MASTER'S THESIS

Sustainable value proposition design in a Product-Service System

A case study at Volvo Aero Corporation

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Division of labour

Both authors (Kristofer and Niclas) have together complied this study and both have put the same amount of labour. Both authors have worked together in the same office, which has allowed a large proportion of discussion and cooperation throughout the study. Hence, decisions about the study have been made with both authors. The cooperation has been embraced throughout the whole study including all data collections, analyses and also writing this report.

The workflow used to compile this report has served as follows. One author has written a section or a chapter, and then the other author have read through the text and made comments. The comments were then discussed between both authors, which lead to further development of the text and hence cooperation between both authors.

This way of working has been used throughout the whole study, which makes both authors equally responsible for all chapters in this report.

Abstract

Many companies have started to add services to their tangible products in order to defend themselves from increased competition from low-cost economies. Research regarding the transition towards product-service systems (PSS) and how the PSS providers' business models are affected exists, but there is a lack of research regarding how the suppliers to the PSS providers are affected of the transition towards PSS. Therefore, this thesis studies the situation for a supplier/partner to an OEM that has changed their business model to a PSS providing one. As a first step in a development of a new business model aims this thesis to provide guidelines for how to set up value propositions suitable for a supplier/partner in this new environment.

When technologically complex products, such as aircraft engines, are provided through PSS offerings it is hard to translate customer needs into quality parameters, which makes it hard to sustain the value to customer over time. Therefore, how to keep the value offering sustainable over time is also investigated in this thesis. The aim of this study was to investigate how a sustainable value proposition can be designed for a product and technology supplier/partner to an OEM that offers PSS solutions.

The research has been performed through studying relevant literature and collecting empirical data from a case company through semi-structured interviews and a workshop. The case company in this research is Volvo Aero Corporation (VAC).

The empirical findings show that VAC wants to offer product-service bundled solution, which fit the whole spectra of PSS value propositions, to their partners/customers. To be able to deliver these different types of product-service bundled solutions different value propositions that suit the different kinds of PSS offerings are needed. Requirements that must be fulfilled to be able to offer and deliver the different types of value propositions exist in terms of securing sufficient information access, aligning the incentives of all actors involved and achieving an internal consensus of what is delivered.

Sammanfattning

Många företag har börjat addera tjänster till deras fysiska produkter för att försvara sig mot ökad konkurrens från lågkostnadsländer. Forskning som rör övergången mot kombinerade produkt och tjänstelösningar, eller så kallade produkt-service system (PSS), samt hur PSS-leverantörens affärsmodell påverkas av denna övergång finns. Däremot är forskningsbeståndet betydligt mindre gällande hur leverantörer till PSS-leverantören påverkas av övergången mot PSS. Därför är denna studie koncentrerad till att undersöka situationen för en leverantör/partner till en PSS-leverantör, som har förändrat och anpassat sin affärsmodell till PSS. Som ett första steg mot att utveckla en ny affärsmodell syftar denna studie till att ta fram riktlinjer för hur ett nytt värdeerbjudande som passar PSS-leverantörens leverantör i en PSS-miljö ska kunna utvecklas.

När teknologiskt komplexa produkter, som exempelvis flygplansmotorer, säljs genom PSS-lösningar är det svårt att översätta kundbehov till kvalitetsparametrar, vilket försvårar bibehållandet av värdeerbjudanden som överensstämmer med kundens behov över tid för att göra värdeerbjudandena hållbara. Därför undersöks även hur värdeerbjudanden ska kunna hållas hållbara över tid i denna studie. Syftet med denna studie var att undersöka hur ett hållbart värde kan utvecklas för en produkt och teknologileverantör till en PSS-leverantör.

Studien har genomförts genom studerande av relevant litteratur och genom att inhämta empirisk data från ett fallstudieföretag via semi-strukturerade intervjuer och en workshop. Fallstudieföretaget i denna studie är Volvo Aero Corporation (VAC).

De empiriska resultaten visar att VAC vill erbjuda en kombination av produkter och tjänster, som passar hela spektrumet av värdeerbjudanden i PSS, till sina kunder och partners. För att kunna leverera denna kombination av produkter och tjänster behöver värdeerbjudanden som passar olika typer av PSS-lösningar utvecklas. Krav som måste uppfyllas för att kunna leverera sådana typer av värdeerbjudanden finns i from av säkerställande av tillräcklig informationstillgång, lägga alla aktörers intressen i linje och att få en intern samsyn i organisationen kring vad man levererar.

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1. Introduction

This chapter aim to give an introduction to the background based on the research area, which leads up to a problem discussion, a research problem and furthermore into research questions based on the research problem. Delimitations are also discussed within this chapter.

1.1 Background

Many manufacturing companies have, due to increased competition, felt pressure to add value to their tangible products through provision of services (Baines et al., 2007; Oliva & Kallenberg, 2003). These services aim to create value-adding capabilities that are distinctive, sustainable and easier to defend from competition based in low cost economies (Baines et al., 2009). Since the late eighties the aero engine industry, and foremost the original equipment manufacturers (OEM) of aircraft engines, have driven the packaging of their products towards integrated tangible product and service offerings, such as TotalCare® by Rolls-Royce (Buxton & MacCarthy, 2005). These offerings or product-service bundled deals are defined as PSS, product-service system (Baines et al., 2009). The process when manufacturing companies switch their focus from a product focused business towards a service focused one, where the companies offer their customers a product-service-bundled solution, is called servitization (Vandermerve & Rada 1988).

Manufacturing companies in general have traditionally met their customer's needs by offering tangible products. When going through the servitization process customer value has evolved to lie in the function of the product rather than generated from the tangible product itself, which means the value-in-use of the bundled product-service solution for the customer. Value-in-use is defined as the customer's outcome, purpose or objective that is achieved through service (Macdonald et al., 2011). The servitized companies' customers recognize their value from the value-in-use, but this value-in-use and the value adding services have often been developed through a product-based thinking (Johnstone et al, 2009). Johnstone et al. (2009) found in their study that the engineering culture in servitized companies generated a viewpoint where the companies still looked upon their tangible product as their core value whilst the services are value-adding factors.

As long as servitized manufacturing companies don't realize that it is the function of their product (the customer's value-in-use) rather than the product itself that generates customer value, they will not efficiently create efficiency, effectiveness or customer satisfaction (Smith et al., 2011). There are many viewpoints, in different studies, in why companies do this servitization transition and how they describe the transition, but what is common for all of the studies is that they identify that: Traditional manufacturing companies, when gone through the servitization process, suddenly identify that a greater part of their income comes from services than the tangible product (Cook et al., 2006). It is also identified that it is no longer the product itself that generate customer value, it is the function of the product that generates customer value (Botta & Steinbach 2004; Cook et al., 2006).

Tukker (2004) describes that this servitization transition is not just two sides of a coin, it is rather a spectrum of stages. Tukker (2004) visualizes this in the spectrum in Figure 1, where companies can be plotted depending on the mix of services and products in their bundled offering. To the left in the spectrum companies who have a small amount of services in their offering is plotted and to the right companies that has a large amount of services in their product/service bundled offering.

In Figure 1 Tukker (2004) describes three different dimensions of Product-Service offerings: product oriented, use oriented, and result oriented. These can be divided into eight sub-categories: product related, advice and consultant, product lease, product renting, product pooling, activity management, pay per service unit, and functional result.

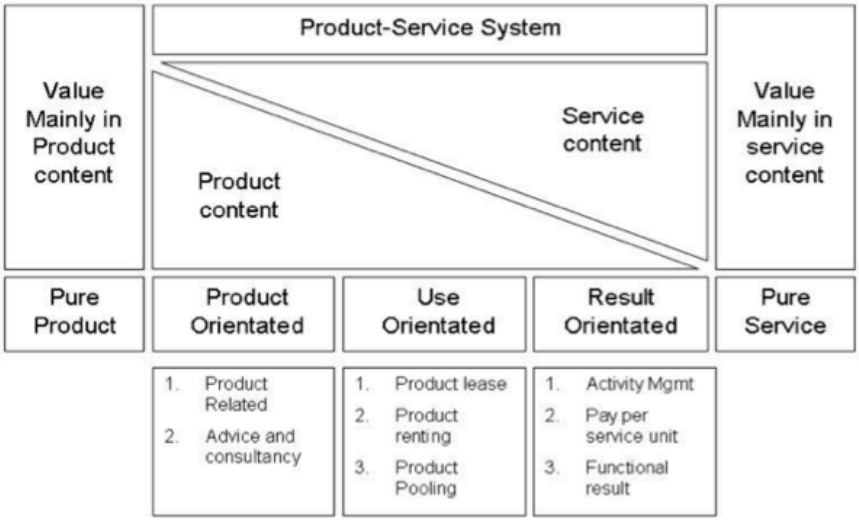

Figure 1 - Product Service-System spectrum (Tukker, 2004: p. 248)

Tukker (2004) describes that the further a company moves their offerings from left to right, in Figure 1, the smaller is the significance of the tangible product for the creation of customer value. At the same time the need for understanding the customer need and the value-in-use is increasing. This generates that the complexity within the delivering firm's organization increases (Tukker, 2004; Smith et al., 2011). Neely et al. (2011) show in their study that the value in use, co-creation of value, and time aspect are key factors for the extent of complexity within the delivering firm's organization. Other important factors that affect the complexity are extension, capabilities, completion, networks and partnership, financial flows, contracting, risk, the transformation journey, and technological complexity (Neely et al., 2011). These factors have direct impact on the complexity of the delivering organization's structure, management and business model (ibid).

The change of focus from product to service affects the business model, regardless of whether the company identifies the change of focus or not. This is something that most manufacturing companies identifies quite late in the servitization process. To succeed with the servitization as a manufacturing company, new principles, structures and processes of their production and support have to be generated. (Oliva & Kallenberg, 2003)

When a company goes from being a pure manufacturing company to a fully servitized company it is not only the corporate strategy that is changing.

"*Servitization entails a very fundamental change in thinking at all levels within an institution as to the way that things have traditionally been done and following this line of thought would seem to suggest that significant resistance can be expected*" (Weeks, 2010: p. 117).

