically, to how the load is picked and piled and the interface of the load carriers used.

RCG and RT allow and support the contracted hauliers selling transport services also to other customers in order to enable improved vehicle utilization. Although improved utilization and efficiency may be achieved this way, the complexity with respect to planning is increased. This not only has an impact on the transport, driver and vehicle plans but also influences the hauliers’ maintenance plan.

To address the challenges with respect to planning and performing vehicle maintenance, several resource ties must be addressed. In Figure 4.16, a maintenance provider has been added to the RCG case network in Figure 4.15. To reflect the fact that the hauliers may also carry out transport for other customers than RCG, an additional transport buyer is also included in the figure.

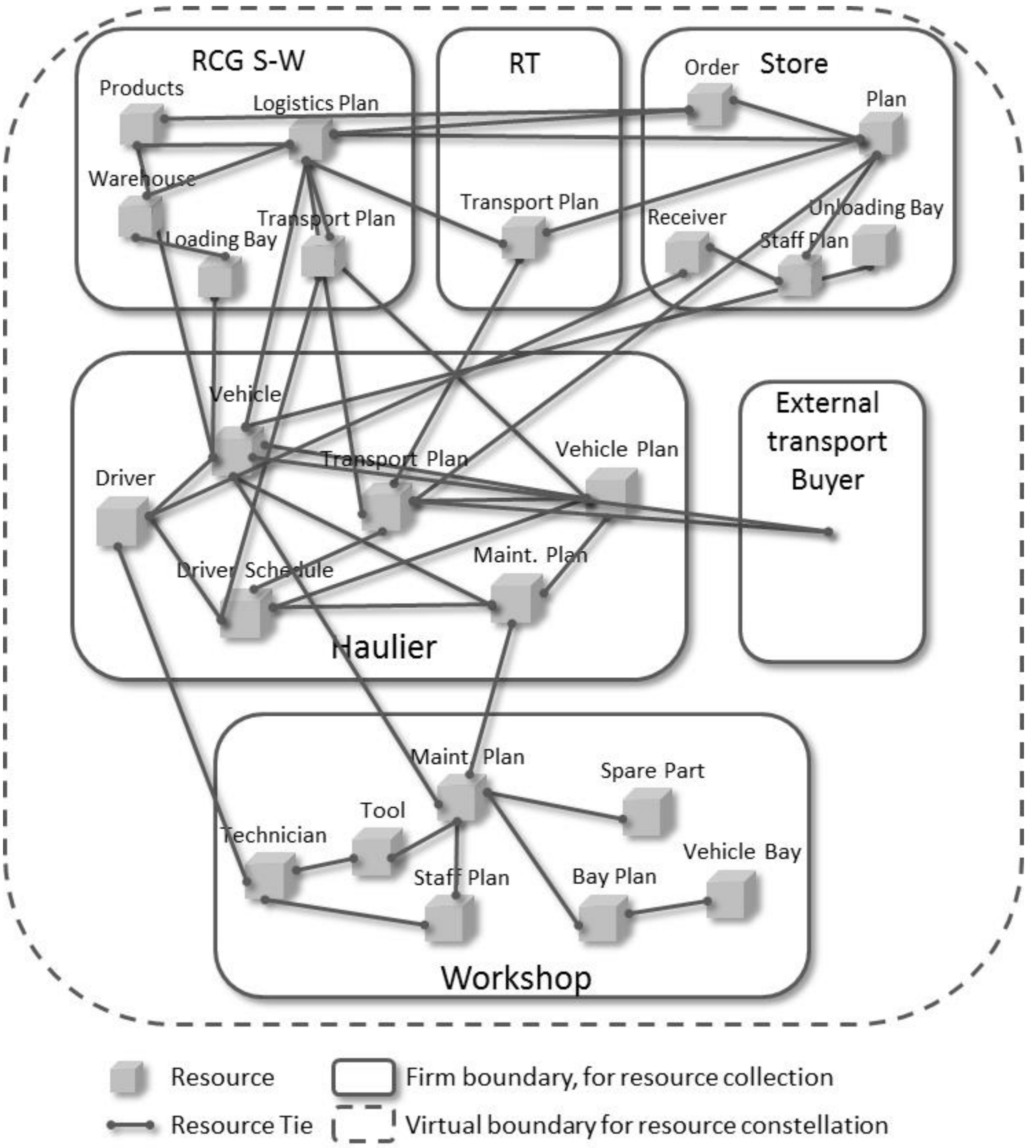

Figure 4.16 Resource ties involving an additional transport buyer,
the workshop and the haulier.

The structure and definition of the resources in the workshop are the same as in the DP case. Similarly, the resource ties between the haulier and the workshop are interconnected in the same way, i.e. the overall maintenance plan of the workshop is influenced by both the specification and usage of the vehicle and the maintenance plan of the haulier.

Once again, it should be emphasized that the complexity of the interdependencies between transport plans and maintenance plans increases when additional external transport buyers are added to the context.

4.5 Case Description of Forest products (FP)

4.5.1 Introduction

Forest Products (FP), owned by an economic association with more than 35,000 forest properties in Sweden, is organized in three business areas of forest management and forest-related products. The three business areas encompass forest management and services, e.g. planting and felling, production and sales of sawn timber and interior fittings, and production and sales of wood pulp. FP also acts as a supplier of biomass fuel for heating and energy. The forest owners of FP supply the business operations with raw material, but material is also purchased from external suppliers.

As part of the operations, FP owns and manages sawmills as well as pulp mills. The mills specialize with respect to the raw material required as input as well as the resulting products. For the operations of the mills, FP requires input of forestry-based raw material and hence relies heavily on transport. The transport operations encompass two main parts, one related to the transport of timber and the other to the transport of pulp wood; see Figure 4.17. Both parts of the transport operations involve internal as well as external suppliers and customers.

FP owns and operates an internal haulage company that manages about 25 vehicles, whereof most are used for timber transport and the remainder for materials such as woodchips. The capacity provided by the internal haulage company is far from sufficient however, so FP relies heavily on external hauliers to share the company's transport needs. For FP's transport purchasers, a central corporate function, the internal haulage company is managed in the same way as the external hauliers. FP's haulage company thus competes with external hauliers and must ensure that its operations correspond to FP's needs and requirements.

Internally FP, the haulage company operated is also seen as a reference and development haulier. Hence, as part of the company's targets, the FP haulier provides information on the costs of vehicle operations and participates in the development of transport and vehicle technology. The external hauliers, who seldom have the capacity required to participate in the development activities, may now instead share the experiences and expertise gained by FP.

The external hauliers operate with a fleet of one to ten vehicles that are positioned in different locations to better cover the geographical area managed by FP. The vehicles thus operate in an area close to the haulier's own facilities. FP aims for long business relationships with contracted hauliers and strives to grow and develop together with them. The size of the external hauliers has grown over time. The contracts signed between FP and external hauliers vary in length from one to three years. A haulier may undertake transport for more than one of FP's three regions. The hauliers are also allowed to drive for other customers and contract other hauliers as sub-contractors. Two to three times a year, FP and the hauliers meet for a discussion and follow up. The topics on the agenda include, for example, capacity, fuel and plans for the future.

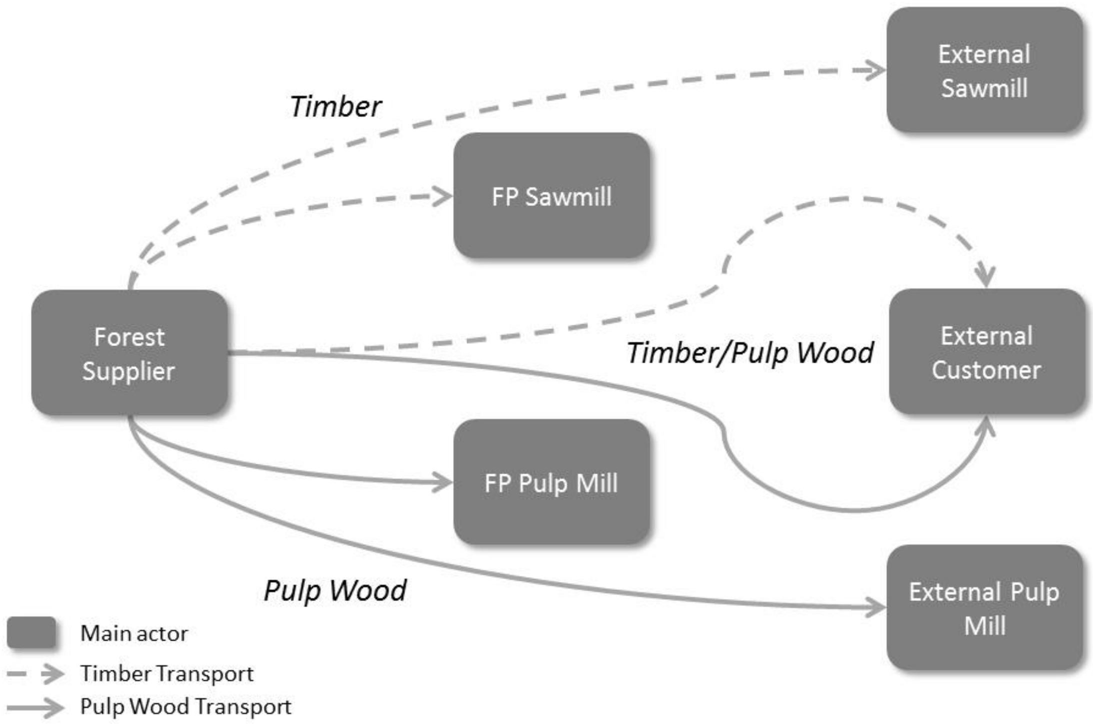

Figure 4.17 Overview of the transport flows for timber and pulp wood in the FP case.

4.5.2 Transport Operations

Once a month, FP's mills estimate the supplies required during the coming period. The monthly estimate establishes how much forest is required to meet the demand. The estimate is divided between FP's three regions, and in a second step between the districts in a region. In addition to FP’s internal needs, those of external customers are added to the estimate.

To cover the needs of mills and other customers, the region’s production management establishes a deforestation plan. A driver in establishing the plan is FP’s aim to always have a third of the volume required for the coming month available in roadside storages. As the forest that is cut down may yield timber varying in type and quality, there may be an excess of one type of material and a lack of volume of another. Having cut down the forest, FP’s staff register the resulting roadside storage using FP’s IT tool. The stored information includes details about volume and location as well as the type of timber and the date of deforestation.

Each region has a team of transport planners tasked with meeting the demands of FP’s mills and external customers. The transport planners draw up weekly plans that divide the volumes required by mills and customers into quotas distributed to the contracted hauliers. The transport planning team for a region manage the vehicles operated by FP as well as those of the contracted hauliers. For region West, for example, the weekly volume required by mills and customers totals about 50-60,000 m3. To meet these demands, about 50-60 vehicles operate in the region. The weekly plan, normally released every Thursday, covers a period from the coming Sunday to the following Saturday. Volumes, loading locations and receiving mills may vary from week to week. FP delivers timber to its mills as well as to external customers.

Every morning, the FP transport planner follows up on the deliveries made and compares them with the plan. If there are any deviations, e.g. under-delivery due to vehicle failure or over-delivery due to short distances between the roadside storages and the receiving mill, the planner addresses these together with the haulier concerned.

When planning timber transport, FP and the hauliers involved in transport use a dedicated IT tool. The IT tool includes a vehicle terminal that the drivers use for daily trip planning and route guidance. The vehicle terminal provides the driver with information about the load to pick up, including, e.g., information on the type of timber, the supplier, the receiver and the geographical position of the roadside storage.

The planning process for the transport of woodchips is slightly different and outside the scope of this thesis. For this, the FP transport planner also assigns weekly quotas to the hauliers, but there is no specific IT tool supporting the planning process. Instead, to manage the detailed transport planning, the size and growth rate of the woodchip storage are monitored remotely by cameras.

FP’s vehicles operate from Sunday evening to Saturday morning every week. To manage this, every vehicle has three drivers who work two shifts. The drivers use the on-board IT tool to manage the transport plan for the coming shift. No time windows are defined in the transport plans for timber loading or for delivery at the receiving mill, instead the daily delivery quota of a mill is the ruling directive for a haulier. Depending on the location of the vehicle, the roadside storage and the receiving mills, the number of deliveries completed by a vehicle in a day varies from just one upwards.

When adjusting the daily transport plan, the driver must consider the age of the roadside storages. There are regulations governing the length of time timber may be stored in the forest once it has been felled. These regulations have been set to reduce the risks of infestations. Due to the regulations, and the fact that the receiving industries prefer fresh timber in order to reduce the amount of chemicals required for the industrial processes, the hauliers must plan to load the oldest timber storages first. This approach also allows FP to shorten the lead times between deforestation and supply.

When the driver arrives at the roadside storage, the data provided by the IT tool are compared with the information on the labels attached to the logs in the storage; see Figure 4.8. Loading then begins to fill the vehicle and trailer with the type and quality of timber the receiver has ordered. The driver reports when the loading has been completed. The driver may then use the on-board IT tool to calculate a suggested route to the receiving industry. The actual circumstances, such as weather and quality of the roads, however, need to be considered carefully by the driver when planning the transport. In conjunction with the stop, a driver normally performs a check of the vehicle’s status to prevent malfunction and unplanned stops.

The current trend is forest management and deforestation on a large scale in order to benefit from economies of scale; hence there are fewer small forest owners. This has resulted in bigger roadside storages. A vehicle may therefore return, sometimes up to ten times, to the same roadside storage to empty it. However, as the type of timber piled in a roadside storage may vary, there are cases when a vehicle may have to visit several storages to complete the load with material of the type and quality required by the receiving industry.

When the vehicle arrives at a mill, see Figure 4.18, the driver reports the load to the receiver who cross-checks this information with the ID marks on the timber in the load. The loaded vehicle is also weighed and the weight recorded for later comparison with the weight of the empty vehicle. In addition, the volume of the load has to be measured. For this, FP applies two different methods. Either the volume of the full load is estimated in one step or the logs are measured individually. The second method, individual measurement, is the most common. If the logs are measured one at a time, the vehicle load must be kept together. This requires additional intermediate storage at the mill, and hence leads to a bottleneck in the transport flow. To address this limitation on capacity, daily quotas are defined for the mills concerned. The volume and weight of the load are used to calculate reimbursements to the haulier and the supplier.

To avoid running empty and to improve transport efficiency, FP trades loads with other companies in the forest and timber industry. FP and the companies also trade loads in cases when there is a surplus of raw material but no receiving mill requiring immediate supply.

Due to changing requirements and the trend of large-scale operations, the numbers of both mills and hauliers are expected to fall. Hence, fewer hauliers will need to transport more timber, operate with more vehicles and undertake transport over longer distances.

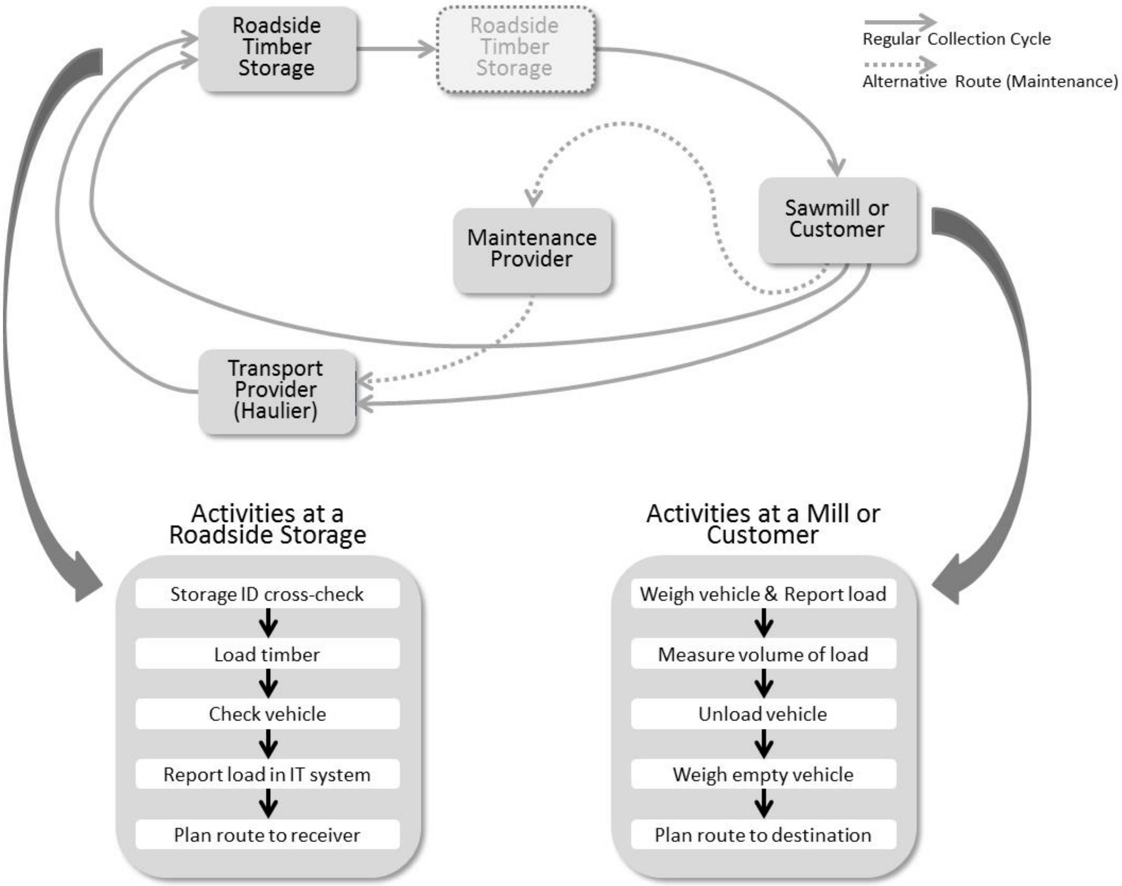

Figure 4.18 Overview of the main activities of timber collection, transport and delivery.

4.5.3 Vehicle Maintenance

FP's mills and other customers require a continuous flow of supply, and disruptions to the transport flow may jeopardize the processes. In a worst case scenario, a mill may have to shut down its operations due to an interruption of the supply. Hence, if a vehicle is at a standstill due to technical issues, it requires immediate attention.

FP does not have any spare vehicles on standby; hence if a vehicle needs to be taken out of operation for some time, a temporary solution is required immediately. For this reason, FP signs maintenance contracts for most of its vehicles. If a problem occurs, FP and the OEM cooperate to find a solution that meets their needs. Even if an external haulier were able to provide a replacement vehicle at short notice, it is not a given that this vehicle would be of the right specification. The specification of a vehicle is adapted to the specific assignment performed, and hence systems such as timber locking mechanisms vary.

FP used to operate a vehicle workshop of its own. Today, with the increase in the number of vehicles and the vehicles being positioned in different locations, FP does not consider it possible to manage vehicle maintenance internally – even if there could be benefits in terms of costs and flexibility. Hence, for the vehicles owned and managed by FP, workshops connected to the OEMs are used for service and repairs. The quality of service and distance to the workshop are important factors for FP and influence the choice of make when new vehicles are bought.

Most of FP’s vehicles use RME fuel and cover long distances every year. A vehicle can cover an average distance of 250,000 km in a year. FP’s vehicles are kept for about four years, which equates to about 1,000,000 kilometres, before being replaced. Optimally, the vehicles should be replaced earlier, but the time required for depreciation does not allow for this.

Due to the long distances covered and the use of RME fuel, the vehicles require maintenance every two weeks. The day and time of the maintenance visit is agreed with the workshop a week ahead, and the transport planning is adjusted accordingly. As the first shift of the day starts at 04.00 in the morning, the driver normally manages to complete one delivery before the workshop visit.

FP does not require the OEM workshops it uses to provide maintenance services during evenings or weekends. One of the reasons for this is that the driver of the FP vehicle normally follows the vehicle to the workshop; hence there would be an extra salary cost during evenings or weekends.

The cranes used when loading and unloading the vehicles also require maintenance. To secure functionality, the cranes are normally greased once or twice a week. To manage the maintenance of the cranes, FP’s own haulage company applies three different solutions. Part of this maintenance need is managed by the drivers themselves, while others are managed by the contracted vehicle workshops. For urgent repairs, FP also uses third-party workshops.

Even though vehicle availability is important to FP, and implicitly required through the assigned delivery quotas, the contracts for external hauliers do not involve any specific requirements for vehicle uptime. Nor does FP pose any requirements regarding vehicle maintenance or the use of maintenance contracts.

Hauliers are required to operate efficiently, respond quickly to changing demands and provide timely services. A distance of one hour to the nearest workshop is deemed far for a haulier operating with high demands for efficiency and timeliness. A haulier may therefore decide to set up its own workshop within the company. As timber vehicles include systems that require specific knowledge and tools, for example loading cranes and timber locking systems, the haulier must decide on the limitations of the workshop's capabilities. Demands for vehicle availability and distance to the nearest workshop are also important drivers. Other important factors relate to the size and operations of the haulier and the possibility of managing the maintenance costs by also using the workshop for external customers.

FP does not currently envisage that the demands on vehicle uptime and workshop availability will differ from the company's requirements today. However, FP does hope that future solutions will better meet existing demands.

4.5.4 Overview Regarding Main Actors in the FP Case

Figure 4.19 provides an overview of the main actors in the FP case. The diagram shows the actors involved in the transport of timber and other materials such as pulp wood. The overview includes internal and external hauliers as well as external transport buyers that influence the operations.

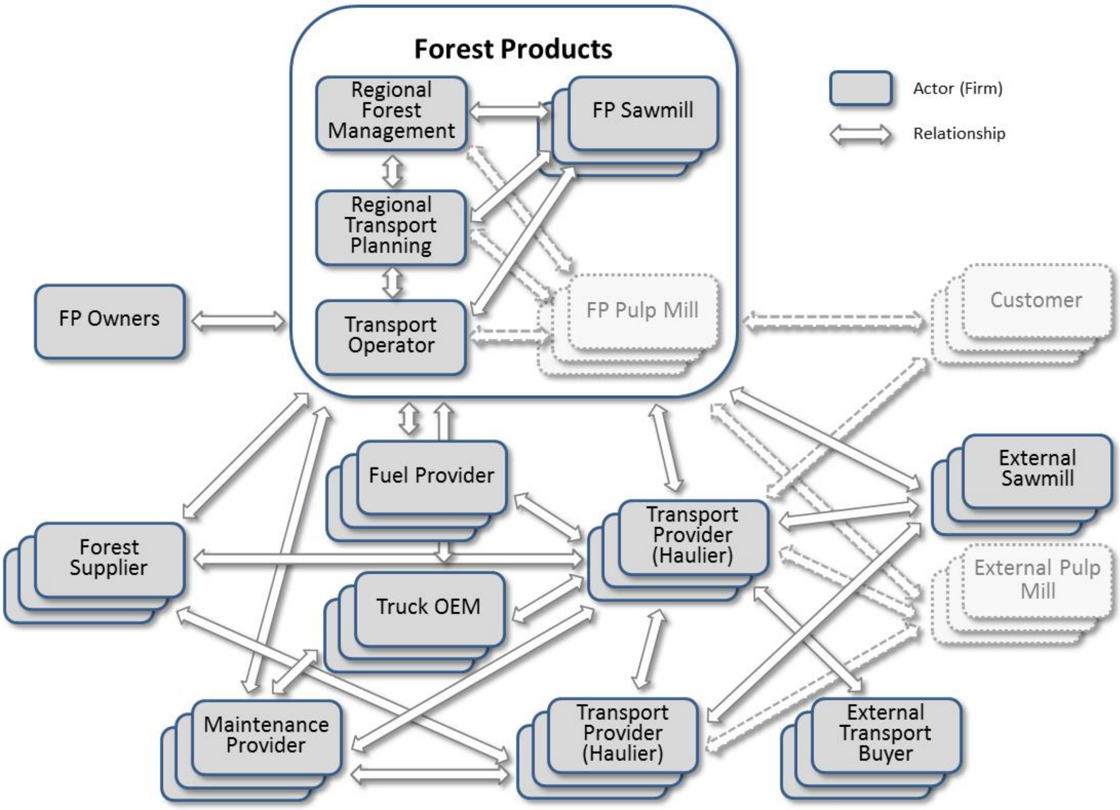

Figure 4.19 Main actors and their relationships in the FP case.

4.6 Analysis of Case Forest Products

4.6.1 The Actor Dimension

For FP, the transport related to timber constitutes a critical part of the overall operations of the company group. The timber transport operations must address demands posed by the supply side, the forest owners and FP Forestry Management, as well as those by the demand side, the receiving industries and customers.

DP’s timber transports involve several actors in a more complex web than those of the two previous cases; see Figure 4.19. The complexity is increased by the fact that transport is carried out by several actors, both internal and external transport providers, and that contracted hauliers may use subcontractors and also offer their services to other transport buyers. To reduce the complexity of the discussion in this section, the subsequent analysis focuses on a context in which the timber is supplied by a forest owner part of FP, the transport is carried out by an external haulier, and the receiving mill is part of the FP company group.

Similarly to the DP case, the FP forest owners have dual identities: they are owners of the FP group and also suppliers of timber. The relationship between FP and a forest owner therefore involves several bonds with different features and purposes. The relationships are long term, also reflecting the fact that investment in forest is a long-term business. For the supply of timber, FP Forestry Management and the forest owner agree on a deforestation plan. The deforestation results in timber stored in roadside storages that are loaded and transported by the contracted haulier. Even if contracts between FP and the hauliers are short term, FP's strategy is to develop long-term relationships with the transport providers. The haulier receives transport assignments from FP, and the plans are followed up as part of the continuous interaction between the two companies. As timber grows slowly, it may take a long time before the haulier returns to an area and forest owner, which influences the bonds between a forest owner and the haulier. The timber loaded by the haulier is transported to the receiving mill part of the FP group. At the mill, specific routines for delivery and measurement of the load have to be followed by the haulier, and the bonds established between the mills, the drivers and the hauliers influence the efficiency.

The hauliers contracted by FP are also allowed to sell their services to other customers and may utilize capacity from subcontracted hauliers. Moreover, in order to improve efficiency and vehicle utilization, the FP group exchanges loads with other players on the market. The hauliers transporting for FP thus develop several business relationships and actor bonds among which they have to prioritize with respect to investments and depth.

For vehicle maintenance, the hauliers involved face a similar situation to that of the transport providers working for RT in the RCG case. The hauliers are involved in several business relationships and must coordinate their plans with respect to demands from FP as well as other transport providers by which they are contracted.

4.6.2 The Activity Dimension

Similarly to the DP case, the activity pattern for timber transport operations involves collection cycles. The timber is collected at roadside storages, and when the vehicle is fully loaded, the raw material is transported to a receiving industry; see Figure 4.20. The number of loading stops depends on the size of the roadside storage. If the storage contains a large number of logs, the vehicle has to return to the storage several times, and if the storage is small, the vehicle may have to stop at more than one location in order to complete the load.

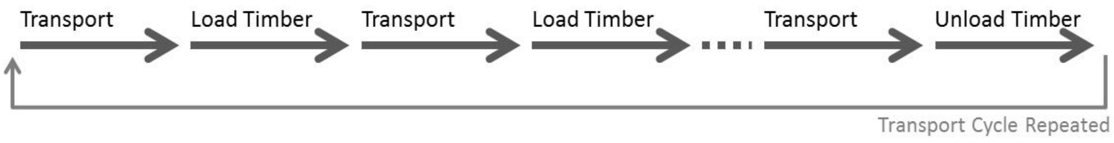

Figure 4.20 Main activities of the cycle for timber transport.

The activities in a timber collection cycle are performed in sequence according to the transport plan set jointly by the FP planner and the haulier. As in the case of DP, the chain of activities displays serial interdependencies with a sequential feature. The timber collected has specific characteristics that are important with respect to the processes of the receiving sawmill. The activities of the chain therefore involve interdependencies that are tightly sequential, and the activities are mutually adjusted.

Although there are similarities with the collection cycle in the DP case, there is one major difference. In the case of DP, the loading cycle is predefined and repeated every 48 hours. For timber transport, however, the geographical locations of the loading sites, i.e. the timber roadside storages vary over time. As a result, the geographical route of a specific loading cycle is unique in most cases.

For the loading and unloading activities of the chain in Figure 4.20, we observe interdependencies with respect to the activity structure of the haulier and the activity structures related to forest management and the sawmill; see Figure 4.21. Note that both the loading and unloading activities include a number of sub-activities, as shown in Figure 4.18.

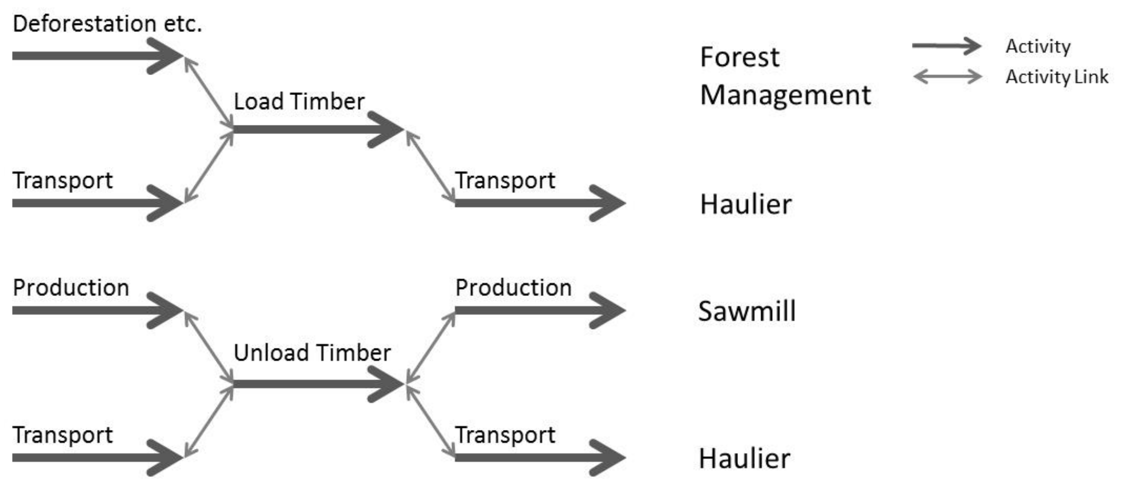

Figure 4.21 The load and un-load activities link the activity structures of the actors involved.

In the case of loading, the activities for deforestation and transport display joint interdependence. Before loading the timber at a roadside storage, it has to be felled and piled. Even if the plans for deforestation and transport are related to FP's overall production plans, the joint interdependence observed does not necessarily need to be strong. The timber that is loaded by the haulier may have been stored for a while after deforestation.

Through the unloading activity, the activity structures of the haulier and the industry become jointly interdependent. Plans for the transport operations are based on the production plans of the FP mills. The transport operation is thus adjusted to the capacity and needs of the receiving mills. If there is a change in the production process of a mill, the transport plans may need to be adjusted accordingly. Similarly, if the inbound flow of timber is subject to disruption, this will influence the production processes of the mill.

The vehicles transporting timber are normally operated six days a week, with two shifts of drivers per vehicle. To manage the operations and meet the requested delivery volumes, the hauliers must coordinate the plans for transport, vehicles and drivers. For hauliers contracted by FP, the complexity of planning is further increased as the hauliers are allowed to sell transport services also to other customers.

The vehicles cover long distances and the haulier must address the need for frequent vehicle maintenance. Maintenance must be coordinated with the transport assignments as well as planning for vehicles and drivers. In the case of timber transports for FP, the interdependencies between deforestation and loading are less strong. However, the interdependencies between the timber supply and the processes of the receiving mills are stronger. Vehicle maintenance, an activity part of the activity structure of the maintenance provider, therefore mainly becomes interdependent with respect to timber transport and the production plans of the mills; see Figure 4.22.

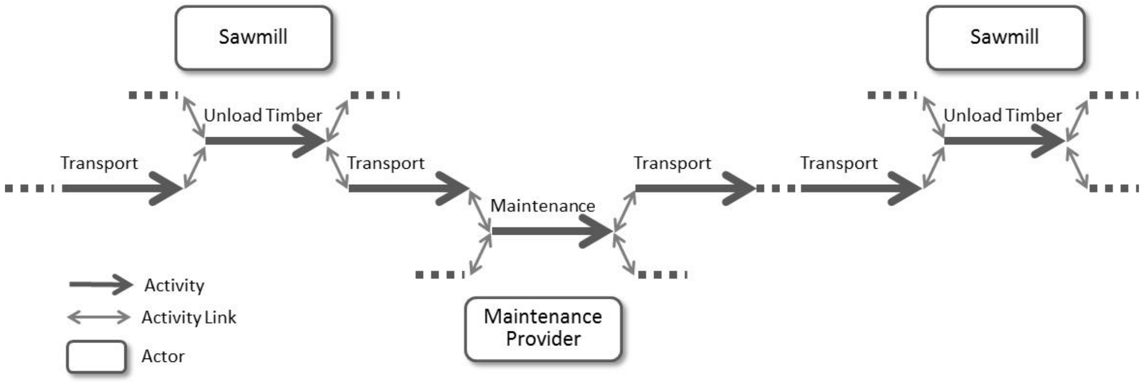

Figure 4.22 The load, un-load, and maintenance activities link the activity structures of the actors involved.

Vehicles used for timber transport are specialized, and a replacement vehicle is difficult for a haulier to arrange in the event of an unplanned stop or failure. The processes of the receiving mills are dependent on a steady supply of timber, and the transport operations of the hauliers involved must fulfil the plans set by FP. To secure reliability and uptime of the resources involved in transport, it becomes essential that preventive maintenance is performed as required.

4.6.3 The Resource Dimension

The FP case displays similarities to the DP case with respect to the transport needs, i.e. the collection of raw material for further processing. Similarly to the RCG case, however, the complexity with respect to the number of stakeholders involved is high.