But before you can change the culture within a organization, the employees must be willing to admit that the current situations is not satisfying in the new way they do business (Weeks, 2010).

1.1.1 Value propositions in PSS

As previously mentioned, there are a broad spectrum of PSS-offerings that combines tangible products and services to different extents. Smith et al. (2011) argues that one can divide the spectrum of the full product-focused and full service focused, as exemplified in Figure 1 (Tukker 2004), in four dimensions, which he describes as four different types of value propositions that differ in how they create value-in-use. These value propositions by Smith et al. (2011) are described in Table 1.

Table 1 - Value propositions (Smith et al., 2011: appendix A)

Value propositions	Attribute and definition
Asset	*Equipment performance* The first value proposition is offered by the product itself, specifically its potential performance in any given use situation. Different performance parameters are valuated by customers for their ability to facilitate certain consequences in use situations that help them achieve their goals. The asset value proposition is essentially the pure product offering and customers realize the value and achieve benefits for themselves with little or no input from the provider.
Recovery	*Technical query resolution, technical variance, equipment repair service* The attributes that constitute the recovery value proposition follow the traditional equipment support model and would normally be offered as part of a repair, spares or post-design services contract (Hockley et al, 2010). Value in this case is in the provider's and customer's joint ability to ensure the asset recovers quickly to a usable state.
Availability	*Equipment maintenance service, component forecasting & provision, through-life and obsolescence forecasting & planning recommendations, capability forecasting & planning, equipment operation advice* This proposition ensures that equipment is available for customer use. To do so, the firm must consider the proactive replacement of components before the equipment fails *as well as* the customers' lifetime maintenance and operation of the equipment to ensure continued reliability and performance in use. In contrast to the recovery value proposition, the availability value proposition maximizes potential usage of the equipment, therefore supporting the customer's use of equipment to achieve their goals. The attributes that constitute this value proposition are often part of an availability contract, where contract performance is dependent on equipment availability for use, rather than on the performance of activities or tasks.
Outcome	*Equipment configuration advice for operational and contextual capability* The last value proposition consists of attributes that go beyond availability towards actively facilitating the customer's effective use of the equipment, while doing this the delivering firm is actually supporting the customer in achieving their own goals. The customer uses the equipment to achieve goals in coordination with the firm that provides the service, taking into consideration the customer's need for the equipment and the way it is used towards the operational goal. Moreover, they consider how the customer operates the equipment in a use context to achieve those goals, when integrated with other assets and equipment in the customer's use environments. The outcome value proposition is therefore an intervention to support a customer's capability to achieve a desirable outcome.

Tukker (2004) presents a similar division in which he divides the service transition in three dimensions: Product-focused services, user-focused services and results-focused service (Figure 1). These are in their design very similar to the value proportions by Smith et al. (2011) that are presented in Table 1. The division made by Smith et al. (2010) is more in depth and can be seen as four broad perspectives of value propositions whilst the division made by Tukker (2004) more briefly describes the concept where it is seen as a spectrum of

offerings that vary from product to service focused. Hence, the division made by Smith et al. (2011) is used in this study, since it conceptualizes four different broad value propositions that can be used in a PSS contract.

1.1.2 Value measuring, Quality and Product-Service Systems

The complexity within the organization and their relation with customers increases when companies move their offerings from left to right in Tukker's the product-service system spectrum (Figure 1) (Neely et al., 2011; Oliva & Kallenberg, 2003). With an increased complexity the importance of understanding the customer's needs and the true benefit of the products function will also increase. Tukker (2004) argues that the complexity in understanding the core benefits and the customer's needs becomes more abstract to the right in Tukker's spectrum. Because of the complexity in capturing customers' needs it becomes more difficult to translate the customer needs into quality parameters, which complicates the supplier-customer relation. There are many definitions of quality. In this thesis, two definitions of quality are considered:

The American Society for Quality (ASQ) defines quality as:

- *The ongoing process of building and sustaining relationships by assessing, anticipating and fulfilling stated and implied needs.* (ANSI/ASQC, 1987):

Bergman and Klefsjö (2003: p. 24) defines quality as:

- *The quality of a product is its ability to satisfy, or preferable exceed, the needs and expectations of the customer.*

These two definitions complement each other since the definition by ASQ takes building and sustaining relationships into account, while Bergman and Klefsjö have a more explicit definition regarding satisfying and exceeding needs and expectation by the customer. Taking the two definitions under consideration leads to a definition of quality where building and sustaining relationships as well as satisfying and exceeding customer needs and expectations are embraced. In this thesis we define quality as:

- *The ongoing processes of building and sustaining relationships by assessing, anticipating, fulfilling, and preferable exceed the stated and implied needs and expectations of the customer.*

For a company to be able to capture the value that is created in a PSS environment and to be able to fulfil the quality definitions by ASQ and Bergman and Klefsjö, the ways through which quality is measured and delivered needs to be changed (Hong & Hou, 2010).

Today quality is divided into either product or service quality. Measure and evaluate product and service quality are performed in different dimensions, which are presented in Table 2.

Table 2 - Quality dimensions for product quality and service quality (Bergman & Klefsjö, 2003 p. 32)

Product quality dimensions	Service quality dimensions
Reliability	Reliability
Performance	Credibility
Maintainability	Access
Environmental impact	Communication
Appearance	Responsiveness
Flawlessness	Courtesy
Safety	Empathy
Durability	Tangibles

Macdonald et al. (2011) argues that the current product and service quality measures are insufficient for understanding how customers recognize value created in a PSS environment[1]. For example, one of the most common tools for measuring service quality, SERVQUAL, is built up on five dimensions, which are reliability, assurance, tangibles, empathy, and responsiveness (Parasuraman et al. 1988). These dimensions are neither sufficient in measuring the value-in-use nor the customer co-created value (Macdonald et al., 2010).

Using the service quality measures in isolation would be to assume that value is embedded at the moment of service delivery (Macdonald et al., 2010), which Vargo and Lusch (2004) also argue to be incorrect. The goods-dominant perspective, the product quality dimensions, is also inadequate for explaining the role of deriving value-in-use from a provider's services and it is not consistent with an increasing shift towards a continuous process perspective where the customer's role as co-creator of value is recognized (Vargo & Lusch, 2004; 2008).

The critiques to service quality as a measurement tool in a PSS-environment do not invalidate service quality as a useful measure of the supplier's contribution to value creation, but a more holistic approach to how quality of delivered PSS-offerings are measured and evaluated should be designed (Macdonald et al. 2010; Hong & Hou 2010).

1.1.3 Sustainable value creation

The value-in-use is changing throughout and Macdonald et al. (2011) found that customers' objectives change at different stages of the PSS of relationship, which affects how customers' evaluate value. Activities that might have initially led to high levels of satisfaction may later be considered as 'just as given' at subsequent stages of the relationship.

Osterwalder and Pigneur (2010) define a business model as: "A business model describes the rationale of how an organization creates, delivers, and captures value" (Osterwalder & Pigneur, 2010: p. 14). This definition shows that value is a crucial part of business models. Since value is fundamental in business models (Chesbrough, 2007) and value-in-use is changing throughout PSS-contract durations (Macdonald et al., 2011), there is a need for sustainable value creation in order to keep the business model functional over time. In order for a supplier to a PSS-provider to be able to deliver quality in terms of value in PSS contracts, the value proposition that is offered and delivered need to be looked after continuously through adequate quality measurements. How a PSS-provider could sustain their value proposition, and thus keep their business model functional, throughout contract durations is investigated in this thesis.

[1] A PSS environment refers to a supply chain where one or more actors offer PSS contracts to some extent.

1.2 Problem discussion

Traditional providers, OEMs, of tangible products in manufacturing industries have since the eighties started to offer product-service bundled solutions and studies have been made in order to look into the relationships between the OEMs and their customers and how to design such business models (Oliva & Kallenberg, 2003; Bowen et al, 1991; Wise & Baumgartner, 1999). Since the OEMs have changed their business model into one where value proposition is created through PSS-contracts the rest of the actors in the supply chain, including the OEM's suppliers, needs to react on these changes in order to continue to be successful actors in the supply chain (Lockett et al., 2011). It is also important that the actors align their interests in the same direction in order to maximize the performance of the supply chain network (Lockett et al., 2011).

Research has been made to study the relation between the OEM and their customers (Oliva & Kallenberg, 2003; Bowen et al, 1991; Wise & Baumgartner, 1999), but there is a lack of research on the supplier's part in these types of supply chains (Lockett et al., 2011). Since the OEMs have shifted from product focus to a PSS focus, the way of doing business has also changed in terms of guiding principles, structures and processes for production and support operations (Oliva & Kallenberg, 2003). In order to create value in this environment, the suppliers to the OEM need to design their business models and thus also value proposition so that the value proposition offered is appropriate for the OEMs and their customers.

The value created in PSS differs from value created in exchange transaction. The value created during exchange transactions represents only one level of the service value proposition, while a second level, called value-in-use, is created after the exchange is complete (Lapierre, 1997; Macdonald et al., 2011). Value-in-use is defined as the customer's outcome, purpose or objective that is achieved through service (Macdonald et al., 2010). Smith et al (2011) argues that a company can only offer value propositions, and its realization can only be done through co-creation with the customer. Therefore a company cannot "satisfy" a customer; they can only collaboratively support value co-creation.

In order to create a business model that is suitable for a supplier or partner to an OEM in a PSS environment, requirements for what this business model should be able to achieve need to be established. In this thesis these requirements are identified through identification of problem areas within the current business models used by suppliers or partners to OEMs that are about to enter a PSS-environment, but also through by mapping the value creation in a PSS supply chain.

When identifying what the business model should be able to achieve it is of most importance not only to look at the new design as incremental improvements. Even though incremental improvements could be the case, the approach in this thesis is to start with a "blank page" to be able to design a new business model but not to be constrained by how the supply chain relationships look today. What should be realized when designing the new business model is that the supplier is no longer "just" a supplier, they are to some extent an enabler for both the OEM and the customer. By enabler, from the aero engine industry perspective, it is meant that the supplier enables the OEM to deliver the engines that the customer askes for and therefore enables the customer take advantage of the features of the engine.

The supply chain for PSS offerings differs from a supply chain for products or services alone (Johnson & Mena, 2004). Figure 2 illustrates a supply chain where the supplier, OEM and customer to the OEM are included. What the suppliers business model should look like in order to co-create value in this supply chain is, as previously mentioned, not obvious. But to investigate what the value proposition should look like, more information about how value is transferred between different actors is needed.

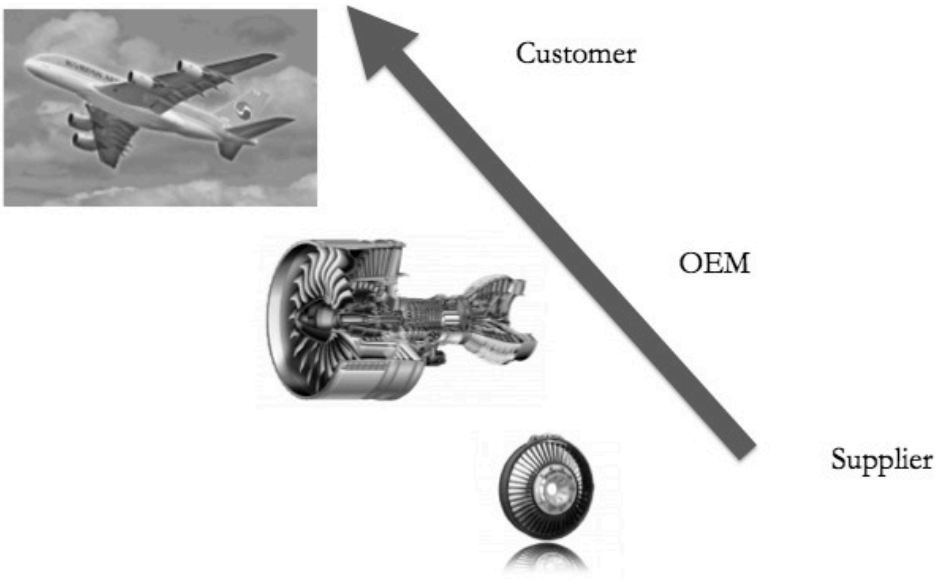

Figure 2 – Generalized picture of the aero engine supply chain

1.2.1 How the servitization process affects a supplier's business model

The business model design in PSS is quite young concept and hasn't yet been studied to a large extent. There are today different views on how business models should be designed in PSS. Commonly they state that customer segment is the first part of a business model that should be stated and when this is done the value propositions should be designed. When it is researched how a business model used by a supplier/partner to an OEM that has shifted towards PSS shall design their business model the customer segment is already set. Therefore this study has a value-centered viewpoint on business models which is here furthered explained:

Magretta (2002) argues that a 'good business model' provides an answer to the following two questions, originally written by Drucker (1954):

- Who is the customer and what does the customer value?
- What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?
  (Magretta, 2002: p. 87)

Providing an answer to these questions means telling how a company earns money by identifying and creating value for customers, and capturing some of this value as the company's profit in the process (Magretta, 2002). Magrettas argument takes value as a center of the business model. But a business model consists of more parts than just value. One of the most used descriptions of how business models are built up and their different parts is Osterwalder and Pigneur's (2010) description of a Business Model's nine dimensions, (Key Partners, Key Activities, Key Recourses, Cost structure, Revenue, Structure, Value proposition, Channels, Customer relationships and Customer segments).

Casadesus-Mansell and Ricart (2010) argue that even though different blocks build a business model these different blocks/dimensions[2] should be categorized in two different

[2] Casadesus-Mansell and Ricart 2010 refers the different parts of a business models as building blocks of the model. Margretta (2002) refers to this as parts and Osterwalder and Pigneur (2010) as dimensions. Since it is Osterwalder and Pigneur's (2010) model we continue with in this thesis we will refer to the building blocks or parts as dimensions of the business model.

groups. The different dimensions should be categorized as either (a) a concrete choice made by management about how the organization must operate, and (b) the consequences of these choices.

Magretta (2002) argues that value is a core choice in a business model, Osterwalder and Pigneur (2010) describes nine dimensions of a business model and Casadesus-Mansell and Ricart (2010) argues that there are concrete choices and consequences to these choices in a business model. In order to describe how the choice of value proposition affects the different dimensions of the business model, Table 3 has been drawn up. Table 3 describes nine business model dimensions by Osterwalder and Pigneur (2010) and how they are affected by the choice of value proposition, as described by Smith et al. (2011) in Table 1.

Table 3 is compiled to conceptualize the authors view on that value proposition is the core choice when designing a PSS business model and hence the strategic choice that an organisation can make. The table is compiled in order to describe how the other eight dimensions (Osterwalder & Pigneur, 2010) are affected by this choice and hence consequences of the value proposition chosen.

Table 3 - The effects of changing value propositions on other business model dimensions

A business models dimensions	Implications in a PSS environment
Value Proportions describes the bundle of products and services that create value for a specific *Customer Segment*.	The Value proposition is either Asset, Recovery, Availability or Outcome related. Depending on which type of value proposition dimension the value proposition can be categorized as, the rest of the eight business model dimensions will be affected depending on that value proposition choice.
Key Partnerships describes the network of suppliers and partners that make the business model work.	The network of suppliers and partners will differ depending on the value proposition offered. Partly because of the level of integration with the customer that increases if a higher level (asset, recovery, availability, or outcome) of PSS value proposition is offered. When the higher level of value proposition is offered other partners and suppliers will have to be used in order to deliver what is promised. Even if the delivering company can produce both the services and products in house the partnership with the customer will differ depending on the value proposition.
Cost Structure describes all costs incurred to operate a business model.	The different value propositions have different levels of involvement with the customer. But the thing that differ the most between the different dimensions is the level of services offered. The greater the involvement the greater the level of services is, which will determine the cost structure of the business model.
Revenue Streams represents the cash a company generates from each *Customer Segment* (costs must be subtracted from revenues to create earnings).	Just as the cost structure, the revenue streams are dependent on the type of value-proposition. Depending on the value proposition different values are co-created with the customer. This implies that the value-in-use will differ for the customer depending on the proposition that affects the parameters that the delivering company's PSS offering is priced upon.

A business models dimensions	Implications in a PSS environment
Key Resources describes the most important assets required to make a business model work.	The resources used to deliver the propositions differ depending on whether for example asset or outcome is proposed to the customer. Which implies that even the Key resources are directly depending on what type of value proposition is offered.
Key Activities describes the most important things a company must do to make its business model work.	Just as the key resources the activities will also change due to the nature of the propositions. Because that different activities needs different resources and depending on which of the proposition is offered different activities is needed.
Customer Relationships describes the types of relationships a company establishes with specific *Customer Segments*.	The relation to the customer is changing because of the different levels of involvement with the customer depending on the value proposition. When outcome is delivered a much higher level of involvement is needed compared when asset is delivered.
Channels describes how a company communicates with and reaches its *Customer Segments* to deliver a *Value Proposition*.	The level of involvement and co-creation of value with the customer difference a lot depending on which value proposition is proposed. The level of involvement increases when the offerings moves from left to right in Tukker's spectrum. Due to the difference in involvement with the customer the channels used depending on the proposition will alter.
Customer Segments defines the different groups of people or organizations an enterprise aims to reach and serve.	The customer segments can alter depending on which value is proposed because the different proposition is in a way different products that generate that different needs are fulfilled. But looking at this from a point of view where the customer is set and that value proposition is different approaches on how the business between the entities shall be designed, this dimension is then obsolete in this case.

Table 3 concludes that all of the eight dimensions are affected by the choice of value proposition hence the value proposition is, as described by Casadesus-Mansell and Ricart (2010), a concrete choice made by management. This thesis focuses on the design of the value proposition because of its core importance in a business model. How the rest of the dimensions are affected is used as evaluation criteria's in order to evaluate to what extent the different value propositions suit the proposed company.

How value proposition should be designed for OEMs in PSS environments are previously studied in research, but the gap in the research today consists in the situation of OEM's suppliers in the PSS supply chain (Lockett et al, 2011). The gap in research does also include how value is offered, captured and sustained throughout a PSS contract (ibid.). This thesis will study the supplier's situation and how they could and should design their value proposition in a PSS-environment.

1.2.2 Sustainable value creation in PSS contract

As discussed in chapter 1.1.3, value-in-use is changing throughout PSS-contract durations (Macdonald et al., 2011). In order to make value proposition sustainable throughout the contract duration methods for measuring how customers perceive the value proposition

are needed. Existing quality measurement methods for measuring product and service quality are insufficient for measuring how customers perceive value in PSS-environments (Macdonald et al., 2011). Therefore, sufficient quality measurement methods for measuring the value that is delivered to customers over time are needed.

Many of the manufacturing industries have product life cycles up to 20-25 years. To be able to set up a PSS-contract for products with life cycles that long, the contracts need to be as long or longer (Buxton & MacCarthy, 2005). This implies that since the value preserved is changing over time and since the durations of the contracts can be more than 20 years suitable quality systems are needed in order to identify fluctuations in value delivered and perceived. Sufficient quality measurements methods for measuring value are also needed since it is very hard to sustain something that is unknown. In order to fulfil customer's needs and wishes the value delivered and perceived by the customer has to be measured to be sustained over time. Hence, how value proposition can be sustained throughout PSS-contract duration needs to be investigated in this thesis in order to design a suitable and sustainable business model for a product and technology supplier/partner.

1.2.3 Problem summary

The supply chain for PSS offerings differs from a supply chain for products or services alone (Johnson & Mena, 2004). Lockett et al. (2011) denote that all actors in a PSS supply network must align their interests in the same direction in order to create a successful PSS supply chain. When an OEM decides to transfer into PSS offerings the rest of the actors in the supply chain must react with changed business models in order to keep the supply chain successful. That suppliers and/or partners to OEM need to evaluate and reshape their business model in supply chains that contains PSS has been discussed and will be furthered studied. It has emerged that there is a lack of research on how the business models for suppliers should be designed and function in a PSS environment (Lockett et al 2010).