Figure 4.23 provides an overview of the key resources involved in the timber transport studied. For this specific analysis of the resources in the case, the focus is on the external hauliers contracted by FP. As a result of this, FP's internal haulier is excluded from the main discussion.

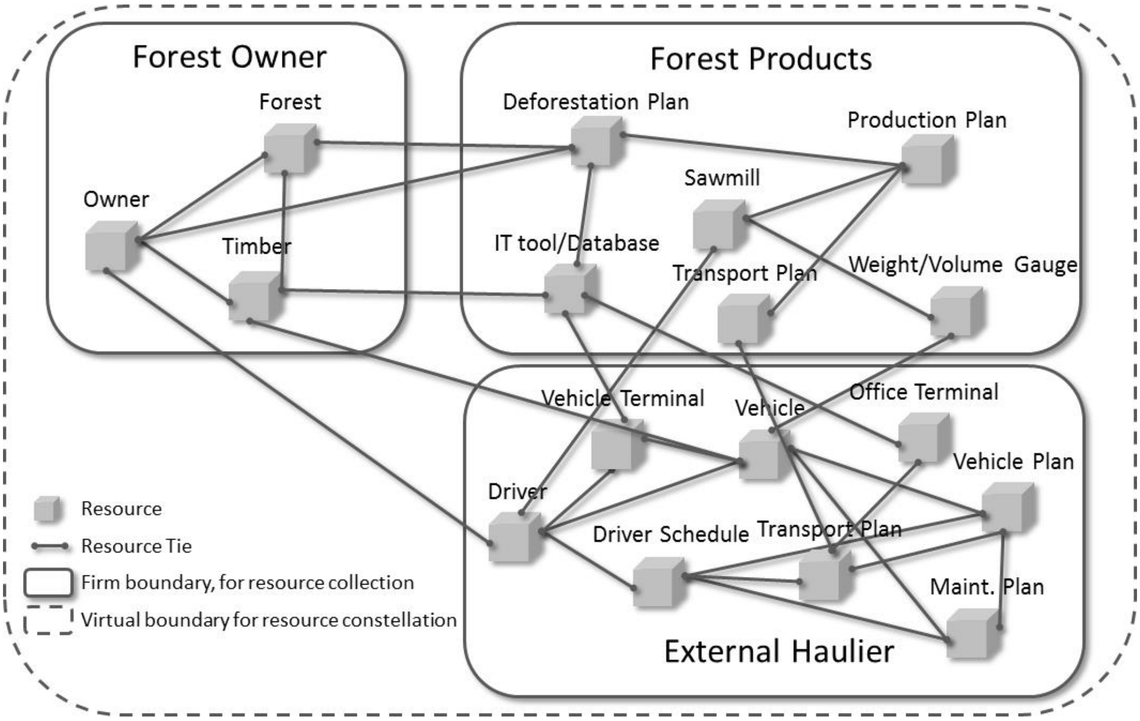

Figure 4.23 Resource ties interconnecting the resource collections of the actors involved.

The three stakeholders in Figure 4.23 are all related to a collection of resources involved in the timber transport operations. Even though the internal haulier, external customers and subcontracted hauliers are left out of this visualization, the complexity of the remaining resource constellation becomes clear.

For the Forest Owner, the three main resources are the owners, the forest and the timber resulting from deforestation. All three resources are tied together into a smaller resource collection. FP's resource collection includes the plans for deforestation and transport, both of which are based on and thus tied to the overall production plan of the FP mills. The mills represent a key resource for FP and are tied to the production plan as well as the equipment (gauge) for measuring the timber received. The IT tool database stores the information from the deforestation and roadside timber storages. The resource collection of the haulier resembles the collections in the two previous cases, with the exception that an office terminal and an in-vehicle-terminal are used by the haulier and the driver for the daily transport planning. The on-board IT terminal, timber crane and load-fixation systems (not included in Figure 4.23) add complexity to the vehicle specification and increase the vehicle specificity.

The resource constellation, which combines the three stakeholders' resource collections, displays a variety of boundary-crossing resource ties, some of which have already been mentioned in the discussion above. Additional ties represent the connection between FP's deforestation plan and the owner of the forest, as well as the forest itself.

The aspects and issues related to the plans and vehicle maintenance are similar to those observed in the DP and RCG cases. The vehicles, operated by two shifts of drivers for six days a week, cover long distances in a year. Hence, regular preventive maintenance must be performed with short time intervals, about two weeks in general, in order to meet the required maintenance plan.

The mills receiving timber as raw material for their production require a steady and reliable inflow of timber. To secure this inflow and improve vehicle utilization and efficiency, the haulier strives to perform vehicle maintenance during periods when the vehicle is not required by the customer. Hence, as presented in Figure 4.24, the workshop plan is tied to the haulier's maintenance plan. If the haulier also carries out transport for other customers, as shown in Figure 4.24, this results in interdependencies between the various plans.

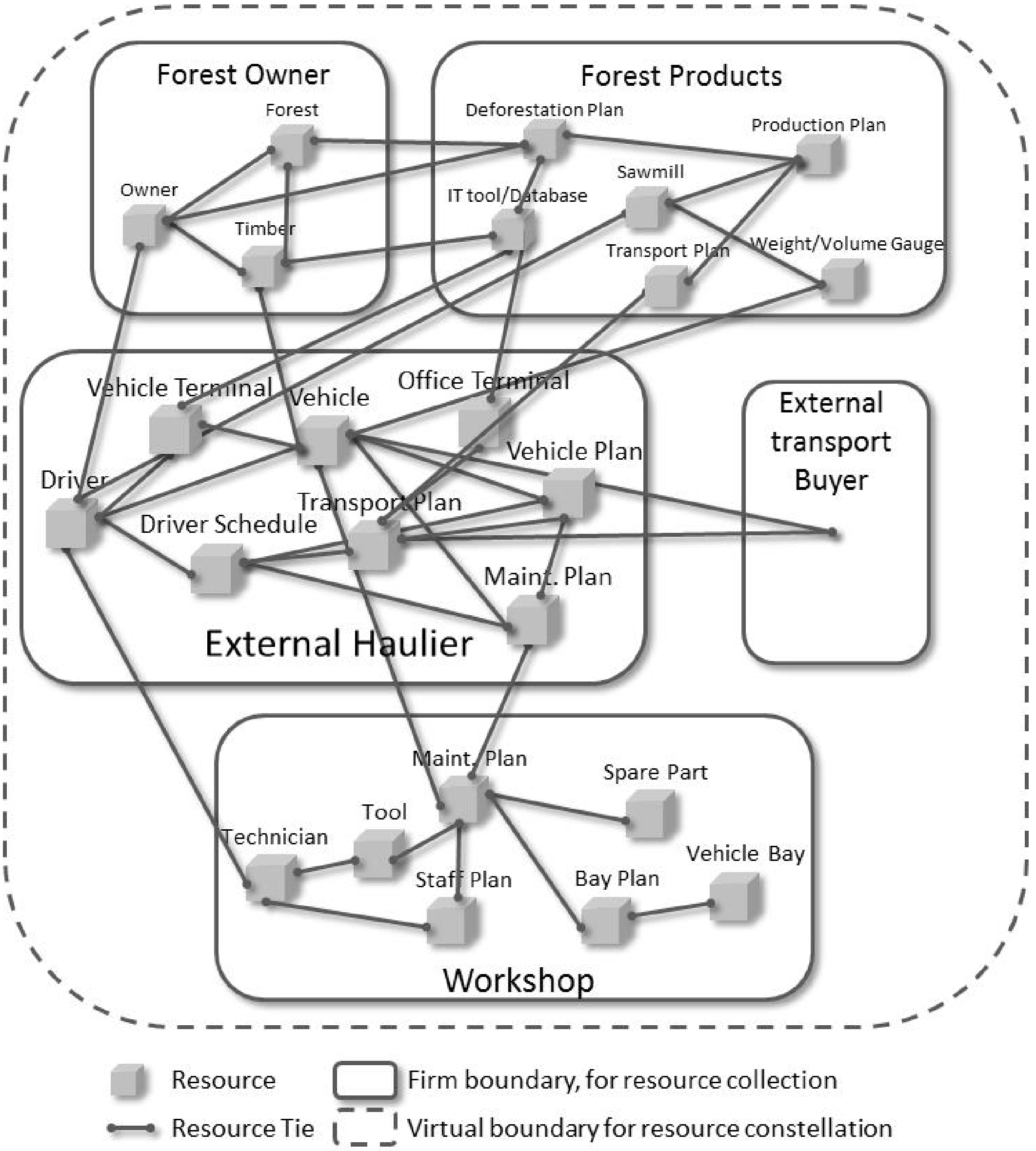

Figure 4.24 Resource ties involving an additional transport buyer,
the workshop and the haulier.

For a vehicle specified for timber transport, the crane and the load-fixation system are crucial to operations. To allow for a high degree of vehicle utilization, the reliability of these two systems must be secured through regular maintenance. Maintenance of cranes and load-fixation systems requires specific knowledge, a resource that must be arranged by the haulier or the workshop. If the workshop is equipped with the required knowledge, interdependencies between the maintenance plans for systems and equipment of the complete vehicle configuration may be better addressed.

5. CROSS-CASE ANALYSIS

In this chapter a cross-case analysis is performed. The cross-case analysis focuses on variety and similarities between the three cases. The analysis is guided by the three research questions that were articulated in Chapter Two. The questions relate to the three dimensions of the ARA model and reflect various aspects of the vehicle maintenance activity:

RQ 1: How do actors and their interconnections influence the conditions of vehicle maintenance?

RQ 2: How is vehicle maintenance interconnected to, and influenced by, other activities in the network?

RQ 3: How do resources and resource ties of the network influence the conditions for vehicle maintenance?

5.1 Introduction

All three cases involve firms that are heavily dependent on transport and known to be large buyers of transport services, a criterion when selecting these specific cases. The transport operations in the three cases also reveal times when strict requirements for delivery time, precision and quality apply. In all the cases, transport is a crucial part of the operations, and demands from suppliers as well as receivers must be met to enable functionality and efficiency of production and sales.

Looking deeper into the context and networks of the cases, the similarities observed are accompanied by dimensions of variety. Even though transport is carried out and goods are moved, the context and prerequisites differ on many points. For instance, the goods themselves vary between the cases, something that influences the activities and resources related to the transport services.

The structure of the cross-case analysis below reflects the three research questions, each of which relates to one of the three dimensions of the ARA model: Actors, Activities and Resources. A discussion on variety and similarities between the cases follows. Finally, a discussion on embeddedness and interdependencies concludes Chapter Five.

5.2 Actors Influencing the Conditions for Vehicle Maintenance

All three cases display business networks involving complex structures of actors. The complexity of the business relationships and interdependencies becomes clear just by scratching the surface of the cases. The bonds and relationships spanning among the actors indicate that interdependencies are common and must be managed by the actors involved.

For the transport process in each case, a Transport Service Triad (Andersson et al., 2014) is formed by the key stakeholders; see Figure 5.1. A transport service triad includes the transport buyer, the transport service provider and a third party involved in the focal transport operations. The business relationships between these three key stakeholders relate to the actor bonds, the activity links and the resource ties shaping the transport operations context and the demands on the haulier. Additionally, business relationships external to the focal transport service triad influence the operations of the firms of the triad.

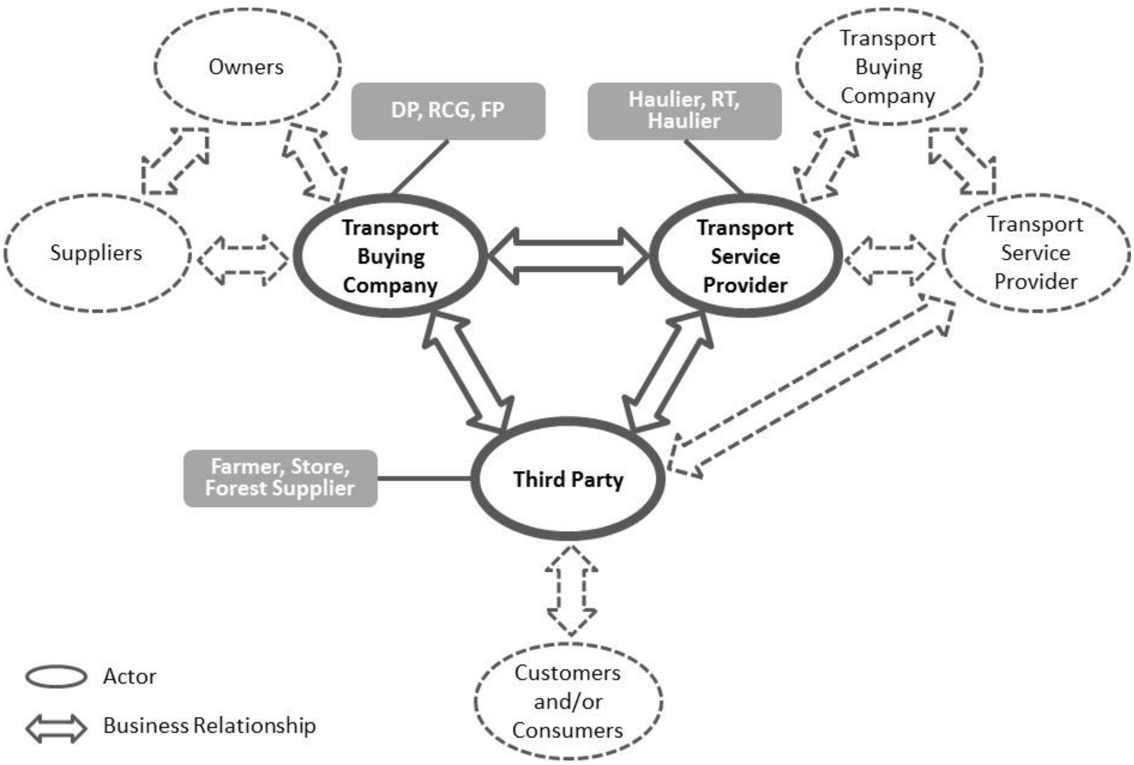

Figure 5.1 The Transport Service Triad applied for the three cases of this thesis.

In each of the cases studied, the transport service procured is regulated and directed by strict demands. The demands concern areas such as transport capacity, time windows for loading and unloading, and handling the transported goods. As a result, the internal planning of vehicle utilization, and the haulier’s business relationships and bonds becomes critical when addressing and balancing targets set by different stakeholders.

To perform vehicle maintenance, an activity embedded in the network, it is necessary for the haulier and the maintenance provider to interact and mutually adjust their internal plans. Similarly, the maintenance provider needs to address restrictions underpinned by internal plans as well as demands related to the Truck OEM(s) and its/their other customers, i.e. other hauliers. Business relationships between firms of the network and bonds between the actors involved are vital for coordination and planning.

To plan and perform vehicle maintenance interaction between numerous stakeholders in the business network is required. In Figure 5.2, the focal haulier and the maintenance provider, engaged in a joint dyad, form the centre of this figure. Moreover, the transport service triad(s) in which the haulier is involved influences the business relationship of the ‘maintenance dyad’. However, drawing on the embeddedness of the maintenance provider, additional business relationships involving Truck OEM(s) as well as other hauliers both influence and are influenced. In the figure, a few actor bonds have been added as examples of the numerous bonds that over time develop between individuals of the companies involved. For example, the technicians of the workshop establish bonds with the drivers of the vehicles being maintained.

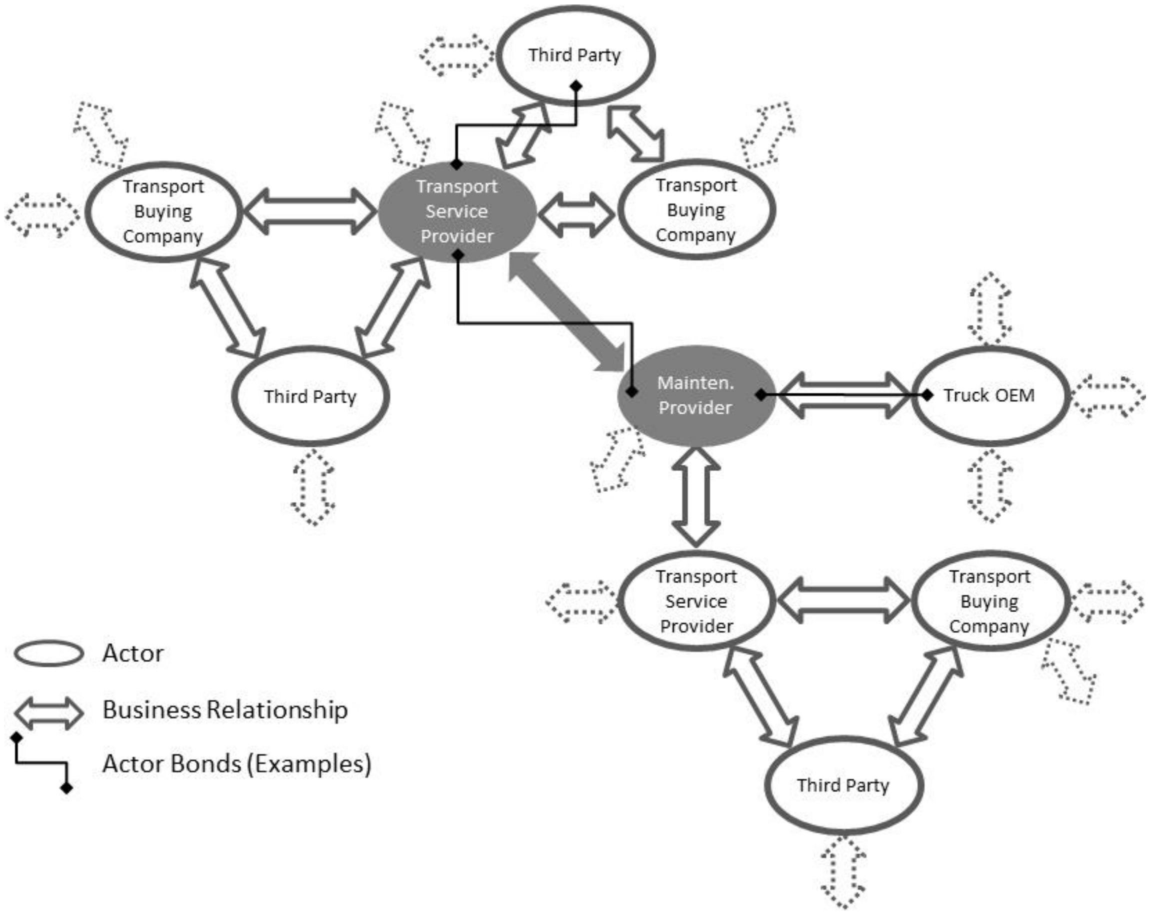

Figure 5.2 Actors, business relationships and actor bonds influence the conditions for vehicle maintenance.

5.3 Activities Influencing the Conditions for Vehicle Maintenance

Activities use, produce and exchange resources and are managed and performed by actors. The activity structures of each actor are interlinked in an activity pattern spanning firm boundaries: a pattern reflecting the complexity of the web of actors in each case.

All three cases display interdependencies between the activities: the most obvious being the serial interdependencies in the transport chain in each case. A transport chain primarily includes activities related to transport, loading and unloading. As the activities have to be performed in sequence, and the previous activity has to be concluded before the next one can start, the serial interdependencies take a sequential form. In the case of a resource requiring specific handling, e.g. organic milk in the DP case, the serial interdependencies may even feature a tightly sequential form.

In the cases studied, the loading and unloading activities of the transport chains interconnect the activity structures of the stakeholders involved. The loading and unloading activities must be jointly planned by the stakeholders and frequently also jointly performed. Figure 5.3 shows the interdependencies introduced in the transport service triad due to the activities for loading and unloading.

As a result of the interdependencies from loading and unloading, the activities part of the transport provider's activity structure becomes adjusted over time to better fit the context. Hence, the internal planning processes related to, for instance, vehicles and drivers, reflect the context and demands of the internal activity structures of the transport buyer and the third party.

Once again, a pooled interdependence is observed. Each of the activities contributes to 'the whole' and, at the same time, is supported by 'the whole'. The activities part of the activity pattern fills a purpose like cogs on a cogwheel.

It is worth noting that Figure 5.3 involves an example with comparably lower complexity. The complexity and interdependencies become even higher if, as in the RCG case, an intermediary such as RT is introduced or, as in the FP case, additional transport buyers that utilize the capacity of the transport provider are involved.

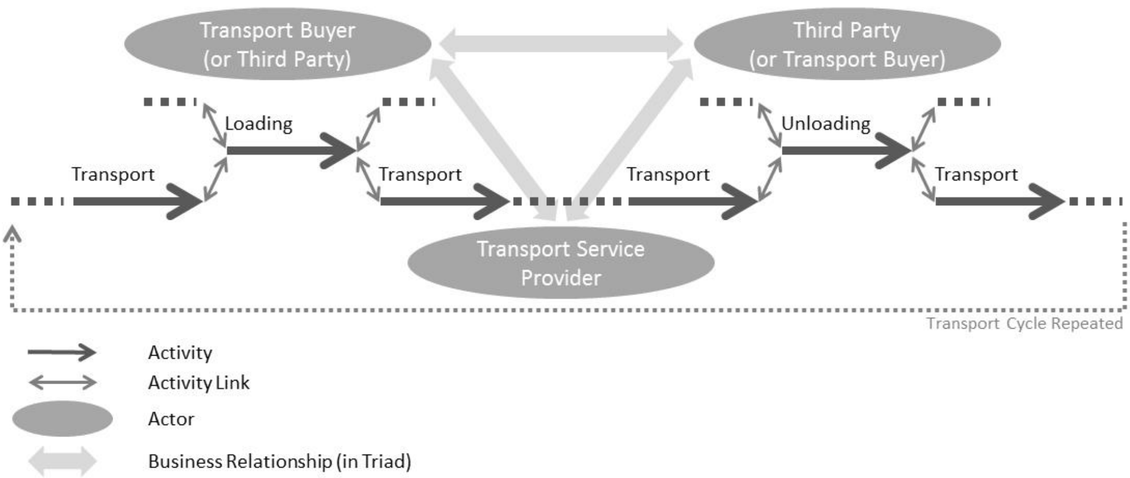

Figure 5.3 Interdependencies are introduced in the transport service triad due to loading and unloading.

In all three cases, the vehicles used are subject to tough demands for availability and uptime. Efficiency and reliability of transport are required by transport buyers, suppliers and receivers. Maintenance is a prerequisite for ensuring that the vehicles are operational. However, vehicle maintenance must be coordinated with and adjusted to the other activities managed by the actors involved.

The maintenance activity links the activity structures of the transport provider and the maintenance provider, see Figure 5.4, similarly to the way that the loading and unloading activities interconnect the activity structures of the companies in Figure 5.3. As the activity structure of the maintenance provider is also linked to the activities of other actors, for example a Truck OEM and other transport service providers, the maintenance activity becomes embedded in an activity pattern stretching far outside the dyad between the transport provider and the maintenance provider.

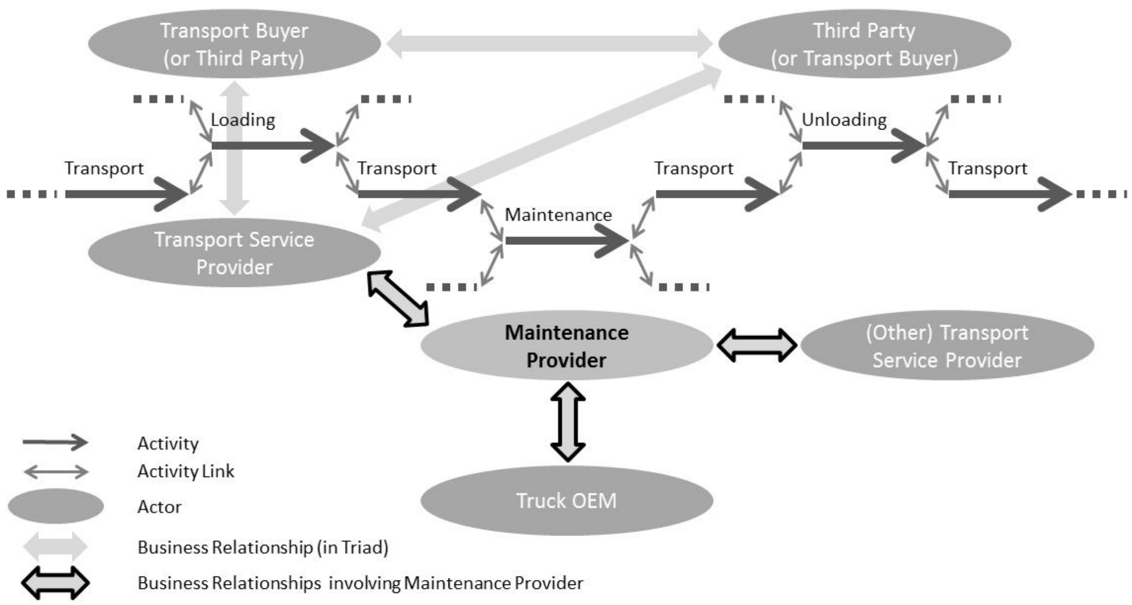

Figure 5.4 Activity links and business relationships interconnect the activity structures of the companies.

The embedded nature of the maintenance activity is clearly observed in Figure 5.5. The activity structures of the actors involved are linked together through the activity layer of the business relationships. The business relationships between the firms influence and are influenced by each other, and interdependencies between the activities and their activity links lead to issues that must be managed through coordination and adjustment.

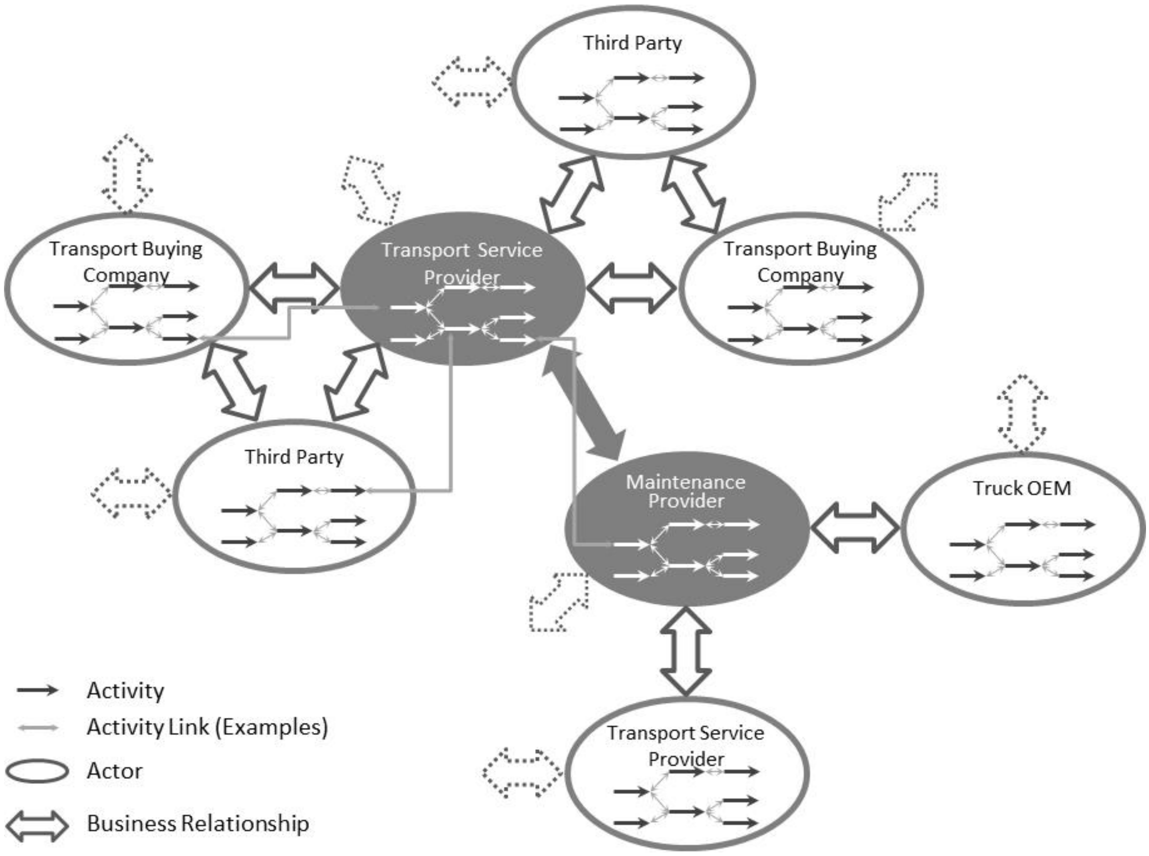

Figure 5.5 Activity links spanning firm boundaries interconnect the activity structures of the companies.

Through the business relationship of the dyad between the transport provider and the maintenance provider, the maintenance activity forms part of a shared activity pattern. This activity pattern relates to the vehicle being maintained by the workshop, a vehicle that has a unique specification. As the maintenance activity is adapted to the specification of the vehicle, this result in a joint activity configuration aimed at the maintenance of this specific vehicle.

Vehicle utilization is managed by the haulier and is planned with respect to the transport planning and driver scheduling. Moreover, the transport planning process reflects the demands posed by the transport buyer. Demands are frequently also defined by the senders/receivers of the goods. If the haulier provides its services to more than one buyer, vehicle utilization has to cater for all these demands. The pooled interdependencies of the activity pattern involve the vehicles being utilized. For efficient vehicle utilization, these interdependencies must be considered.

Planning of vehicle maintenance managed jointly by the transport provider and the maintenance provider, another example of reciprocal interdependencies, hence involves interdependencies between the activity structures of the transport buyer and the third parties of the transport operations. As the specification of the vehicle is adapted to a certain transport assignment, the joint activity configuration will be related to a specific vehicle specification.

For the maintenance provider, internal planning is related to the maintenance of its customers' vehicles. As the content of a maintenance activity depends on the unique vehicle specification, the activities of the workshop will be embedded in several activity configurations, each of them related to a specific vehicle (specification). Planning of maintenance is managed jointly with the owner of the vehicle, and as the workshop may have several customers, the plans become interdependent.

The Truck OEM provides knowledge, tools and parts to the maintenance provider. These are all related to different vehicle models and systems, and the interrelated activities therefore become part of a joint activity configuration involving the specific vehicle maintenance activity. Hence, the activity structures of the Truck OEM, the maintenance provider and the transport provider become interdependent.

5.4 Resources Influencing the Conditions for Vehicle Maintenance

Resources embedded in the network are used, produced and exchanged by activities. The resources, durable or with a shorter lifespan, represent physical and tangible assets such as machinery, raw material and end products, as well as intangible assets in the form of, for instance, human resources and expertise.

Through the business relationships of the network, resource collections managed by the different actors are tied together into resource constellations. For the studied transport operations, the goods to be transported, the transporting vehicles, the drivers, the loading infrastructure and the transport plans represent different types of resources. Figure 5.6 shows a typical example involving key resources.

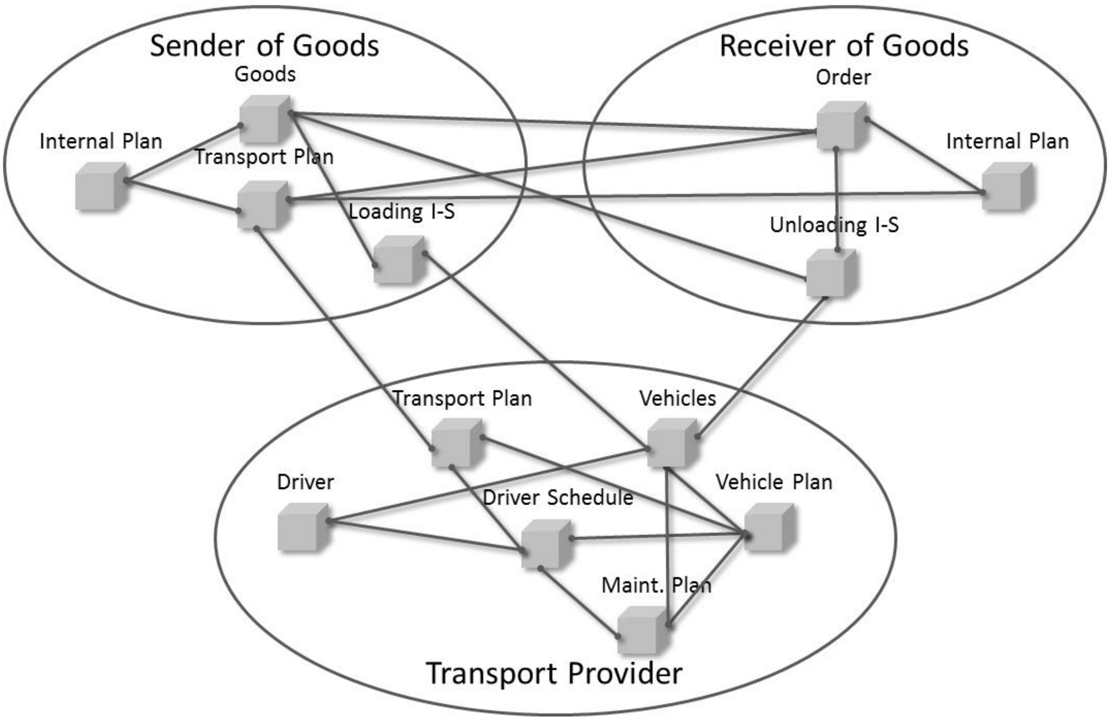

Figure 5.6 The resource collections of the companies are interconnected through resource ties.