The value creation in a product-service system is sprung from a co-creation of value, when a company promises to deliver a function of a product they need to be a greater part of the customer's organisation in order to actually deliver this value (Smith et al. 2011). It is therefor impossible to deliver a transactional form of value in contrast to when a material product is sold to the customer hence co-creation of value is central in a product-service system (Smith et al. 2011)

It has been identified that suppliers to OEMs who offer PSS contracts should redesign their business model in PSS supply chains. It has also been identified that the value proposition is essential in the business model and that sustainable value creation is needed in these contracts. The problems found in chapter 1 are summarized in table 4, which leads up to the research problem and the research questions for this thesis.

Table 4 - Summarize of identified problems

Problem	Reason	Implication
Servitization	OEMs have started to create value to their customers through product-service bundled solutions, PSS. The OEMs have due to the servitization process changed their business models in order to make them fit PSS solutions.	Since the OEMs have changed their business models to fit PSS the rest of the actors in the supply chain must react to these changes and change their business models in order for them to continue to be successful actors in the industry.
The Value proposition dimension	Business models consist of dimensions that can be chosen by management and dimensions that are consequences of these choices. The dimension that can be chosen and also affects the rest of the dimensions in PSS business models is value proposition.	The suppliers in a PSS value chain need to look over what type of value proposition they can and want to deliver to whom, since the choice of value proposition in a PSS business model is essential for designing the rest of the dimensions and thus a complete business model.
New quality measurement methods are needed	It is found that how customers perceive value-in-use change over time. When PSS contracts span over many years there is a need to understand this shift in customer's perceived value over time. It is also found that the quality measurement tools used today are not sufficient to use in PSS relations. Hence, new measurement tools for measuring PSS quality is needed to identify these fluctuations in value.	In order to implement new business models in a PSS environment it is important to be able to have sustained value over the contracts duration. Hence new quality measurement tools are needed in order to oversee the value-in-use fluctuations over time.

1.2.4 Research problem

The research problem is generated from the three major problems that have been identified in the background and discussion. These are presented in table 4:

The problem background and discussion leads us to this research problem (RP):

RP: *How can a sustainable value proposition be designed for a product and technology supplier/partner to an OEM offering PSS solutions?*

1.2.5 Research questions

In order to answer the stated research problem, the study has been divided into four different research questions (RQs). By answering the four RQs sufficient data are gathered in order to answer the research problem.

In the problem discussion it is stated that suppliers to OEMs need to modify their business model when the OEM starts to offer PSS-contracts. Since this change is needed problems must exist in the business model used today. The first question investigates the problems that a supplier to an OEM may find in their current business model, which also are the drivers for redesigning the business model. This brings an understanding why the business model needs to be changed and what a new business model should be capable of.

RQ1: Which are the problems with the existing business model for a product and technology supplier when OEMs start to offer PSS solutions?

One driver to why the supplier's business model needs to be redesigned is the changed situation in the supply chain. The second research question investigates the value creation in a PSS supply chain in order to bring understanding to how value is created, by whom and to whom throughout the supply chain. As described in the problem discussion, how value is created for the customer and how this value creation generates value (and income) to the delivering company is fundamental questions to answer in order to successfully set up a value proposition. Information about the situation in the PSS supply chain provides guidelines to how a company should behave to be successful in a PSS supply chain. Therefore the second research question investigates which value is created by who for whom in a PSS supply chain.

RQ2: How can the value creation in a PSS supply chain be characterized?

The problems found in RQ1 together with the guidelines found in RQ2 generates data that make it possible to construct set of requirements, which should be fulfilled when designing new value propositions suitable for PSS. In the problem discussion it is described that the value proposition affects most of the other business model dimensions by Osterwalder and Pigneur (2010) in a PSS environment. The value proposition is the core of a PSS business model and this study will research how value propositions should be designed. In order to investigate which value propositions is suitable it is important to get an understanding of which type of value propositions could be formed in order to evaluate these.

RQ3: How can the value proposition in business model for a product and technology supplier in a PSS environment be characterized?

Characterizing the value proposition in the business model doesn't imply that the value proposition is kept consistent over contract durations. In the problem discussion it is argued that the way customers recognize value is changing over time. Since PSS contracts are set up over long periods of time it is of utter importance to sustain the value proposed in order to keep high customer satisfaction. To be able to sustain something it most be measured in order to be preventive of customers actions. How customer realize value is measured through different quality measurement tools. Customer value cannot be measured with traditional product or service quality parameters, which infers that new quality measurement methods are needed. In order to find these quality measurement methods and make the value proposition sustainable an investigation that regards how customer value is sustained in a PSS-contract over time is needed. Hence, the fourth research question is how the value proposition can be sustained throughout contract durations.

RQ4: How can the value proposition be sustained throughout PSS-contract duration?

1.2.6 Delimitations

The Business model dimensions

This study describes how a business model can be described and designed from Osterwalder and Pigneur's (2010) point of view. In chapter 1 it has been discussed and explained that the value proposition dimension in the model by Osterwalder and Pigneur (2010) is the driving choice of the business model, which means that it has been explained that in a PSS environment the value proposition dimension is the strategic decision and the rest of the dimensions are affected by this choice. This study does hence research the value proposition dimension and use the rest of the dimensions as criterias for evaluate the

choice of value proposition in a PSS environment. This study will not elaborate more on the 8 other dimensions more than what is described in the theory chapter.

1.2.7 Disposition

The first chapter describes the background to what product-service systems is, why it is used toady and which problems arise within the system. The problem discussion elaborates on the problem companies realize in a PSS environment.

The second chapter describes the theory that the study is built upon. It elaborates on problems between principals and agents, business models, product-service dependencies, value creation in a PSS environment, value measuring methods in PSS contracts and strategic alliances.

The third chapter visualizes how the authors connect the research questions with the theory.

The fourth chapter describes how the study is executed, which methods are used and how the authors intend to find the answers to the research questions.

The fifth chapter presents the data gathered in the research. The data is presented so that empirical findings used to answer the different research questions are presented in the section that belongs to that research question.

The sixth chapter presents the authors analysis of the gathered data and provides answers to the research questions.

The seventh chapter presents the conclusion drawn from the analysis of the gathered data and provides an answer to the research problem. It also includes recommendations for the case companies and suggestions for further studies.

2. Literature overview

This chapter presents a literature overview of the theoretical background in the concepts relating to the problems between suppliers and OEMs in a product-service system supply chain in general. This chapter does also create a theoretical background of systems for measuring quality in product-service systems. The chapter contains information about the theories that this thesis is built upon and it creates a foundation for the upcoming frame of reference.

2.1 Literature presentation approach

The theories presented handle a broad spectrum of disciplines. This literature presentation approach aims to provide the reader with an understanding on why the theories are presented and how they are used throughout the study.

First, theories are presented that regard implications on the relationship between suppliers/partners and OEMs from a PSS supply chain perspective. The Principal-agent theory is first presented and describes problems between suppliers and OEMs. Furthermore, findings by Lockett et al. (2011) are presented, where it is found that not all actors in a PSS relation have positive outcome from a PSS relation.

This study has a value centred view on business models and describes that when value is delivered in a PSS, co-creation of value is needed. With the problems described in the first chapter the value creation in PSS can be discussed, but first there is a need for describing the differences of value-in-exchange, value-in-use, and co-creation of value to get an understanding how value is delivered and experienced.

When the challenges between suppliers and OEMs and how value is created in the PSS environment is known, there is a need for describing how companies can interact with each other through a relationship in order to create a basis for value creation. Therefore, theories on strategic alliances are presented in order to generate a background on what type of different collaboration methods there are to choose from when two actors have chosen to co-create value.

The presented theories create a sufficient theoretical background to be able to analyse and answer RQ1-3, together with the empirical data collected.

The fourth research question regards sustaining value throughout the duration of a PSS contract. Discussed in the background and problem discussion is that new quality measurement tools are needed to be able to sustain value sufficiently. The Kano model is described to explain how different values can be categorized depending on how customers perceive the values and to form a deeper understanding on why perceived customer value change over time. Further on, Macdonald et al. (2011) describes quality parameters for PSS together with a framework, which is presented as a measurement tool used to measure PSS quality. The importance-performance analysis by Geng and Chu (2012) is presented as a tool used to sustain value over time. The Kano model, Macdonald's framework, and the importance-performance analysis form the theoretical base for developing a PSS quality measurement tool used to sustain value to customer over time.

How each theory is connected to each research question is further described in chapter 3, frame of reference.

2.2 Principal-agent theory

The principal-agent theory affects the relationship between suppliers and OEMs indirectly (Penttinen & Palmer, 2007). The theory does basically describe the problem of motivating one party to act on behalf of another. Within this theory, a principal (in this case, the OEM) hires another actor, the agent (in this case the supplier), to perform tasks on its behalf. But the principal cannot ensure that the agent performs these actions in a

satisfactorily way. When a principal hires an agent to perform a set of specific tasks, there are two main problems that the theory addresses (Eisenhart, 1989). The first problem relates to something that is called an agency problem, in which there are conflicts between the desires and goals of the principal and the agent, and moreover that it is both difficult and costly for the principal (OEM) to monitor and verify that the right tasks are performed. The second problem that could arise is relating to risk sharing, where the attitude and perception of this may differ between the two parties (Garen, 1994).

Lockett et al. (2011) describes that the provision of PSS contracts commonly involves a transfer of risk from the customer to the PSS provider and that it is difficult for the provider to predict and control these risks. The PSS provider may also share risk with its suppliers or other actors in the PSS supply network. The situation gets more challenging when potentially hazardous products are involved, since responsibilities for these products need to be managed (Lockett et al. 2011).