The vehicles of the transport provider, resources used when transporting the goods from the sender to the receiver, are tied to several resources inside and outside the haulier's firm boundary. Ties between the vehicle and the vehicle plan (reflecting the routes of the transport plan) and ties between the vehicle and the goods to be transported are reflected in the vehicle specification. Similarly, ties between the vehicle and the loading and unloading infrastructures influence the specification of the vehicle. Furthermore, potential demands related to environmental aspects of transport may be reflected in requirements related to the fuel to be used. This in turn also influences the specification of the hauliers' vehicles.

Demands on the supply of goods, related to the production plans or the sales plans, are reflected in the established transport plan. For the haulier, this plan is tied to the vehicles through a vehicle plan and to the drivers via the driver schedules.

The maintenance plan of the transport provider is tied to the vehicle plan. In this way, ties between the maintenance plan and the transport plan are introduced. The maintenance plan also has to reflect the maintenance directives for each specific vehicle and by that we observe a tie between the plan and the vehicles. Hence, to meet the maintenance directives of a vehicle and at the same time ensure that transport is carried out as requested by the customer, the haulier has to adapt the plan.

For maintenance, planning is not only an issue for the haulier however. The haulier's maintenance plan has a strong tie to the maintenance provider's maintenance plan(s); see Figure 5.7. Moreover, the vehicle specification influences the type of maintenance to be performed, an interdependence resulting in a tie between the vehicle and the maintenance plan of the workshop.

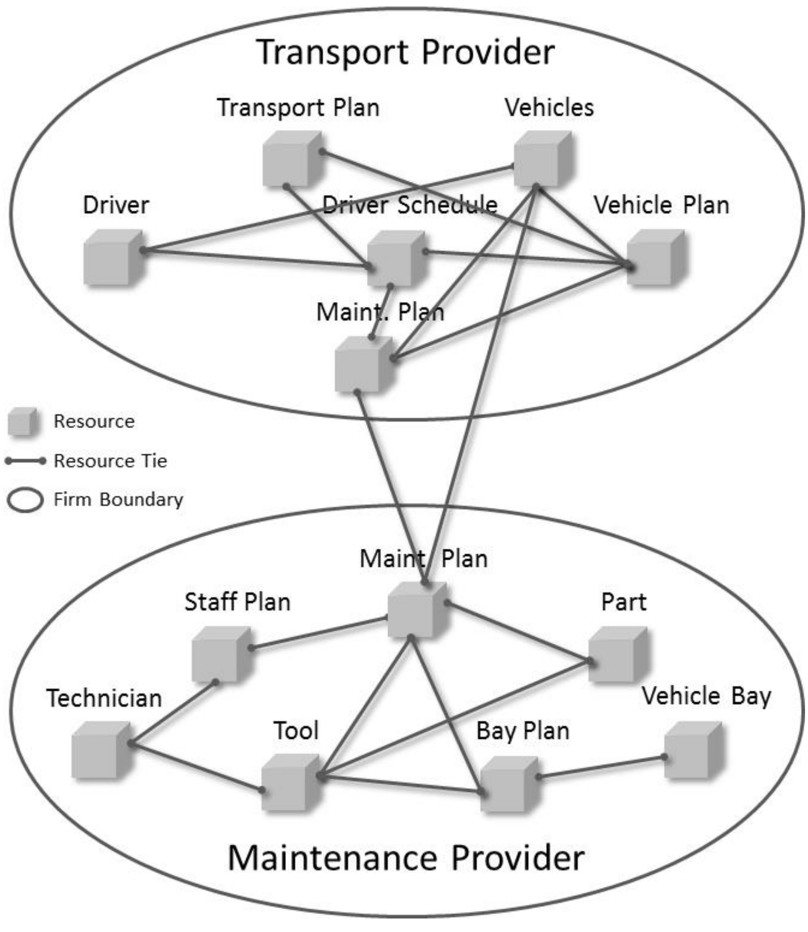

Figure 5.7 Resource collections of maintenance provider and transport provider are interconnected through resource ties.

For the maintenance provider, the maintenance plan is tied to the plans for the staff (technicians) and the workshop facility (workshop bays etc.). The tools required for maintenance depend on which maintenance operations are to be performed, resulting in a tie to the maintenance plan. The tools also reflect the requirements of the (spare) parts required for the operation. As some tools require specific knowledge, for example more advanced diagnostic tools, there is a tie between the tool(s) and the (knowledge of the) technician(s).

Most maintenance providers serve a number of customers for which they perform vehicle maintenance. This results in the workshop's maintenance plan being tied to the maintenance plans and vehicles of all its customers. Hence, interdependencies between the workshop's customers develop. The workshop's resources are also tied to the resources part of the Truck OEM's resource collection. The OEM provides the workshops with resources such as tools, (spare) parts, maintenance instructions and expertise. Consequently, the web of actors includes resource collections with interdependencies established through resource ties spanning company boundaries; see Figure 5.8.

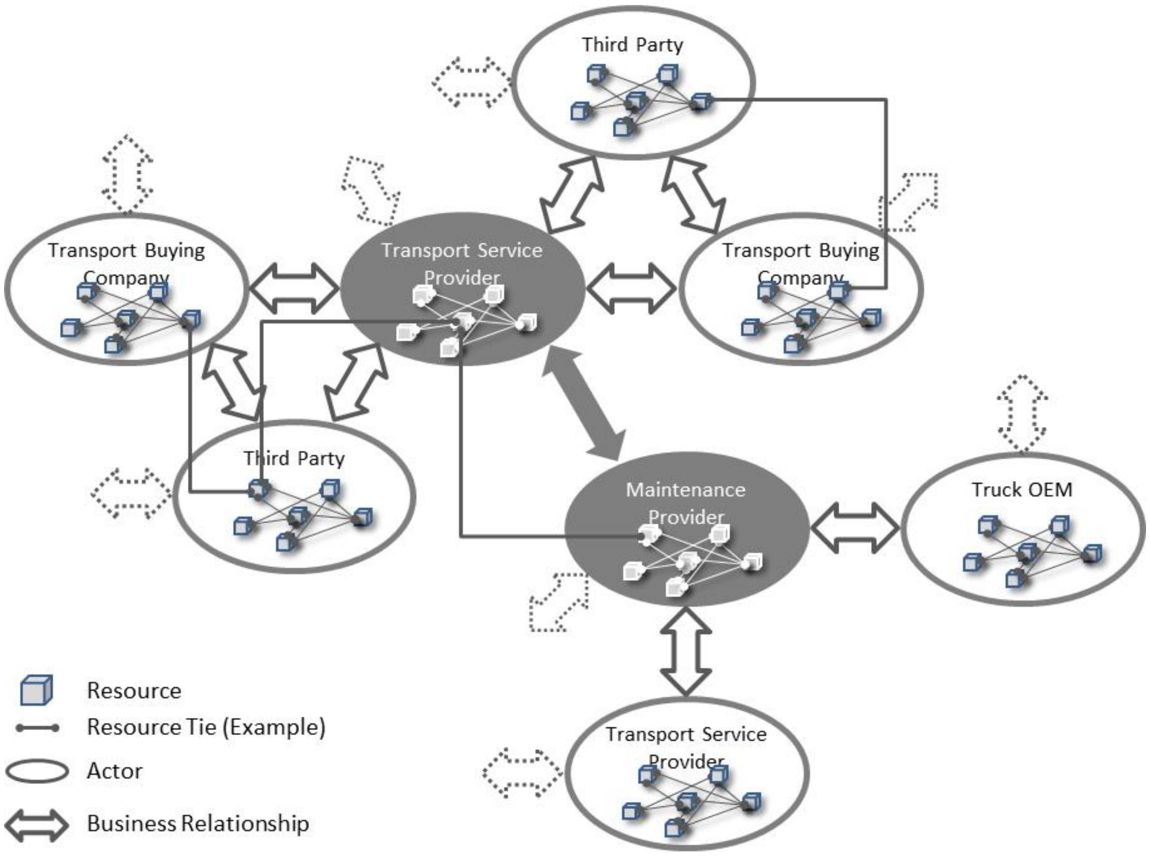

Figure 5.8 Resource collections of the companies form a resource constellation.

The vehicle(s) and the customer's maintenance plan both have ties to the workshop's maintenance plan. As the customer's maintenance plan is based on demands related to the transport operations, the overall transport plan and the workshop's maintenance plan are interdependent. Moreover, the workshop's plan and the customer's vehicle are interdependent, as the (type of) goods transported and facilities such as the loading and unloading infrastructures influence the vehicle's specification.

As the workshop also manages business relationships with other hauliers, the maintenance provider's plan features resource ties to the other customers' maintenance plans and vehicles. Parts and consumables required for maintenance have to be ordered by the workshop and, as a result, ties between the resources of the maintenance provider and the Truck OEM(s) develop. The Truck OEM also provides maintenance instructions and expertise, resulting in additional resource ties spanning the two actors.

For some of the resources, such as the trucks (tractors), trailers and bulk tanks in the DP case, interdependencies related to vehicle utilization and maintenance may develop due to the resources being part of the resource collections of different actors. Hence, for planning, this result in challenges that must be managed by the companies involved.

5.5 Interdependencies – An Overview on Three Levels of Investigations

The case analysis performed reveals the complexity of the business network in which the transport provider and the maintenance provider are embedded. The interdependencies are numerous and exist for each of the three network layers: the actor layer, the activity layer and the resource layer.

To provide examples of the type of interdependencies observed, an overview related to each of the three network layers has been compiled. The focus of this supplementary analysis is on the interdependencies that are assumed to have a stronger influence on the conditions for vehicle maintenance. Hence, the research questions guide the analysis and how the results are presented.

Firstly, an analysis at firm level is performed for the transport provider, i.e. the haulier. Secondly, interdependencies related to the dyad consisting of the transport provider (haulier) and the maintenance provider (workshop) are investigated and, thirdly, interdependencies on a network level are identified. The examples are summarized in Table 3.

Table 3 Overview regarding examples of interdependencies observed for each layer of the ARA model.

Firm Level (Haulier)	**Dyadic Level (Haulier - Workshop)**	**Network Level (As in Figure 5.2)**
Actor Layer		
	The workshop's planner is interrelated to the haulier's owner(s)/manager(s)	The haulier is interrelated to the Transport Buyer(s) (TB), the (goods) senders and the (goods) receiver(s)
	The workshop's customer receptionist is interrelated to the haulier's driver/operator (handing in the vehicle)	The haulier is interrelated to the workshop(s) engaged for vehicle maintenance
	The workshop's technician(s) is/are interrelated to the haulier's driver/operator (following the vehicle due for maintenance)	The haulier is interrelated to the Truck OEM(s) supplying the vehicle(s)
	The workshop's accounts clerk is interrelated to the haulier's owner/manager (paying the cost for maintenance)	The workshop is interrelated to the Truck OEM(s) providing parts, tools etc.
		The workshop is interrelated to the (other) haulier(s) that is/are (a) customer(s)
Activity Layer		
The maintenance planning is interrelated to transport planning, vehicle planning and driver scheduling	The workshop's maintenance planning is interrelated to the haulier's maintenance planning	The haulier's transport planning is interrelated to the to the transport planning of the TB(s)
	The maintenance activity is interrelated to the haulier's activities related to vehicle delivery and pick-up	The TB's transport planning is interrelated to the internal planning of the senders and receivers of the transported goods
	The maintenance activity is interrelated to the haulier's activities related to specification of the vehicle	The workshop's maintenance planning is interrelated to the maintenance planning of the customer(s), i.e. haulier(s)
		The workshop's maintenance planning is interrelated to the parts supply planning of the Truck OEM(s) concerned
		The haulier's vehicle specification activity is interrelated to the development, assembly and sales activities of the Truck OEM(s)
Resource Layer		
The vehicle maintenance plan is interrelated to the vehicle (utilization) plan and the driver plan	The workshop's maintenance plan is interrelated to the haulier's maintenance plan	The haulier's vehicle (utilization) plan is interrelated to the transport plan(s) of the TB(s)
The vehicle maintenance plan is interrelated to the vehicle (specification)	The workshop's maintenance plan is interrelated to the haulier's vehicle (specification)	The haulier's vehicle (specification) is interrelated to the goods, the transport route(s) and the loading/unloading infrastructure
The vehicle (specification) is interrelated to the vehicle (utilization) plan		The workshop's maintenance plan is interrelated to the maintenance plan(s) of its customer(s)
		The maintenance plan(s) of the workshop's customer(s) are interrelated to the transport plan(s) of other transport buyers involved
		The workshop's maintenance plan is interrelated to the parts supply plan(s) of the Truck OEM(s) involved

A company or group of companies aiming to improve the efficiency of vehicle maintenance should identify and address the interdependencies. A conceptual framework for this is considered further in the concluding discussion part of Chapter 7.

5.6 Variety and Similarities between the Cases

There are numerous similarities between the cases studied for this thesis. To start with, the companies selected involve transport buyers that are heavily dependent on transport and known to be big buyers of transport services. The studied cases also all involve transport cycles with activities displaying serial interdependencies with a sequential feature.

The transport operations discussed also have strict demands for transport reliability and/or loading and unloading time windows. All three cases encompass processes for sales or production that require a steady input flow of goods or raw material.

Additionally, the actors and business relationships in all the cases form complex networks involving interdependencies spanning company boundaries. To plan and carry out transport, the embeddedness of actors, activities and resources must be acknowledged.

Maybe even more important, the cases also display variety with respect to several important areas. Table 4 provides an overview of a few examples related to the transport operations of each case. The variety observed influences long-term aspects, such as investment in relationships and vehicle procurement, as well as more short-term aspects such as transport planning and vehicle maintenance.

The variety observed is an indication that the context of each case differs, which in turn results in the implications for the transport operations and the firms involved varying from case to case. Solutions aimed at factors such as vehicle utilization and transport efficiency must therefore address different conditions and demands from case to case.

Table 4 Examples of variety among the cases studied.

Dairy Products	Retail Corporate Group	Forest Products
Contracts and Business Relationships		
Contracts are fairly short but relationships are long term and the turnover limited.	The contract involving RT and the hauliers is comparably long (five years).	Contracts are fairly short but relationships are long term and the turnover limited.
The Transport Buyer's Share of and Influence on the Transport Provider's Vehicle Fleet		
DP only owns a few spare vehicles - but owns the trailers and bulk tanks used.	RCG does not own any vehicles, and RT does not use any of its own vehicles.	FP operates an internal haulage company involving vehicles used for transport.
All inbound transport is carried out by external hauliers.	All transport is carried out by external hauliers contracted by RT.	External hauliers carry out a majority of the transport.
Transport Planning and Vehicle Utilization		
Transport plans are established by DP in co-operation with the hauliers.	Transport plans are established by RCG and RT in co-operation with the hauliers.	Transport planning, reflecting the weekly quotas from FP, is done by the haulier.
The hauliers work full time for DP and do not carry out transoport for other customers.	The contracted hauliers are allowed to carry out transport for other customers.	The contracted hauliers are allowed to carry out transport for other customers.
Milk collection is carried out 24 hours a day, 7 days a week.	Distribution transports are mainly carried out during the daytime.	Transports are carried out 24 hours a day, from Sunday night to Saturday morning.
Transport Cycles, Loading and Unloading		
The locations for loading (farms) and unloading (dairies) milk are fixed.	The locations for loading(warehouses) and unloading (stores) of goods are fixed.	The locations for timber loading vary extensively, but delivery locations are fixed.
The transport cycles are repeated every 48 hours but the milk volume varies over time.	Cycles are regularly repeated but the type and amount of groceries vary over time.	The transport routes vary extensively due to the variation of loading locations.
Well-defined transport cycles including time windows for milk collection at the farms.	Cycles involving fixed time slots for loading and time windows for unloading.	The transport plans do not involve any precise loading or unloading times.
The transport cycles do not involve any return load (to the farmers).	The transport cycles involve a return of empty load carriers.	The transport cycles do not involve any return load (to the forest owners).
Vehicle Specification		
The trucks and trailers used are generally of standard specification.	The trucks and trailers used are generally of standard specification.	The specifications of the vehicles used are adapted to the transport assignment.
The bulk tanks mounted on the vehicles (tractors) and trailers are adapted for the assignments.	The trucks and trailers are adapted to the goods and loading/unloading infrastructure.	Timber banks and lifts are adapted to the specific assignment.
Vehicle Maintenance		
The maintenance of trailers and bulk tanks is planned by DP (haulier for the tractor).	The hauliers have full responsibility for the maintenance of the complete vehicle.	The hauliers have full responsibility for the maintenance of the complete vehicle.

5.7 Implications of Embeddedness and Interdependencies

Vehicle maintenance is an activity that is embedded in a wider network. Interdependencies develop over time through business relationships between the actors of the network. The interdependencies must be addressed by the companies involved if efficiency is to be achieved. Moreover, a holistic interorganizational perspective must be applied. Due to the bounded rationality and different aims and scopes of the actors involved, efficiency could be understood differently by the companies concerned.

Hence, for heavy vehicle maintenance, a narrow perspective encompassing only the workshop or the haulier will not be sufficient. Nor will a pure dyadic perspective involving the transport provider and the maintenance provider address the full spectra of constraints as well as opportunities. To address the question of improved efficiency of vehicle maintenance, a wider network-based perspective must be applied.

Maintenance is linked to other activities in the activity structure of the maintenance provider as well as to the activities part of the activity structures of its customers (the hauliers) and the Truck OEM. If the companies involved strive to plan and perform maintenance with the focus on efficiency, the notion of efficiency has to be clearly understood and agreed by all parties. Improving efficiency will mean different things to the various companies. Moreover, improving efficiency for one actor may have a negative effect on efficiency from the perspective of another.

Having defined a common aim with respect to improved efficiency, interdependencies between activities have to be identified and properly managed. Coordination, adjustment and standardization provide means for the companies concerned in this mission.

Similarly, resources involved in or influencing vehicle maintenance can be found as part of the workshop’s (internal) resource collection as well as within the wider resource constellation. To manage vehicle maintenance with the focus on efficiency, interdependencies between the resources must be handled.

6. DISCUSSION

The aim of this thesis is to contribute to the understanding of heavy vehicle maintenance from an interorganizational perspective. Specifically, the thesis aims to identify context-based antecedents with implications for vehicle maintenance.

For managers, a supplementary aim of the present work is to identify issues to address for further improvements with respect to the efficiency of vehicle maintenance.

The characteristics of the settings studied are of great importance for an analysis of the implications for vehicle maintenance, many of which are assumed to be context related. Moreover, to address issues related to the efficiency of vehicle maintenance, knowledge about different actors' notions of efficiency is critical.

To satisfy the needs for context-related data and capture the various perspectives of the stakeholders involved, a qualitative case study has been performed. Data have been collected through semi-structured interviews with representatives from transport buyers and transport providers. The three firms representing transport buyers were selected based on being known to be heavily reliant on transport and large buyers of transport services. Additionally, the assumed variety with respect to the characteristics of each case was considered important during the selection process

The cases encompass a number of companies directly or indirectly involved in the analysed transport operations. A common goal for the transport buyer and the transport provider is efficient and reliable goods transport. Vehicle maintenance, a prerequisite for efficient and reliable vehicle utilization, is therefore essential.

This thesis is theoretically grounded in a framework based on the Industrial Network Approach. The analytical framework defined provides support for an analysis of the business network and its business relationships and interdependencies. Specifically, the maintenance activity is studied with respect to interdependencies between the activities, resources and actors embedded in the network.

The rest of this chapter encompasses a discussion divided into three parts. First, there is a discussion based on findings related to embeddedness. This is followed by a discussion related to interdependencies. Finally, the findings related to variety in context, preconditions and needs are discussed.

6.1 Embeddedness

The network pictures for each of the three cases studied clearly show that the Transport Service Triad in which the transport provider is engaged is embedded in a wider network of companies directly or indirectly involved in the transport operations.

In the RCG case, for instance, the Transport Service Triad encompassing the transport service provider, the transport buyer and the third parties (in this case the grocery stores) is embedded in a business network involving additional firms such as other (external) transport buyers, maintenance provider(s) and Truck OEM(s). The complexity is further increased due to RT acting as an intermediary between RCG and the hauliers carrying out the transport.

Actors, such as the firms discussed above, are embedded in the business network of each case. Actor bonds form part of the business relationships between the firms embedded in the network and also interconnect individuals in the companies such as the drivers and the workshop technicians.

Putting the DP case under the magnifying glass as an example, it becomes clear that a variety of activities need to take place in order to fulfil the task of milk collection. The activities, which are interconnected in the activity structures of different companies, are interlinked and embedded in an activity pattern spanning firm boundaries.

In a similar way, the resources involved are owned by different companies belonging to the business network and thus become embedded not only within the resource collection of a company but also in a resource constellation spanning the network. In the case of FP, for instance, the vehicles, timber and sawmills are all interconnected but owned by different actors.

Similarly, the maintenance provider, an in-house operation or external partner, is embedded as a node in the web of actors representing each case. The actor performing vehicle maintenance is but part of a bigger whole, a cog in the multitude of cogwheels necessary for the machinery required for transport.

Vehicle maintenance, a ‘support activity’ ensuring that the vehicles can be used for their intended purpose in an efficient way, is performed by the maintenance provider. Hence, the activity is part of the actor’s internal activity structure and also embedded in the wider activity pattern.

The dyadic relationship between a transport provider and a maintenance provider cannot be seen in isolation. The dyadic relationship is part of a larger network of business relationships connecting firms. Relationships are developed over time with suppliers, customers, competitors as well as other stakeholders. For a firm embedded in a network, business relationships are an integral part of the environment and strongly influence its operations.

Embeddedness is thus a network feature that has to be understood and addressed. Hence, embeddedness influences the way we should understand and manage a phenomenon like vehicle maintenance.

The implications resulting from the embeddedness of vehicle maintenance can be addressed on three levels.

Firstly, the vehicle maintenance activity itself is embedded. The activity is embedded in the activity structure of the maintenance provider and in the activity pattern of the network. Hence, the activity must be seen in the light of its embedded position in this activity pattern spanning firm boundaries.

Secondly, the maintenance provider is embedded as an actor in the web of actors. This implies that the actor performing vehicle maintenance has to be observed in relation to other actors. As a result of its embeddedness, a maintenance provider cannot operate without influencing and being influenced by other actors.

Thirdly and lastly, the dyad involving the maintenance provider and the transport provider, a dyadic relationship of outmost importance to vehicle maintenance, is embedded in a network of dyads interconnected by business relationships. Due to its embeddedness, the dyadic relationship both influences and is influenced by other dyads of the network.

All in all, to effectively plan and perform vehicle maintenance, the embeddedness of activities, actors and business relationships must be fully understood, and the implications caused by embeddedness must be identified, analysed and addressed.

6.2 Interdependencies

When analysing the activities and resources of the three cases it becomes obvious that along with embeddedness, interdependencies between the network elements are frequent. The interdependencies could be seen as an effect of the embeddedness and as the result of the decisions and adaptations made by actors. Hence, interdependencies may be a result for which the companies concerned are striving or an unwanted and unexpected side effect.

One of the most obvious cases of interdependencies observed is the serial interdependencies that exist between activities in the transport chain. The activities have to be performed in sequence, and the previous activity has to be concluded before the next one can start. In this case, the serial interdependencies have a sequential form. For specific cases, e.g. the organic milk in the DP case, the serial interdependencies even feature a tightly sequential form.

Another common type of interdependence between the activities involved in the transport chain is the joint interdependencies of the loading and unloading activities. The loading and unloading activities introduce interdependencies between the activity structures of the two parties involved. The joint interdependencies lead to the activities of the firms concerned having to be mutually adjusted and coordinated.

With respect to the resources embedded in the network, we also observe interdependencies related to the transport of goods. In the case of DP, for instance, the vehicles (trucks) used are owned by the hauliers, while the bulk tanks and (most of) the trailers are owned by DP. As the bulk tanks are mounted on the vehicles (trucks) and trailers, and the trailers are combined with the vehicles into vehicle combinations, this results in ties between the resources of the two actors. Moreover, as in the case of RCG, we observe resource ties between the vehicle (specification) and the type of goods transported as well as the loading and unloading infrastructure.

Resource ties are also observed with respect to the plans established by various actors of the network. A transport plan established by the transport buyer must be adapted to the plans of the sender and the receiver of the goods. Moreover, the transport provider's internal plans for vehicles and drivers must be adapted to the transport buyer's transport plan.

However, interdependencies also exist between the three different network layers: the activity layer, the resource layer and the actor layer. Transport planning, for instance, displays interdependencies with respect to the vehicles (specification) as well as the infrastructure for loading and unloading. In the case of DP, for example, planning must address constraints with respect to the maximum volume of the farmer's milk tank and the loading capacity of the vehicle. Similarly, the planning for timber transport has to address issues related to the infrastructure of the receiving mill.

When planning and preparing for vehicle maintenance, the maintenance provider's maintenance plan must be adapted to the transport provider's maintenance plan. Moreover, the haulier's maintenance plan must be adapted to the internal plans for the vehicles and drivers as well as the transport plan for the transport operations.

When the transport provider outsources vehicle maintenance to an external firm, the influence of the other dyads in which the workshop is involved makes the planning more complex. The maintenance provider must adapt its internal plans not only to the needs of one customer but to the needs of all its customers. In addition, the maintenance provider must address possible constraints resulting from interdependencies caused by activity links and resource ties involving the Truck OEM(s).

The workshop's resources must be adapted to the activities to be performed as part of the vehicle maintenance. The specific content of a maintenance activity depends on the vehicle (specification), its usage and the maintenance recommendations of the OEM. For each sub-activity of the maintenance, the specific procedures, tools and parts are interrelated. Additionally, for some sub-activities, specific skills are required, which may lead to not all technicians being able to perform the operation.

Interdependencies are thus a common feature of the networks in which vehicle maintenance is embedded. To manage vehicle maintenance with the aim to improve efficiency, these interdependencies must be understood and properly addressed by the parties involved.

6.3 Variety in Context, Preconditions and Needs

The three cases display several similarities with respect to the context in which the transport operations are performed. The transport operations, all of which involve cycles with activities that display serial interdependencies, have strict demands for transport reliability and/or loading and unloading time windows.

However, the variety in the cases becomes significant when the context of each case is studied in detail. What at first seem to be cases with a high degree of similarities are found to involve varieties that strongly influence the conditions for the companies operating.

A most important difference relates to the share of the transport provider’s transport capacity purchased by the transport buyer. In the case of DP, for instance, the hauliers collecting milk are fully occupied with transport for DP. The hauliers could therefore be seen as an integral part of the wider operations of DP. In the case of FP, however, the external hauliers are free to perform transports also for other customers. Additionally, these hauliers are able to subcontract transport to other transport providers. The transport buyer’s share of the transport provider’s capacity heavily influences issues such as the buyer’s control over the vehicle fleet and the complexity of the transport planning.

Moreover, even if many of the relationships between transport buyers and transport providers are long term, the lengths of the contracts vary between the cases. In the case of RCG, the contract lasts for five years, while the two other cases feature shorter contracts. Contract length, for instance, influences decisions on investments and financing, two highly critical issues to a transport provider.

A third dimension of variety regards the transport cycles as such. In the cases of DP and RCG, the loading and unloading locations are known and the transport cycles are repeated. Over time, the drivers gain extensive knowledge about the locations, the route and the specific demands a supplier/sender or receiver may have. In the case of FP, the receiving mills only vary to a very limited degree while the loading points, the timber roadside storages and the routes vary more extensively. A higher degree of variation with respect to the location of loading or unloading as well as the routes travelled could be assumed to influence factors such as transport reliability and the timeliness of loading and unloading.

Resource specificity is yet another dimension that is central for embeddedness and the resource specificity varies among the three cases studied. Even though the vehicles used for distribution in the RCG case have to be adapted to the loading and unloading infrastructure as well as the load carriers, the vehicles have a fairly common specification. In the cases of DP and FP, however, the vehicles are highly specialized and adapted for the goods and transport missions. The resource specificity, in this case of the vehicle's specification, influences issues of, for instance, reliability and redundancy. If a more specialized vehicle is being used, it can be more difficult to find a replacement if one is required. To address this concern, DP, for instance, owns a few replacement vehicles for redundancy.

With respect to resources, the cases also display variety with regard to resource ties across firm boundaries. In the cases of RCG and FP, the hauliers own the complete vehicle combination, i.e. the truck (tractor), the trailer and the other equipment. In the case of DP, on the other hand, the trucks (tractors) are owned by the hauliers while the bulk tanks and most of the trailers are owned by DP. The kind of 'shared' ownership displayed in the DP case influences issues related to vehicle management and maintenance.

Consequently, the three cases display interesting differences with respect to maintenance. In the cases of RCG and FP, the hauliers are fully responsible for the maintenance of the complete vehicle combination. In the DP case, the situation is different. Due to the 'shared' responsibility for the vehicle, the responsibility for maintenance also becomes 'shared'. The hauliers operating for DP are responsible for the maintenance of the truck (tractor) while DP is responsible for the maintenance of the bulk tanks and trailers it owns. The question of ownership and responsibility split influences how contracts and cooperation are formed, as well as the operations planning process.

If similarity in context, preconditions and needs together form possible grounds for standardized solutions, variety could be expected to drive the need for more adapted offerings. This would most certainly also be applicable to vehicle maintenance solutions. Hence it could be assumed that the efficiency of vehicle maintenance is improved if standardized maintenance offers are supplemented or replaced by solutions better adapted to the customer's specific context, preconditions and needs.

7. CONCLUSIONS AND IMPLICATIONS

In the First section of this final chapter, the conclusions based on the foregoing discussion are presented. Thereafter, the managerial implications and the research implications are presented.

7.1 Conclusions

Vehicle maintenance may appear quite an unproblematic and straightforward activity. However, as is evident from the foregoing analysis, the activity involves quite a few challenges. This is especially valid if the ambition is to perform vehicle maintenance in an efficient way. The term ‘efficiency’ in itself puts the focus on one of the important challenges that is faced. Improving efficiency is an aim that is seen differently depending on the context and scope of the firm concerned.

To enable efficient vehicle maintenance, a number of issues need to be addressed and, in a first step, they must be identified and analysed.

According to the discussion in Chapter Five and Six, the Industrial Network Approach allows us to identify three important issues characterizing the context, pre-conditions and needs of the three cases studied.

Firstly, we observe that the maintenance provider, the dyad involving the maintenance provider and the transport provider, as well as the maintenance activity in itself are all embedded in a wider network of firms. Due to their embedded nature, the elements both influence and are influenced by other elements of the network. Hence, to effectively plan and perform vehicle maintenance, the nature of the embeddedness must be understood and the implications analysed and addressed. Vehicle maintenance cannot be managed as an activity in isolation but has to be seen as part of a bigger whole that will influence the possibilities to perform maintenance in an efficient way.

Secondly, interdependencies between actors, activities and resources result in constraints as well as opportunities. Activities and resources involved in the planning and performance of vehicle maintenance are interconnected to other activities and resources embedded in the network. To perform vehicle maintenance in an efficient way hence also becomes an issue of how to manage the interdependencies observed.

Thirdly and finally, the variety observed in the context, preconditions and needs of each case must be understood and properly addressed. If we assume that variety drives the need for varied and more adapted offers, it can also be assumed that the efficiency of vehicle maintenance improves if standardized maintenance offers are supplemented or replaced by resource specificity and solutions better adapted to the varying contexts, preconditions and needs of the companies concerned.

As discussed in Chapter One, however, there is a catch here: the efficiency of vehicle maintenance is perceived differently by different stakeholders (see Figure 7.1). Efficient maintenance from the perspective of a maintenance provider differs from that of the transport provider. Moreover, maintenance efficiency from the perspective of the transport buyer differs from the perspectives of the transport provider and the maintenance provider.

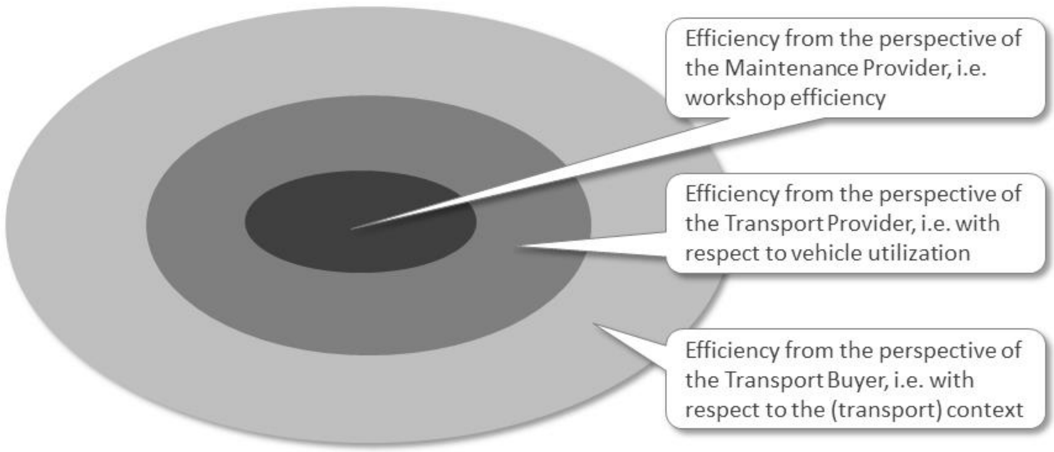

Figure 7.1 Efficiency from different perspectives.

For the maintenance provider, maintenance efficiency revolves around issues related to efficient utilization of workshop resources; hence, maintenance efficiency from a workshop perspective mainly addresses areas such as workshop planning, staff planning, etc. Maintenance efficiency for a transport provider instead relates to vehicle utilization, i.e. the transport provider's targets for vehicle efficiency and reliability. A transport provider therefore requires the maintenance provider to carry out the maintenance tasks as efficiently as possible. Moreover, the transport buyer's perspective differs from those of the two other actors. For a transport buyer, efficiency relates to the overall transport and logistics operations; efficiency of vehicle maintenance thus relates to the overall objectives: efficiency and reliability of the transport services procured.