Lockett et al. (2011) argue that OEMs can suffer from negative effects when setting up partnerships with suppliers. The negative effects include possible knowledge leakage when partnering with suppliers, which means that suppliers can utilize this knowledge develop new capabilities (Cook et al., 2006). Furthermore, Mathieu (2001: p. 466) suggests three cost related gains with partnership: "First, it provides the manufacturing company with essential resources and skills in building and maintaining a competitive advantage. Second, it is an innovative and imaginative way of building such a competitive advantage. Third, it can moderate the political costs caused by the implementation of the service manoeuvre." Lockett et al. (2011: p. 297) suggests that barriers to developing a successful PSS supply chain include "unexpected competition between members of the supply network and concerns about knowledge leakage through the supply chain".

To further understand how the principal-agent problems affect the product-service system supply chain, the supply chain is described in the next chapter.

2.3 Product-service system supply chains

Lockett et al. (2011) argue that PSS offerings tend to consist of complex, long-life products that require support throughout the whole lifetime. Furthermore, the supply networks that the PSS providers act in differ from those that offer products or services alone. Lockett et al. (2011) claim that "co-ordination of manufacturing systems, maintenance, spare parts, logistics systems and so on" (Slack et al., 2004: p. 384) is required for providing PSS effectively. PSS offerings may involve external actors in addition to internal functions of the PSS provider and the degree of integration between these actors should according to Slack et al. (2004) be similar to the degree of integration between the products and services that the organizations provide. Lee (2004: p. 110) argues that "great companies take care to align the interests of all the firms in their supply chain with their own. That's critical because every firm – be it a supplier, an assembler, a distributor, or a retailer – tries to maximise only its own interests", which means that all actors within a supply network work towards maximising the performance of the network (Lockett et al., 2011).

By providing goods and services through PSS-contracts usually transfers the risk from the customer to the provider (Lockett et al., 2011). As Tukker (2004: p. 251) denotes; "By promising a result, the provider often faces difficulties in predicting and controlling risks, uncertainties and responsibilities that otherwise were the problem of the user". The nature of some PSS supply networks enables a further transfer of the risk from the PSS-provider to its suppliers and this risk transfer gets even more complex when there is a need for managing accountabilities for hazardous products (Lockett et al., 2011).

Partnering competences enable a PSS-provider to build alliances and partnerships with suppliers and deliver greater value to their customers (Lockett et al., 2011). A supplier that

partners with an OEM could gain increased control as a result of increased information possession and knowledge (Cook et al., 2006). Lockett et al. 2011 claim that this collaborative approach could also lead to sharing of risk, provision of skills and an innovative way to gain competitive advantage. Lockett et al. (2011) argue that empirical work by Johnson and Mena (2008) show that information exchange, which affects customer and supplier relationships, is particularly important in PSS supply chains.

To describe the differences between a traditional supply chain and a PSS supply chain an example by Lockett et al. (2011) is used, which is shown in Figure 3 and 4. Note that this example cannot be used as a general situation, but it can be used to see the differences between a traditional supply chain and a PSS supply chain and also what problems that can arise in this kind of situation.

In a traditional supply chain, as shown in Figure 3, the OEM does not necessarily need to have any on-going relationship with the customer and the only interaction between OEM and customer is at the point of purchase (Lockett et al., 2011). "Once the product has been purchased the customer's main relationship is with the maintenance centre, which coordinates the provision of spare parts and repairs from OEM, supplier and repair shop" (Lockett et al., 2011: p. 300).

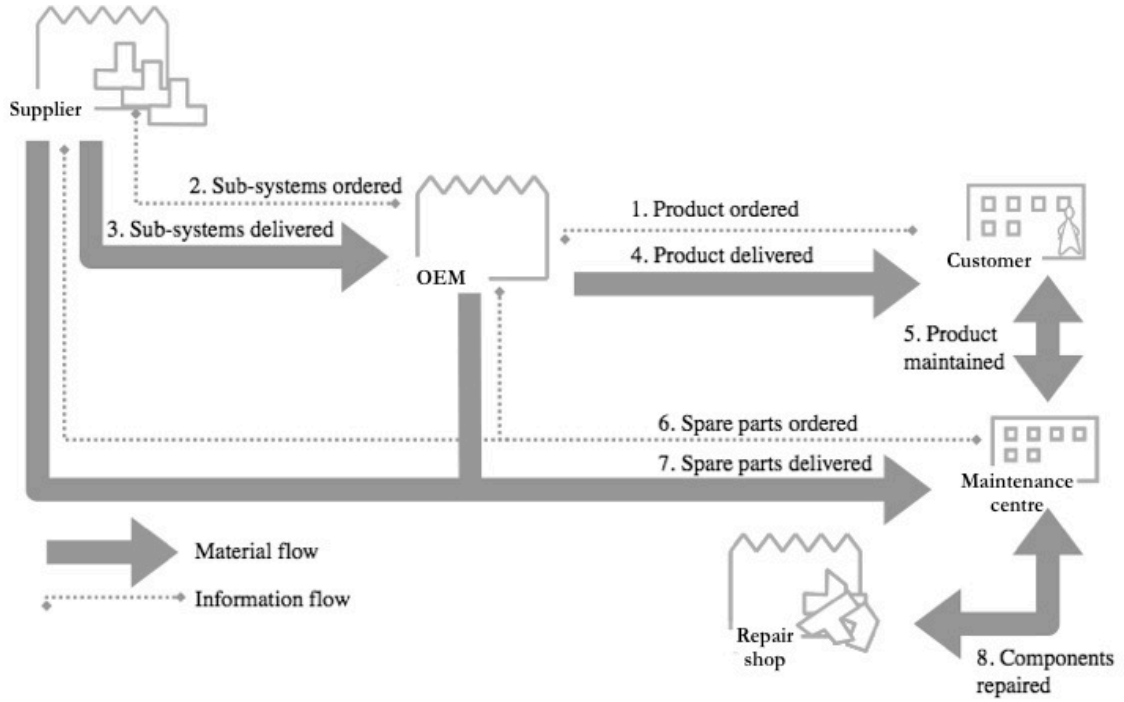

Figure 3 - Traditional supply chain (Lockett et al., 2011: p. 300)

In the PSS environment shown in Figure 4 the OEM has an on-going relationship to the customer, since the OEM is the PSS provider (Lockett et al., 2011). In a typical PSS contract the OEM takes care of various services during the contract duration (ibid), which are described as maintenance and repairs in this example. The OEM handles most of communication within the PSS supply network (Lockett et al., 2011), so that the customer does not need to contact anyone else than the OEM. This means that the maintenance centre role has been taken over by the OEM. In this example the OEM and the supplier have engaged a risk-sharing partnership for providing the PSS contract (Lockett et al., 2011). This means that both risk and revenue in the PSS contract are shared between the supplier and OEM throughout the contract duration.

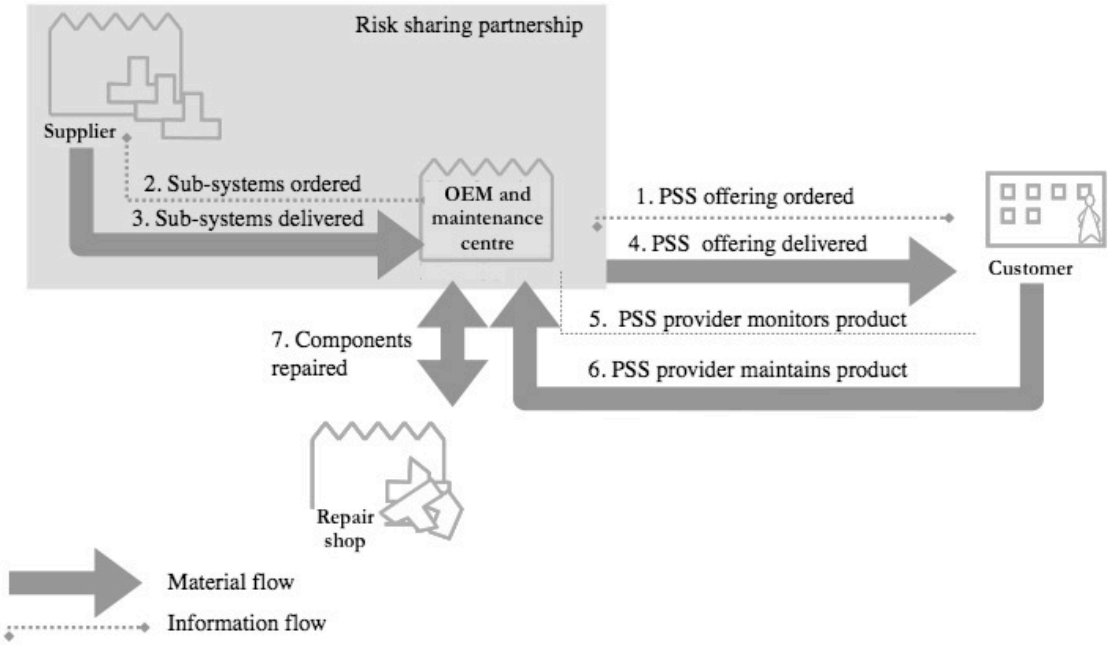

Figure 4 - PSS supply chain (Lockett et al., 2011: p. 301)

This example, which is characterized in Figure 3 and 4, shows that the differences between a traditional supply chain and a PSS supply chain are significant (Lockett et al., 2011). In the traditional supply chain a separate maintenance centre managed the product support throughout the product lifetime, but in the PSS supply chain the OEM plays a central role during the entire PSS life cycle (ibid).

In this particular example the repair shop recognized an overall reduction in their business with the OEM, as a result of introducing PSS. This was because the OEM, as a maintenance centre, wanted to assure that their product always returned to their customers in an "as new" condition by fitting new components rather than repairing used ones. This has also made an impact on the profitability of the PSS contract, since new components are more expensive than repaired ones. (Lockett et al., 2011)

There is a great need for information sharing in a functional PSS supply chain. The relationships between the OEM, the supplier and the repair shop in this particular example were influenced of tensions because of a mismatch between expected and actual levels of information exchange. Another relationship related issue in this example is that the OEM's suppliers must have confidence in the OEM's ability to recruit sufficient customers in order to keep the risk-sharing program profitable. (Lockett et al., 2011)

2.3.1 Requirements for successful PSS supply chains

Characterizing the value creation in a PSS supply chain is the theme of RQ2. To be able to evaluate a PSS supply chain, requirements for what a successful supply chain must be determined.