To achieve overall efficiency of vehicle maintenance, i.e. meet the expectations of all the stakeholders in Figure 7.1, the implications of embeddedness, interdependencies and variety have to be addressed with a holistic perspective in mind. For instance, it is not enough to meet the expectations of the transport provider or to address only the demands of the transport buyer.

A holistic approach encompassing the three perspectives discussed above needs to be structured. The structure proposed draws on the perspectives in Figure 7.1 and defines three network-oriented levels for analysis: the firm level, the dyadic level and the network level.

The maintenance provider and the transport provider are analysed at the firm level. Moreover, the dyad involving the transport provider and the maintenance provider is analysed at the dyadic level. Finally, at the network level, we analyse the network encompassing the transport buyer as well as other concerned stakeholders such as the sender and the receiver.

The analysis, performed on the three levels proposed, highlights some of the issues and concerns that must be addressed in order to improve the efficiency of vehicle maintenance at each level and as a whole.

However, the current status of a business network reflects the past as well as the expectations of the future. The possibilities for efficient maintenance are thus partly underpinned by decisions made long before and partly depending on the expected future. Relationships with suppliers, customers and competitors evolve and interdependencies change over time as the result of interactions between companies. Over time, activities in the network become mutually adjusted, and the features and interfaces of a resource reflect previous interactions and resource combinations. Hence, in order to prepare for efficient maintenance, the concerned stakeholders must address vehicle maintenance and the related issues from both a short and a long perspective. For this analysis, I propose a structure allowing the companies concerned to address vehicle maintenance and the related issues in an approach that considers the three perspectives discussed above as well as the different time horizons; see Figure 7.2.

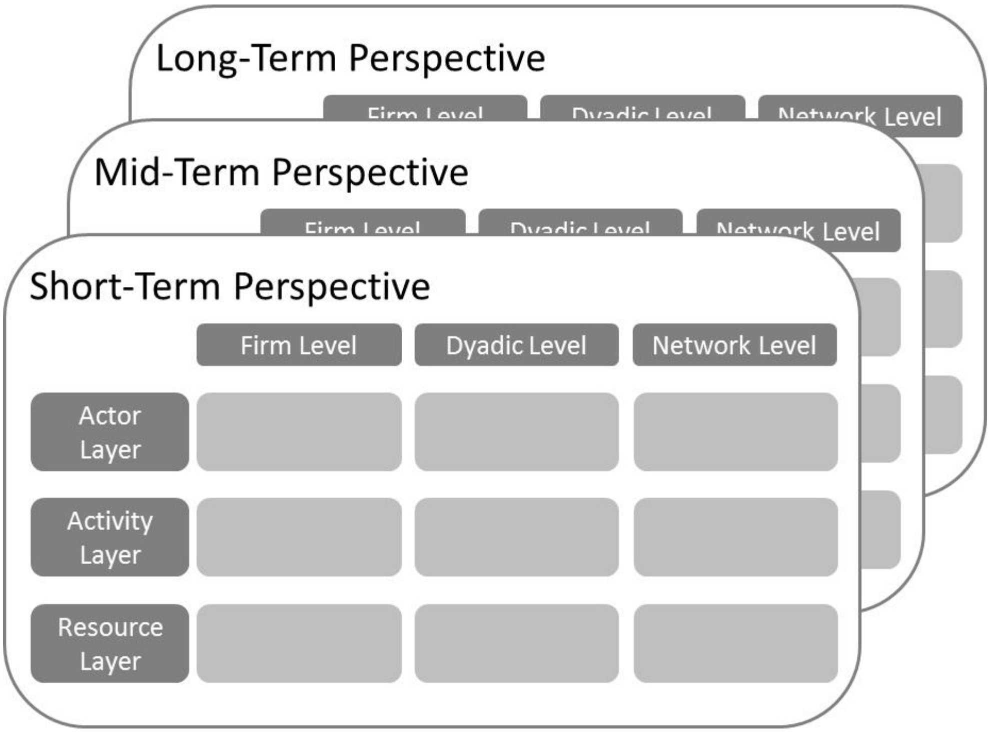

Figure 7.2 Structure proposed for analysis of short-term, mid-term and long-term implications.

In Figure 7.2, three different time horizons are addressed: short-term, mid-term, and long-term. Three different time horizons should be sufficient, at least for most companies.

As the transport operation in itself is closely related to the focus of this thesis, a comparison is made with terms used by researchers and managers for decision-making in the area of transport and logistics. In the area of transport and logistics, the three types of perspectives for decision-making are operational, tactical and strategical (Jonsson, 2008).

In logistics, the operational perspective applies to the short-term, daily perspective. The aim of the decisions that are made is to enable efficient use of the existing resources utilized in the transport operations. In this type of decisions we identify issues related to, for example, purchase orders and daily changes of transport routes.

The tactical perspective encompasses issues within a mid-term perspective. Here, the aim is also to enable high efficiency, but it concerns structural issues that require more time to develop and implement. Decisions related to the reorganization and developments of existing resources are examples applicable to the tactical horizon.

Lastly, the strategical perspective regards issues that require a longer planning horizon. Decisions on investments, company policies, strategies, outsourcing and business relationships are all related to the strategical planning perspective.

Drawing on the empirical data and results from the preceding analysis, it is now possible to structure the main findings according to the model in Figure 7.2. The three tables developed, one for each planning horizon, are presented as Tables 5, 6 and 7. (Please note that table 5 and 6 each are split over two pages.)

As discussed above, the network level encompasses the main stakeholders involved directly or indirectly in the transport operations, while the dyadic level focuses on the dyad involving the transport provider and the maintenance provider. At the firm level, I focus on the maintenance provider and the transport provider separately.

The first table address issues and tasks that the companies should address from a long-term perspective. When studying the content of the first table, it becomes obvious that the results of these ‘long-term-oriented’ activities ‘set the scene’ for activities addressed from mid- and short-term perspectives.

Table 5 This table provides examples of issues that maintenance providers, transport providers and other stakeholders need to address from a long-term (strategical) perspective in order to enable efficiency of vehicle maintenance.

Long Term / Strategical Perspective

Issues related to, e.g., long-term strategies, policies, investments, planning and partnerships.

Firm Level Maintenance Provider (incl. Truck OEM where applicable)	**Firm Level** Transport Provider	**Dyadic Level** Maintenance Provider <--> Transport Provider	**Network Level** The network of firms directly or indirectly involved in the operations
Actor Layer			
Maintenance Provider’s (MP) decision on geographical location (influences the firm’s possibilities to attract and serve customers)	Transport Provider’s (TP) decision on truck make and type (influences issues related to vehicle maintenance and other support)	Form and content of relationship (and contract) between MP and TP (influences how planning and day-to-day issues are managed)	Transport Buyer’s (TB) ‘make-or-buy’ decision on transport (influences issues of planning and control of vehicle fleet)
MP’s decision on scope of service (influences the firm’s possibilities to attract and serve customers)	TP’s ‘make-or-buy’ decision on vehicle maintenance (influences internal investments, vehicle utilization and business relationships)		TB’s decision on how much of the supplier’s capacity to procure (influences issues of planning and integration into buyer’s operations)
MP’s decision on opening days/hours (influences the firm’s possibilities to attract and serve customers)	TP’s decision on the firm’s maintenance strategy and operation (influences maintenance planning and costs)		TB’s decision on length of contract (influences issues related to the TP’s investments and vehicle utilization)
Maintenance solutions and business models offered by MP/Truck OEM (influences the firm’s possibilities to attract and serve customers)			The decision on whether to cooperate with other TBs procuring transport from the same TP (influences efficiency of vehicle utilization)
Activity Layer			
Establish process for internal coordination of plans for, e.g., staff, facilities and maintenance. (enables improved efficiency)	Establish internal coordination of plans for transport, vehicles, drivers and maintenance. (enables improved efficiency)	Establish a joint process for MP and TP for continuous improvement (influences efficiency and commitment)	Establish a joint process for TB and TP (and possibly for third parties) for continuous improvement. (influences efficiency and commitment)
Establish internal process for continous improvement. (supports improved efficiency and quality of work)	Establish internal process for vehicle maintenance, incident/failure reporting and pre-/post-trip inspection (improves robustness, reliability, uptime)	Establish a joint process for MP and TP regarding contingency planning (improve possibilities to manage disruptions)	Establish a joint process for TB and TP (and 3rd parties) for contingency planning (improve possibilities to manage disruptions)
Establish programme for training technicians and other staff. (supports improved efficiency and quality of work)	Establish programme for driver training which that supports better use of the vehicles. (reduces operation and maintenance costs)	Establish a joint planning process for MP and TP (enables coordinated vehicle maintenance)	A joint planning process for the firms involved (e.g. TBs and TPs) to coordinate planning of vehicle utilization (improves efficiency of transport)
	Establish a programme for monitoring and following up maintenance cost (influences vehicle replacement and/or adjustment of maintenance contract)	Establish a joint programme for monitoring and following up of maintenance cost (influences vehicle replacement and/or adjustment of maintenance contract)	

Long Term / Strategical Perspective

Issues related to, e.g., long-term strategies, policies, investments, planning and partnerships.

Firm Level Maintenance Provider (incl. Truck OEM where applicable)	Firm Level Transport Provider	Dyadic Level Maintenance Provider <--> Transport Provider	Network Level The network of firms directly or indirectly involved in the operations
Resource Layer			
Investment in facilities and tools (influences the firm's possibilities to attract and serve customers)	TP’s decision on truck make (influences issues related to vehicle maintenance and other support)	Establish a common tool for maintenance planning (supports improved efficiency and vehicle utilization)	Resource specificity, demands for a unique/specific vehicle specification (may result in "lock-in" effects leading to lower resistance to disruptions)
Investment in recruiting technicians and other staff (influences the firm's possibilities to attract and serve customers)	TP’s decision on truck specification (influences possible ‘lock-in’ effects, operating costs and requirements and plans for vehicle maintenance)	Decision on possible ‘spare trucks’ (influences the firm's possibility to manage contingencies)	Establish a common tool for transport planning (and vehicle utilization) (supports improved efficiency and vehicle utilization)
Maintenance solutions/offers for customers (influences the TP’s procurement and MP's possibilities to attract and serve customers)	TP's decission about trailers and Body Builder-equipment (influences requirements/plans for vehicle maintenance)		Split ownership of resources, e.g., different owners of trucks (tractors) and trailers (challenges with respect to efficiency and planning of use and maintenance)
Decision on possible offer for ‘spare trucks’ (influences the firm's possibilities to attract and serve customers)	Decision on possible ‘spare trucks’ (influences the firm's possibility to manage contingencies)		TB's decission on possible "spare trucks" (influences possibilites to manage contingencies)
Establish supply chain process/systems for parts and consumables required for maintenance			

Contrary to what may be expected, but in line with the discourse and ideas regarding connections between maintenance and business strategies, Table 5 indicates that issues related to a long-term (strategical) perspective have a big influence on vehicle maintenance. Decisions and agreements made from a long-term perspective set the boundaries for the possibilities to improve maintenance efficiency from a mid- and a short-term perspective.

For the maintenance provider and the Truck OEM, decisions on the location of and investments in the workshop are critical. Moreover, decisions related to the workshop operations, for instance the type of solutions and services offered as well as opening days/hours, are important parameters. Transport providers generally tend to prefer workshops that are able to offer flexible opening hours and are located in the vicinity of the haulier.

As a result of the decision on the vehicle type and make to procure, the transport provider also, explicitly or implicitly, makes a choice of maintenance solutions and workshop facilities. Moreover, the need for and plan of maintenance are influenced by the vehicle specification, its assumed usage profile and guidelines from the Truck OEM.

For the transport provider, the decision on possible outsourcing of vehicle maintenance has a major impact. The decision influences how vehicle maintenance is planned and performed. Additionally, a decision on outsourcing influences the level of in-house competence that is retained as well as planning flexibility.

The upsides and downsides of outsourcing maintenance should be carefully scrutinized ahead of a decision. Tsang (2002, p. 11) underlines the importance of a careful and professional decision process:

> “The selection of maintenance service-delivery options should not be regarded as a purely tactical matter. The decision should be made in the context of the company's overall business strategy. When companies consider outsourcing of their maintenance activities as a strategic option, they need to answer three key questions:
>
> (1) What should not be outsourced?
>
> (2) What type of relationship with the external service supplier should be adopted?
>
> (3) How should the risks of outsourcing be managed?”

Vehicle maintenance is a key issue for the transport provider and the maintenance provider. However, the transport buyer also heavily influences the preconditions for vehicle maintenance. The transport buyer's decisions related to the procurement of transport services involving, for instance, contractual issues, capacity planning and cooperation for efficiency improvement, all influence the operations at hand. Hence, these decisions influence the potential for improvements in vehicle maintenance efficiency in the mid and short term.

Processes and forums addressing continuous improvements and contingency planning are important both within and among companies involved in the transport operations in focus. Plans, measures and KPIs should be monitored continuously, and means for improvements in efficiency, quality, cost and uptime must be addressed together.

Although this thesis focuses on the context of the transport operations and companies involved in it, it is important to include a few words relating to the long-term planning horizon with respect to the Truck OEM. The vehicle manufacturer has a key role in the development of products and services, having influence on an area such as vehicle maintenance.

Focusing on vehicle maintenance during product development results in a product 'designed for maintenance'. Component and systems design, as well as vehicle packaging, influences the possibilities for performing efficient maintenance. Similarly, product-oriented services provide possibilities for customer adaptation of product offers as well as maintenance solutions.

Table 6 This table provides examples of issues that maintenance providers, transport providers and other stakeholders need to address from a mid-term (tactical) perspective in order to enable efficiency of vehicle maintenance.

Mid Term / Tactical Perspective

Issues related to, e.g., mid term (structural) changes and adaptations, planning and management of business relationships

Firm Level	**Firm Level**	**Dyadic Level**	**Network Level**
Maintenance Provider (incl. Truck OEM where applicable)	Transport Provider	Maintenance Provider <--> Transport Provider	The network of firms directly or indirectly involved in the transport operations
Actor Layer			
Adjustment of opening days/hours (adapt to new/changed customer needs)	Evaluate choice of truck make and specification (influences next procurement)	Evaluate status, KPIs and form/content of relationship (input to further changes/adaptations of relationship)	Evaluation and adjustment of TB's capacity demands and procurement strategy (influences relationship [and contract] with TPs)
Adjustment of customer solutions and offers (adapt to new/changed customer needs)	Evaluate "make-or-buy" decision on maintenance. (input to further decisions)		Evaluation of relationships and cooperation within and outside Transport Service Triad (influences relationships, coordination and planning)
	Evaluate decision on the firm's maintenance strategy and its operation (input to further decisions)		
Activity Layer			
Review and adjustment of internal coordination of plans for, e.g., staff, facilities and maintenance	Review and adjust internal plans for transport, vehicles, drivers and maintenance	Identify and address interdependencies that reduce efficiency and robustness	Joint review of the transport chain and adjustment of activities and tactical transport plan
Review and adjustment of internal process for continuous improvement	Review results from and process for vehicle maintenance, incident/failure reporting and pre-/post-trip inspection	Follow-up/revise process for contingency management	Joint review and adjustment of contingency management
Training/updates for technicians and other staff to support improved efficiency and quality of work	Training/updates for drivers to support better use of the vehicles	Joint review and adjustment of the mid-term maintenance plan(s) and related process	Joint review of maintenance plans (in the case of split ownerships for, e.g., truck and trailers)
	Evaluate cost for maintenance (influences decision on time for vehicle replacement and/or adjustment of maintenance contract)	Evaluate cost for maintenance (Influence adjustment of maintenance contract)	

Mid Term / Tactical Perspective

Issues related to, e.g., mid term (structural) changes and adaptations, planning and management of business relationships

Firm Level Maintenance Provider (incl. Truck OEM where applicable)	Firm Level Transport Provider	Dyadic Level Maintenance Provider <--> Transport Provider	Network Level The network of firms directly or indirectly involved in the transport operations
Resource Layer			
Upgrade and supplement tools for maintenance	Evaluate choice of truck make and specification (influences next procurement)	Update/adjustment of joint tool/system for maintenance planning	Update/adjust joint tool for transport planning
Adjustment of customer solutions and offers (adapt to new/changed customer needs)	Identify/evaluate short-/mid-term backup solutions for vehicles	Identify/evaluate short-/mid-term backup solutions for vehicles	Identify/evaluate short-/mid-term solutions related to split ownership of resources (e.g. truck - trailer)
Review/adjust supply chain process and systems for parts and consumables required for maintenance			Identify/evaluate short-/mid-term backup solutions for vehicles

From a mid-term tactical perspective, see Table 6, the emphasis should be on following up measures, KPIs and processes. Together, the firms should identify obstacles and issues that hinder improved efficiency, cost or quality. Having identified the problems and concerns, adjustments to processes, plans, tools and coordination should be implemented.

With respect to vehicle maintenance, the focus areas from a mid-term perspective are management of maintenance planning and following up measures related to, for example, maintenance cost, uptime and deviation/problem reports. Moreover, plans and processes for contingency management should be revisited and adjusted if required.

Maintenance planning is dependent on transport and vehicle planning, hence in order to address the potential for improvements with respect to maintenance efficiency; the overall transport planning should also be revisited and adjusted if necessary.

If shared processes and systems have been carefully implemented in the long-term planning phase, they will facilitate adjustments and changes during the mid-term phase in order to improve, for instance, efficiency and uptime.

Table 7 This table provides examples of issues that maintenance providers, transport providers and other stakeholders need to address from a short-term (operational) perspective in order to enable efficiency of vehicle maintenance.

Short Term / Operational Perspective

Issues related to, e.g., short term (daily) adaptations, adjustments and planning related to existing resources

Firm Level	Firm Level	Dyadic Level	Network Level
Maintenance Provider (incl. Truck OEM where applicable)	Transport Provider	Maintenance Provider <--> Transport Provider	The network of firms directly or indirectly involved in the transport operations
Actor Layer			
Management of day-to-day contacts with Truck OEM(s) and suppliers	Management of day-to-day contacts with customers	Management of day-to-day contacts within the dyad	Management of day-to-day contacts in critical business relationships within and outside the focal Transport Service Triad
		Short-term follow-up of status, KPI's and plans	Short-term adjustment of the needs and provisions of transport capacity
			Short-term follow-up of status, KPI's and plans
Activity Layer			
Internal adjustment of facility, staff and maintenance plans	Internal adjustment of vehicle, driver and maintenance plans in relation to TB and MP	Joint adjustment of activities in order to address bottlenecks and improve efficiency	Joint review and adjustment of operative (daily) transport plan(s)
Follow up and address results for internal efficiency and quality	Address issues identified from vehicle monitoring (e.g. maintenance cost and pre-/post-trip inspection)	Contingency management to address issues related to unplanned stops (or similar)	Contingency management to address issues related to disruptions to transport
		Adjustment of the joint maintenance plan(s)	Manage joint maintenance planning in case of split resource ownership
		Address issues related to monitoring of the maintenance cost (and other KPIs)	
Resource Layer			
Secure availability of staff and tools required for maintenance	Secure back-up solutions for vehicles in case of emergency		
Secure availability of parts and consumables required for maintenance			
Secure availability and functionality of replacement vehicles (if applicable)			

From the short-term operational perspective shown in Table 7, only a limited number of areas can be addressed and adjusted. Decisions made in the two earlier phases (long- and mid-term) establish the preconditions and limitations that apply to the daily operative phase.

Areas to be addressed by the companies in this operational phase involve minor/daily adjustments of transport and maintenance plans and activities related to contingency management in the case of vehicle failure or other disruptions.

For the maintenance provider, availability of resources required for maintenance, e.g. technicians and replacement components, is part of the key issues to address on a daily basis. Moreover, the workshop needs to continuously adjust its internal plans to cater for customer support in the case of an emergency, such as an unplanned vehicle stop.

When studying the tables above, it becomes clear that in order to improve efficiency with respect to vehicle maintenance, the firms should not only address issues related to the daily operations. In fact, it will not even suffice if attention is also paid to mid-term issues and activities. To address the full potential of improvements in efficiency of vehicle maintenance, the companies involved have to address a number of areas and issues ranging from the short- and mid-term planning horizons to the long-term planning horizon.

If the efficiency of vehicle maintenance is to be improved, companies must change their mind-sets. Maintenance should be seen as an enabler of efficiency and not as an unwanted cost or necessary evil. Hence, in line with the ideas by Pintelon and Parodi-Herz (2008), the companies involved should address maintenance as a strategic and long-term issue as well as an operational task. Decisions with a long-term impact on vehicle maintenance must be coordinated and managed in interaction with the overall business processes and strategies of the companies. As we have seen in the three cases related to transport in various contexts, decisions made at an early stage strongly influence the preconditions for vehicle maintenance and efficiency from mid- and short-term perspectives.

The results of the case analysis and the conclusions from the discussion in the preceding part of this chapter also highlight the need for a network perspective when addressing issues related to vehicle maintenance. It has become obvious that vehicle maintenance is embedded in a wider network in which interdependencies between actors, activities and resources influence the preconditions for efficient maintenance. Hence, if the efficiency of vehicle maintenance is to be improved, opportunities as well as obstacles in the network should be scrutinized. If the focus is limited to one of the companies seen in isolation, it will limit the possibilities and not address, for instance, issues related to interdependencies involving parties outside the firm boundary. A decision made without a network perspective in mind may even be counterproductive to the overall operations. The tables actually show that the maintenance provider(s) and the transport buyer(s) are better able to influence maintenance efficiency than the transport provider, specifically from a long-term perspective. To address the full potential for improvement of the overall, ‘network-based’ efficiency of vehicle maintenance, opportunities at the firm level (maintenance provider, transport provider), dyadic level (transport provider ←→ maintenance provider) and network level should be addressed.

A specific issue related to the network perspective as well as long-term strategic decision-making involves the maintenance solutions developed and offered by the Truck OEMs. As we have seen, the efficiency of vehicle maintenance is highly dependent on preconditions underpinned by mid- and long-term decisions made by the firms involved in the transport operations. Moreover, efficiency is also closely related to the specific context in which the companies operate. Hence, in order to enable improved efficiency, the Truck OEM should develop solutions adapted to a variety of contexts as well as customer-specific needs and demands.

7.2 Implications

Efficiency and reliability requirements for operations in industry and retail are reflected in demands on related logistics operations. The demands may originate from different settings such as Just-In-Time (JIT) operations, industrial processes, Hub and Spoke operations or port deadlines.

Failure to meet the needs for transport efficiency, reliability and delivery precision may lead to severe implications for the industries, stores and warehouses involved. Hence, transport providers contracted by the transport buyers are required to ensure that demands for transport capacity, reliability and timeliness are met. For this, the vehicles used must be operational and operate efficiently.

Vehicle maintenance is a prerequisite for efficient and reliable vehicle operation. However, maintenance should be performed in such a way that possible negative effects on vehicle utilization and transport efficiency are avoided or minimized.

As has become clear from the analysis and discussion in this thesis, to address the full spectra of opportunities for improving maintenance efficiency, a holistic interorganizational perspective is required. Moreover, efficiency improvements are not only about managing the daily or short-term planning and coordination but also about mid-term and long-term issues such as investments and decisions about outsourcing.

7.2.1 Managerial Implications

To guide managers of companies involved in the transport industry in their aspirations to address vehicle maintenance to make it more efficient and as a means to improve vehicle utilization and transport efficiency, three areas of implications are discussed below.

Embeddedness and Interdependencies

The activities and resources involved in the transport operations are all embedded in a network of firms. Due to their embedded nature, the network elements both influence and are influenced by other elements of the network. Hence, for efficient vehicle maintenance, the implications of embeddedness should be addressed. Moreover, interdependencies between the actors, activities and resources can support or hinder initiatives aimed at improving the efficiency of vehicle maintenance.

The following proposals provide support and guidance on a holistic approach for managers in the industry.

- The overall efficiency of vehicle maintenance should be seen as an aggregate of the efficiency on three different levels:
  - The efficiency of the maintenance performed in the workshop
  - The efficiency from a haulier’s perspective, i.e. in relation to vehicle utilization
  - The efficiency from a freight transport perspective
- Vehicle maintenance should not be addressed in isolation but seen as an activity that is part of a wider structure of activities involving interdependencies.

- Vehicle maintenance planning should not only be the concern of the transport provider but a common issue to be coordinated between the maintenance provider, transport provider and other stakeholders that are part of the Transport Service Triad.
- Issues related to vehicle maintenance should be addressed already in the early phases of transport procurement. Decisions that will influence later phases regard, for example, the transport buyer's control of the transport provider's fleet and divided ownership of resources (e.g. truck/tractor and trailer).

Contextual Variety and Specific Solutions

Variety in the parameters and features of the context may result in different preconditions and needs for vehicle maintenance for each individual case. The specifications of the vehicles used are adapted for the required transport. The utilization pattern reflects the specific details of the transport assignments. Transport plans and routes also influence the vehicle, driver and maintenance plans.

Maintenance solutions should address and reflect the specific preconditions resulting from the variety in characteristics among the contexts. Solutions developed to better fit and address the varying contexts, preconditions and needs of the hauliers and other concerned companies could also better support improved efficiency of vehicle maintenance.

The Three Planning Horizons

Vehicle maintenance is conditioned and influenced by the operations, decisions and strategies of the companies involved in the transport operations. To enable efficient vehicle maintenance, the companies concerned must address issues related to the short, mid and long term.

For guidance and advice, I have proposed a structure involving three different planning horizons: a short-term (operational) perspective, a mid-term (tactical) perspective and a long-term (strategical) perspective.

- Decisions and agreements made from a long-term perspective set the conditions for possible improvements in maintenance efficiency from mid- and short-term perspectives. Hence, the scope and content of business relationships and contracts are important.

- A decision on outsourcing vehicle maintenance has a big impact on the transport provider. The decision influences how vehicle maintenance is planned and performed as well as the level of in-house competence.

- The transport buyer's procurement strategy sets out, for example, how to influence the transport provider's fleet and transport capacity, which affects how vehicle maintenance is planned and performed at a later stage.

- Contingency management, a prerequisite for efficient handling of critical events, should be considered from a long-term perspective in order to avoid unnecessary disruptions and costs.

- For the maintenance provider and the Truck OEM, decisions on the location of and investments in the workshop are critical. Decisions related to the workshop operations, such as the type of solutions and services offered, and the opening days/hours, are other important parameters.

- Processes, forums and tools for joint planning, coordination and follow-up can help the companies concerned strive to improve the efficiency of vehicle maintenance. Moreover, it is critical that the KPIs or measures agreed reflect what the companies involved want to measure and follow.

What Companies Involved Should Ask Themselves

In order to see vehicle maintenance from a new perspective that acknowledges that it is an activity embedded in a wider context and that maintenance strategies should be addressed by the company's management, we must change or replace old habits.

In the past, two main questions have been closely related to vehicle maintenance: 1) What? (should be maintained/replaced) and 2) How often? (at what interval).

The first question (What?) reflects the circumstances in which products and systems require maintenance in order to operate efficiently and safely. Components, such as brake pads and engine oil, for instance, have to be replaced regularly due to wear, and occasionally a vehicle may need to be repaired due to a malfunction.

The second question (How often?) is asked as replacement parts and consumables are usually interrelated to a specific ‘maintenance interval’ based on, for instance, distance or operating hours.

As a result of the growing interest in maintenance as an important part of the operating costs, a third, question was later asked by the industry: How much? (does it cost). This question mirrors cost consciousness and acknowledges the fact that maintenance is a necessity but has an impact on the total cost of ownership. It could be assumed that the interest in maintenance or service contracts, a kind of ‘cost-insurance’, is a result of this awareness.

With increasing demands for efficiency and robustness of transport and the introduction of new transport solutions and technologies, however, maybe we should ask ourselves two additional questions for the future.

The fourth question is “When?” This reflects the influence that timeliness of vehicle maintenance has on the efficiency of vehicle utilization and transport. As observed in the three cases, transport chains involve strict deadlines and require vehicles to be operational. Hence, to keep the focus on transport efficiency, vehicle maintenance has to be performed in a way and at a time that reduce possible negative impacts.

The fifth question is “Where?” This reflects a consciousness of demands on efficiency and costs of road transport. As the vehicles are often used ‘round the clock’, and slack in the time schedule is rare, every minute and kilometre counts. For a transport provider and transport buyer, the question regarding where the maintenance will be performed is of great interest.

Concepts supporting optimization of maintenance planning from a ‘product-centric’ or Life Cycle Cost (LCC) perspective (see, e.g., Fornasiero et al., 2012) that mainly addresses the needs of the transport provider must be supplemented with a holistic approach that also addresses vehicle utilization from a customer’s (transport buyer’s) perspective. In other words, it is not only the cost of maintenance, number of breakdowns and maintenance stops that matter, it is also a question of when and where maintenance is performed in order to reduce the impact on transport operations.

7.2.2 Research Implications

Tukker (2004) defined maintenance as a “product-oriented” service, as opposed to “use-oriented” services and “result-oriented” services. The discussion by Tukker takes place in the context of Product-Service Systems (PSS). Araujo and Spring discuss the distinction between products and services, arguing “that the quest for foundational differences between products and services is misguided” (2006, p. 797). For vehicle maintenance, the question regarding product or service is also applicable. Should vehicle maintenance be seen as a service offered by a workshop or as part of the Truck OEM’s ‘product portfolio’ offered as, for instance, a maintenance contract? However, Araujo and Spring argue that a discussion as such is unproductive and distracting. Instead, they recommend addressing the transition of a company from being product-centric to offering a combination of products and services, a transition that according to the authors is poorly understood. Regarding this transition, the authors state (2006, p. 804):

> “It often involves new forms of organization, new value propositions to customers, new ways of making services tradable, novel pricing strategies and business models” the authors argue The challenge is not just to reorganize corporations but also to find new ways to connect sets

This thesis takes a step towards providing a better understanding of the services of a manufacturing company interacting across firm boundaries with regard to maintenance. This is done by applying a perspective from which maintenance is seen as an activity embedded in a network of actors: a network in which interdependencies between activities, actors and resources influence the conditions for the focal activity of heavy vehicle maintenance. The conclusions and implications underline the necessity to evaluate a service ‘value’ not only from the perspective of the manufacturing company (offering the service) or the customer (buying/using the service) but from a holistic, network-based perspective.

In line with the current discourse on Maintenance Management (see, e.g., Pintelon and Parodi-Herz, 2008; Pinjala et al., 2006), the thesis has underlined the importance of a closer interrelation between the companies’ business strategies and their maintenance strategies. The managerial implications include advice on how a better fit could be achieved. Maintenance Management, defined by the EU as "… all activities of the management that determine the maintenance objectives, strategies and responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and the improvement of maintenance activities and economics" (EN 13306:2010, p. 5), is a research stream that is attracting attention from scholars (see, e.g., Crespo Márquez et al., 2009; Murthy et al., 2002). However, Maintenance Management seems to be addressed as a concern mostly for the focal company, involving issues such as optimization, while this thesis identifies the importance of a holistic and network-based perspective. To address this issue, further research related to maintenance and Maintenance Management from an industrial network perspective is suggested.

A challenge, specifically for vehicle maintenance, involves the development of transport and logistics solutions. Road transport solutions, an important part of supply networks, are in continuous development and must adapt to challenges such as globalization, urbanization, instability and new purchase patterns (see, e.g., Christopher and Holweg, 2011; Stevens and Johnson, 2016). Not only do efficiency and timeliness of transport need to be secured but future transport solutions must also support sustainable development of society (EU Climate Action/Transport). The development of sustainable road transport solutions will involve changes of infrastructure as well as logistics operations (Frostenson and Prenkert, 2015). Moreover, new vehicle technologies must be developed in order to meet demands on emissions, noise and safety. Future supply networks, including more technically advanced vehicles, will thus require revised maintenance strategies and new innovative solutions to ensure trucks are operational and work efficiently. This will require further research on the implications for heavy vehicle maintenance conditioned by the development of road transport and logistics solutions. Moreover, the need for and demands on the structure, content and business models of future maintenance solutions must be better understood.

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APPENDIX

This appendix provides an overview of the content of the interview guidelines used. The example below reflects the final version resulting from consecutive revisions based on the results of the interviews performed.

The interview guidelines cover areas applicable to transport buyers and transport providers as well as questions that are more specific to each company's role. During an interview, the guidelines were used as a 'checklist' to ensure that all areas where covered. However, as the dialogue floated freely, the interview did not have to strictly follow the order of the guidelines.

When discussing specific topics, such as 'uptime', the area was introduced into the dialogue without mentioning the key terms, hence avoiding influence.

Data for the Interview

- Involve facts related to date, time and place of the interview as well as the role and position of the interviewee.

Company Data

- Involve facts about the company, ownership structure, organizational structure and operations.
- Details about the company's transport operations, vehicle fleet and sales/procurement of transport services are also discussed.

Business Relationships

- Address questions related to the company's business relationships within and outside the Transport Service Triad.

Vehicle Purchasing

- Address the vehicle purchasing process and the most important issues/factors.

Transport Operations

- Address issues related to the transport operations, vehicle utilization, its interface to other processes of the companies involved and how planning is performed.

Vehicles and Vehicle Utilization

- Involve questions related to the vehicles of the fleet and how they are used with respect to the transport operations.

Vehicle Uptime

- Address issues related to vehicle uptime, e.g. if and how this is an important parameter and how the firms involved address it.

Vehicle Maintenance (Service and Repair)

- Address issues related to vehicle maintenance, maintenance strategies, maintenance solutions/offers and maintenance outsourcing.
- Vehicle maintenance in relation to other activities, such as the transport operations, is discussed.
- The needs and demands on vehicle maintenance, contract-related issues and maintenance costs are also covered.