Lockett et al. (2011) identified two main themes in the context of PSS supply chain, which are a need for incentive alignment between a PSS provider and their supply network and a need for information sharing through the network.

Lockett et al. 2011 argue that PSS supply chains are not unique in needs for incentive alignment, since companies need to align their incentives in all supply chains. Related to the example described in the previous section (Figure 3 and 4), the OEM and the supplier successfully achieved incentives alignment through their risk and revenue sharing program. On the other hand, the incentive alignment between the OEM and the repair shop was not as well executed.

Lockett et al. (2011) found in their empirical studies that adoption of PSS business models and need for intensive information exchange between key members in the PSS supply chain are closely related. In technology and knowledge-intensive environments even higher levels of information exchange are needed (Johnson & Mena, 2008; Wuyts et al., 2004). Exchange of information is more preferably done through relationships characterized by trust, commitment and mutual adaptions (Lockett et al., 2011).

Lockett et al. (2011) claim that information sharing and the nature of relationships are connected in a mutually reinforcing circle. "Closer and more collaborative relationships will likely involve higher levels of information exchange, and higher levels of information exchange will breed more collaborative relationships" (Lockett et al., 2011: p. 309).

In order to go towards a successful PSS supply chain in terms of information exchange Lockett et al. (2011) argue that three things must be recognized by the OEM:

- Suppliers that support the PSS offering should have access to relevant information
- Increased levels of information exchange require changed nature of relationships within the supply network
- Information exchange and the nature of relationships are mutually reinforcing

2.3.2 Summary of PSS supply chains

Introduction of PSS in a supply chain affects the supply chain greatly. The ways of communication, holders of risk and revenue streams are some of the areas that are affected by PSS introduction and that have been brought up in this chapter.

The alignment of incentives between a PSS provider and its suppliers is important for a successful PSS supply chain. Although this can be difficult to achieve, since the objectives of each company in the PSS supply network could differ. Furthermore, risk transfer in PSS supply chains makes incentive alignment more difficult than in traditional supply chains.

Effective information exchange across the PSS supply network is essential for a successful PSS supply chain in terms of profit and sustainability. The information exchange can be difficult to achieve in practice, especially if the PSS provider is concerned about knowledge leakage into the supply chain.

The empirical studies by Lockett et al. (2011) have shown that adoption of PSS business models can affect companies in the supply chain negatively if the companies are not well integrated into the PSS offering. The relationships in PSS supply chain could also become very complicated, particularly if companies take on multiple roles in the supply network.

Presented in this section are the risks with PSS-partnering but to further study the relations between OEM and suppliers a clear picture of the general business model design needs to be drawn up.

2.4 Value theory

Grönroos (2011) argue that the concept of value is vague and Woodruff and Flint (2006: p. 185-186) believe that "none of the preceding definitions capture the complex nature of customer value". Value concepts in literature (such as Sánchez-Frenández & Iniesta-Bonillo, 2007; Grönroos, 2011) contain some form of assessment of benefits against sacrifices (e.g. Zeithaml, 1988), means-ends-models (e.g. Woodruff, 1997) or hedonic appreciation of the object of consumption (Holbrook, 1994). Grönroos (2008: p. 303) has defined a 'working definition' of value for customers:

> *"Value for customers means that after they have been assisted by a self-service process (cooking a meal or withdrawing from an ATM) or a full-service process (eating out at a restaurant or withdrawing cash over the counter in a bank) they are or feel better off than before."*

Grönroos (2011: p. 282) claims that "understanding when value for a customer occurs is also an elusive issue". Consider the value perceived from a car for an individual, which is an example collected from Grönroos (2011). For someone, driving a certain car could mean value, whilst for someone else value relates to the opportunity to meet with friends enabled by the drive made possible by this car. These are examples of value in a context of physical use. Someone else could find value already in considering buying a particular car (mental use) or the sheer possession of a car with special characteristics (possession).

Value creation refers to "a process through which the user becomes *better off* in some respect (Grönroos, 2008) or which increases the customer's well-being (Vargo et al., 2008)" (Grönroos, 2011: p. 282). According to Grönroos (2011) value-in-use is the experimental value that a customer or user could percept from a product through usage, possession or mental states.

2.4.1 Value-in-use

In order to explain the concept of value-in-use properly, another concept called value-in-experience needs to be introduced. One usual view is that "value for customers is embedded in products that are outputs of companies' manufacturing processes, value-in-exchange" (Grönroos, 2008: p. 299). This view is challenged by an alternative view, which is that value for customers appears as value-in-use in the customer's value-generating process (the so called customer's sphere) (Grönroos, 2008) during usage, possession or at mental stages (Grönroos, 2011). Due to this view, "value is not created by the provider but rather in the customers' value-generating processes" (Grönroos, 2008: p. 299).

Resources for using products or services are provided by companies, which makes them creators of a value foundation. Value-in-use is extracted from the potential of the resources when customers use these resources together with other resources and also skills held by them (Grönroos, 2008). The value-in-use will be lowered or non-existing if the skills and/or additional resources needed to use the resources provided by a company are missing (ibid). If customers cannot use the resources and the value-in-use is non-existing, the value-in-exchange is also non-existing since the resources provided by a company are only valuable for a customer if the customer can make use of the resources (ibid).

Ravald (2001) argues that value-in-exchange is a function of value-in-use. Theoretically, value-in-exchange only exists if value-in-use can be created (Grönroos, 2008). "In practice, goods and services may have exchange value in short term, but in the long run no or low value-in-use means no or low value-in-exchange. Hence, value-in-use is the value concept to build upon, both theoretically and managerially" (Grönroos, 2008: p. 304).

2.4.2 Co-creation of value

In the previous section, it was argued that both suppliers and customers as value facilitators bring a value foundation to value creation. As value is created in the customers' sphere, it emerges in the customers' value-generating process (Grönroos, 2000).

In the management and marketing literature in general the term customer co-creation of value has consistently been used (Grönroos, 2008). The arguments, which are put forward for this, state that value is still created by companies, but customers are to a greater extent involved in the provider's work (Lengnick-Hall et al., 2000; Auh et al., 2007) and enter as co-creators (Grönroos, 2008). But, as Grönroos (2008: p. 305) denotes: "if value is created in the customers' value-generating process and should be understood as value-in-use, and if value-in-exchange for the supplier is dependent on whether value-in-use is emerging or not, the customers have to be the value creators". The gist of this is that there are different views on who creates value.

Grönroos (2011: p. 282) claims that "the creation of value-in-use by the user and value creating as an all-encompassing process including value-creating activities by both the

provider (firm) and the user (customer) cannot be included in the same analysis". One has to choose which view to use and not mix them together. Nevertheless, customers are always involved in the creation of value (Sandström et al., 2008; Vargo & Lusch, 2008; Prahalad & Ramaswamy, 2004). Figure 5 illustrates the differences between value-creation as an all-encompassing process and value creation as creation of value-in-use and also where value is created in each view.

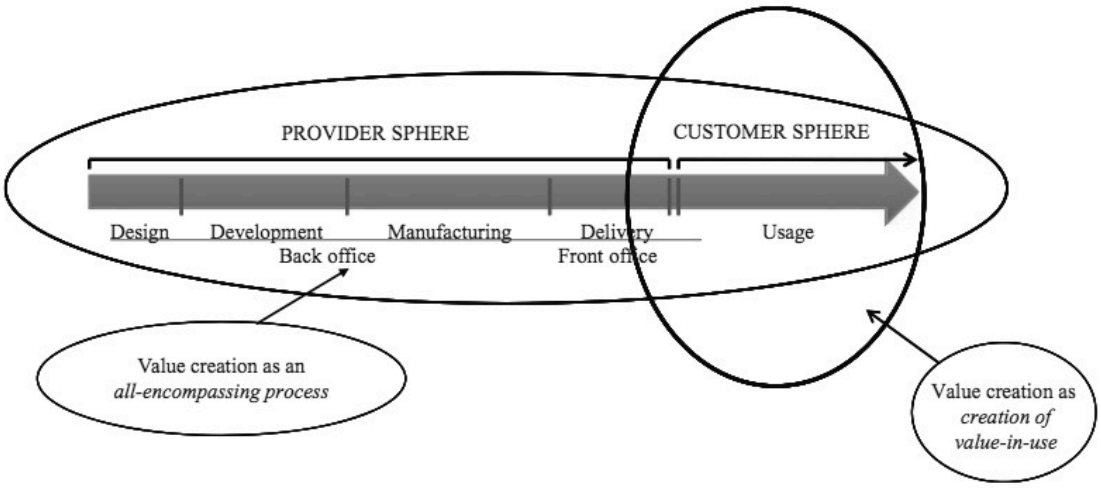

Figure 5 - Value creation as the customer's creation of value-in-use or as an all-encompassing process including provider and customer activities (Grönroos, 2011: p. 283)

Grönroos (2011) concludes that both the provider and customer are involved in an unspecified, all-encompassing process of value creation. Furthermore, Grönroos (2011: p. 287) states, "no implication of this statement beyond this simplistic conclusion is possible". The production and value creation aspects of direct interactions between the provider's process (production) and the customer's process (value creation) are summarized in Figure 6.

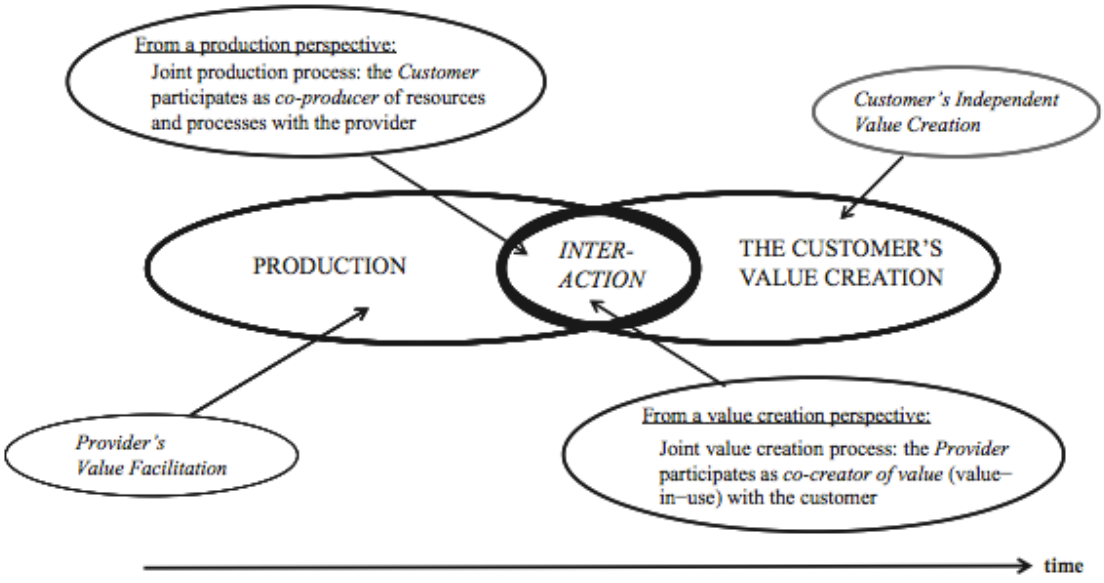

Figure 6 - A value-in-use creation model (Grönroos, 2011: p. 291)

The different forms of value that has been discussed throughout the thesis so far have been explained in this chapter. In a PSS environment value is co-created by the supplier and customer together and how this value is co-created is not obvious. There are many different organizational forms companies can create value together. The different organizational structures create possibilities and difficulties depending on what they are

supposed to generate and how they are formed. Next chapter handles different forms of strategic alliances and what possibilities and difficulties they create.

2.5 Strategic alliances (Enabling co-creation of value)

Ireland et al., 2009 presents three ways of growing as a company, internal development, mergers and acquisitions, and lastly cooperation. Presented in earlier chapters, the PSS environment requires coproduction, co-creation and co-sharing of risks. The preferred strategy would then be cooperation, which can be divided into three sub-categorizes, joint ventures, equity strategic alliances, and non-equity strategic alliances (ibid).

Ireland et al. (2009: p. 226) describes a joint venture as "a strategic alliance in which two or more firms create a legally independent company to share some of the resources and capabilities to develop a competitive advantage". Establishing long-term relationships and transferring tacit knowledge[3] is done effectively through joint ventures as well as improving a company's capabilities to compete in competitive environments, which are characterized by uncertainty (Ireland et al., 2009). When employees from partner companies in a joint venture are working together there are possibilities to learn and exchange tacit knowledge from working experiences (Ireland et al., 2009).

Ireland et al. (2009: p. 226) describes an equity strategic alliance as "an alliance in which two or more firm's own different percentages of the company they formed by combining some of their resources and capabilities to create a competitive advantage".

In a non-equity strategic alliance two or more companies engage in a contractual relationship. The objective of the alliance is to create competitive advantage through sharing unique resources and capabilities. A non-equity alliance demands fewer partner commitments than joint ventures and equity strategic alliances, since a separate independent company is not created. Non-equity strategic alliances are not suitable for complex projects where tacit knowledge transfer is needed, since relative informality and lower commitment levels characterize the alliance. (Ireland et al., 2009)

To summarize, joint ventures suit uncertain and complex environments where the cooperation should be over a long period of time and the transfer of tacit knowledge is essential. The different strategic alliances are formed when there is a lower level of commitment between the partnering companies, especially for the non-equity strategic alliances. Transfer of tacit knowledge is harder in the strategic alliances.

Strategic alliances that have been formed can be implemented in two ways, vertical complementary strategic alliances or horizontal complementary strategic alliances (Ireland et al., 2009).

Vertical complementary strategic alliance is between organisations from different levels in the supply chain, such as suppliers and buyers, in order to create competitive advantage (Ireland et al., 2009). Horizontal complementary strategic alliance, on the other hand is between organisations from the same level in the supply chain, such as two buyers (Ireland et al., 2009). The difference between vertical and horizontal complementary strategic alliance is visualized in Figure 7.

[3] Tacit knowledge is knowledge that is hard to transfer. Tacit knowledge is often somewhat personal and cannot be transferred through writing or other data transfer methods. Tacit knowledge is a companies know-how and personality were it consists of its believes, values and ideals. While difficult to articulate, this cognitive dimension of tacit knowledge shapes the way we perceive the world. (Polanyo, 1966)

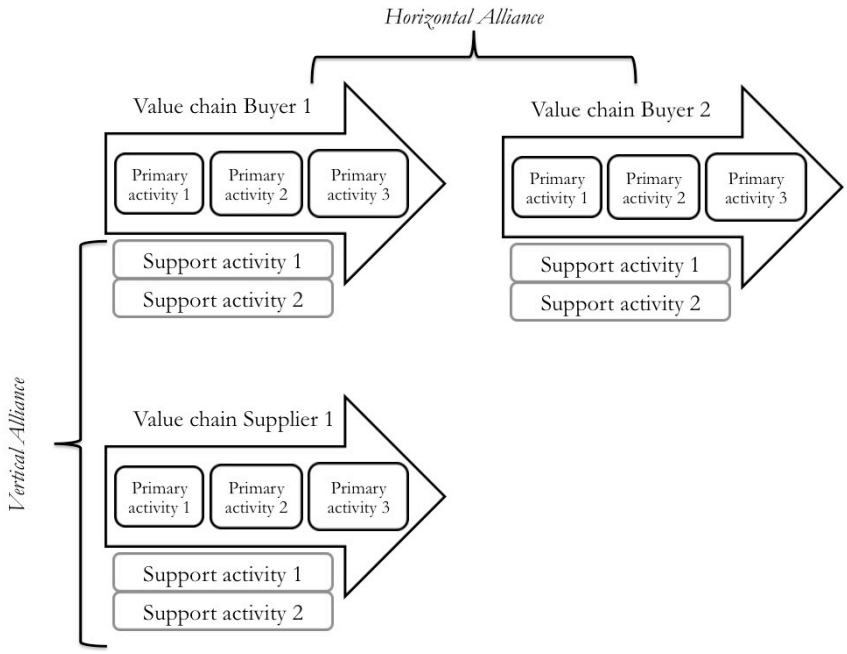

Figure 7 - Vertical and Horizontal alliances (Ireland et al., 2009 p 231)

2.6 The Kano model and PSS quality

The Kano model (Kano et al., 1984) (Figure 8) describes how customers perceived satisfaction of the product/service is in relation to its attributes. The Kano model includes five categories of attributes: Attractive attribute *(1),* one-dimensional attribute *(2),* must-be attribute *(3)*, reverse attribute *(4)*, and indifferent attribute *(5)*.

A competitive product meets basic expected attributes, maximizes performances attributes, and includes as many attractive attributes as financially feasible.

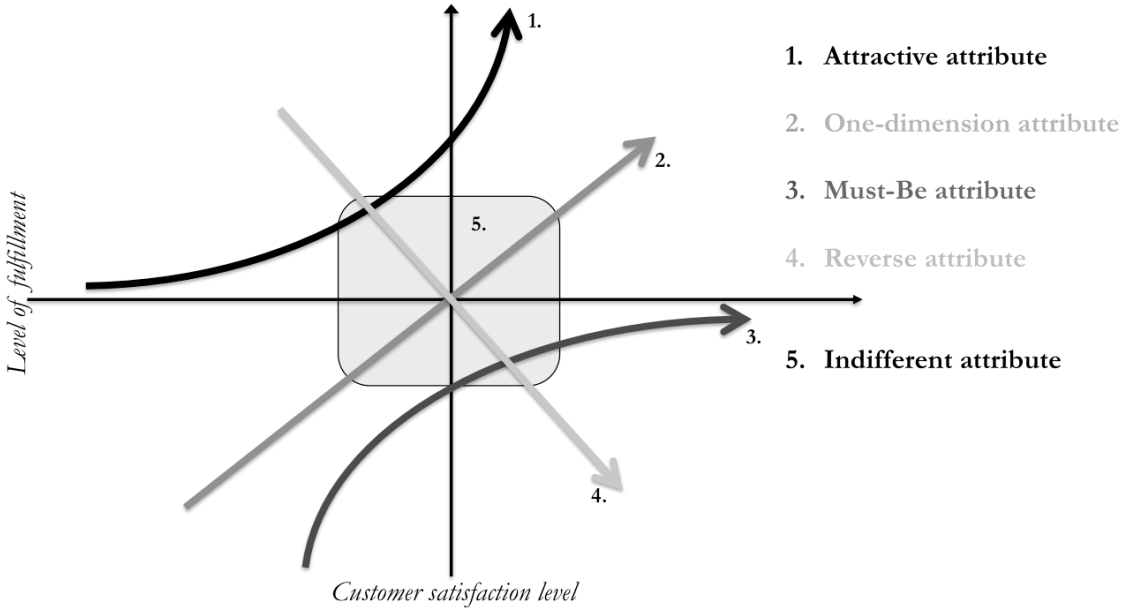

Figure 8 - The Kano-model (Redesigned from Kano et al., 1984)

2.6.1 Attractive attributes

Attractive attributes provide customer satisfaction when achieved completely, but do not cause customer dissatisfaction when unfulfilled. The satisfaction increases further if the

attribute performance exceeds the customer's expectations. Most customers are not aware of the attractive attributes until they have experienced them, which lead to that the customers do not miss the attributes if they are absent.

2.6.2 One-dimensional attributes

One-dimensional attributes result in customer satisfaction when fulfilled and dissatisfaction when not fulfilled. The customers are fully aware of these attributes and will mention them if asked. One-dimensional attributes are important and the customer therefore expects to have these fulfilled (Bergman & Klefsjö, 2003). A company can win customers by fulfilling these needs better than the competitors (ibid).

2.6.3 Must-be attributes

Must-be attributes are the basic quality characteristics considered by costumers. If the attribute performance is better than expected will not lead to any mentionable increase of customer satisfaction. But if performance of these attributes does not fulfill customers' expectations will drastically harm the product. In other words, must-be attributes are taken for granted when fulfilled but result in dissatisfaction when not fulfilled. These attributes are most often so basic that customers do not expect that they need to inform the delivering company that these attributes are valuable for them.

2.6.4 Reverse attributes

Reverse attributes refer to attributes where high performance leads to dissatisfaction. This points to the fact that not all customers are alike. For example, one customer could prefer high-tech products with lots of features, while others find all features confusing and prefer the basic model.

2.6.5 Indifferent attributes

Indifferent attributes refer to attributes that do not matter for the customers and thereby have little or no impact on customer satisfaction.

2.6.6 The Kano attributes shift with time: The Kano model time problem

With time attractive attributes become more and more recognized, which leads to that customer soon sees an attribute as competitive ground when choosing product or service and hence a one dimensional attributes. The one-dimensional attributes will with time be more and more recognized and after some time customers see these attributes as given and starting to expect them. The one-dimensional attributes have now shifted to must-be attributes. This shift is visualized by Figure 9.

The fact that attributes shift with time forms a basis for the problem within a PSS supply chain with long product life cycles because the value promised to the customer year one will shift and hence create different views on what is paid for and what is delivered in form of value. This is why it is important to implement new tools for measuring quality of the value delivered to the customer over time. This is important in order to work proactive with customer satisfaction and reduce the risk of that the customer will leave the contract or exercise rights of economical punishment (if the customer believes that the goals in the agreement are fulfilled).

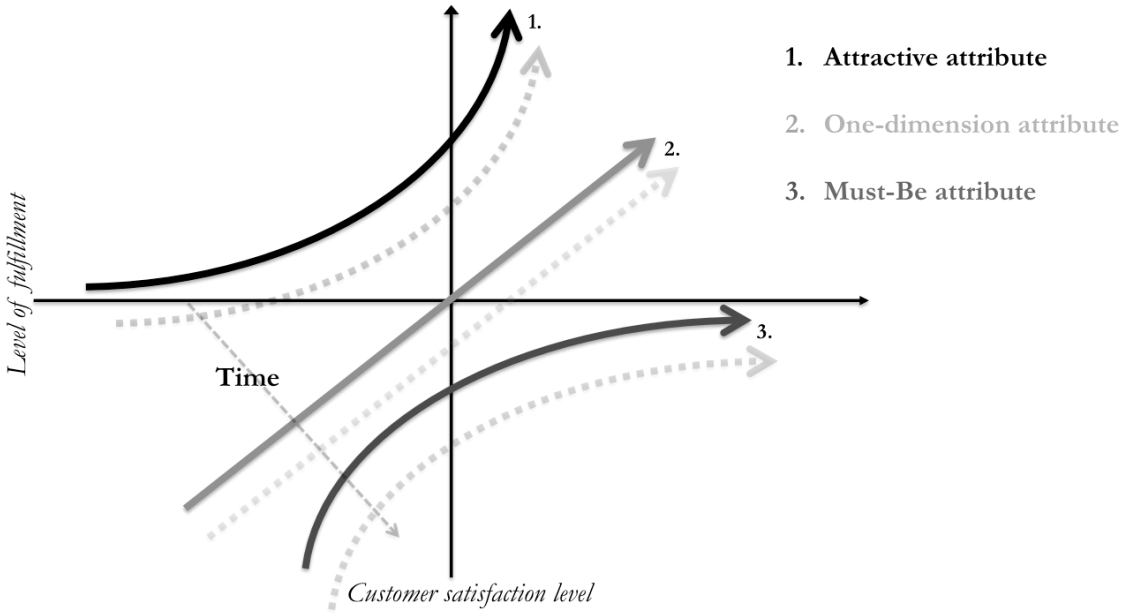

Figure 9 - The Kano-model time problem (Redesigned from Kano et al., 1984)

2.6.7 The Kano model used to measure customer satisfaction in PSS

Geng and Chu (2012: p. 1492) argues that "product-service system (PSS) design focuses on customer value and satisfaction more than traditional product or service systems, and pays much attention to making improvement strategies due to the immaturity of engineering design methodology". Further on they argue that PSS design literature is still immature and that most of the early studies on PSS design were primarily conducted from the viewpoint of marketing and management. Geng and Chu (2012) argues that engineering methods and tools, such as life cycle engineering for technical PSS development, have been developed gradually to support the realization of PSS.

The design objective that PSS providers pursue continuously is satisfying the customers. However, Geng and Chu (2012) means that evaluation of customer satisfaction in order to identify improvement opportunities of PSS design gets much more important in practice. One fundamental step in evaluating customer satisfaction is extracting critical customer perception attributes of PSS (ibid.).

Geng and Chu (2012) claim that an effective way to collect information about the customer satisfaction is through conducting a questionnaire. Designing a questionnaire for extracting customer perception attributes is done through combining the quality characteristics generated in the PSS conceptual design with the data in customer relationship management (ibid.). The survey should be built up by attributes in the PSS offering and the customer shall grade how important the different attributes are and later during the contracts duration grade how well the different attributes are fulfilled. These attributes are then analyzed in an Importance-performance analysis.

2.6.8 Importance-performance analysis

Importance-performance analysis (IPA) is a two-dimensional grid based on customer-perceived importance and performance of attribute analyzed (Geng & Chu, 2011). The IPA grid is shown in Figure 10. The x-axis presents attribute performance and the y-axis presents attribute importance. Theses two axes divide the IPA grid into four quadrants. Geng and Chu (2011: p. 1493) explain that the graphic representation provides "an understandable guide for identifying the crucial product or service attributes in terms of their need for managerial action". IPA has been found to be useful in customer satisfaction analysis.

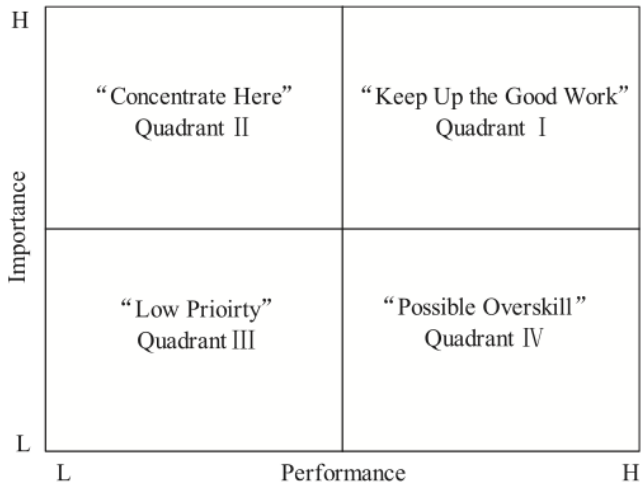

Figure 10 - Importance-performance grid analysis (Geng & Chu 2012, p 1497)

The different attributes can be plotted in the grid and the result shows what type of attention the attribute deserves.

2.7 Macdonald's framework for measuring PSS quality

Macdonald et al. (2011) discusses that the gap in understanding the value between customers and providers[4] of product-service bundled solutions lies in goal theory. Which means that providers fail to recognize the importance of customer value perceptions at multiple levels and, particularly, the importance of higher-level customer goals. Macdonald et al. (2011) argues that a plausible reading of Tuli et al.'s (2007) data is that providers' assessment of value tends to be attribute centric, focusing at the lower end of the hierarchy, whether because of a goods-dominant logic assumption that value creation occurs at the factory gate, or because this level is easier to measure. Macdonald et al. (2011) continues to argue that the notion of service quality is often equally obsessed with what the provider delivers, as opposed to the value the customer gets. Insufficient effort has been put into specifying how customers select and strive for goals. Therefore, in order to effectively stimulate a customer's assessment of value-in-use, customer perceptions need to be measured up as well as down the hierarchy of customer goals.

Macdonald et al. (2011) argues that the implication of goal theory for value assessment is that providers cannot assume that customers' value assessments are made at a single level, nor with regards purely to provider attributes or features. Providers must also allow for assessments made at multiple levels and at increasing levels of the value hierarchy including at the level of subjective benefits.

The framework by Macdonald et al. (2011) (Figure 11) takes direction from these hierarchical goal perspectives. Customers evaluate both *service quality* and *value-in-use* and their goal hierarchy includes a mental model as to how these levels relate. The customer is prepared to pay for the presence of certain attributes not because they exceed expectations but because of their association with higher goals in the customer's mental model.

[4] At this point provider can be looked upon as either OEM or supplier to an OEM. If it is looked upon from a OEMs perspective the OEM is the provider and the airline the customer. If it is looked upon from a supplier's perspective, the supplier is the provider and the OEM the customer.

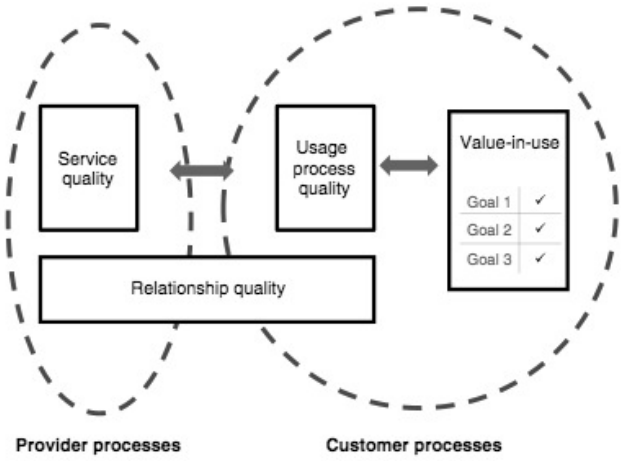

Figure 11 - Macdonald's Framework (Macdonald et al. 2011: p. 673)

Precisely the same reasoning applies to usage processes. If the customer co-creates value through interaction with the provider and other customers, then it would be expected that the customer's mental model would include these usage processes, and their hypothesized relationship to value-in-use in the goal hierarchy. Macdonald et al. (2011) explains that the customer's evaluation of the usage process could be expected to possess a direction in the same way as the customer's evaluation of the provider's service.

The final dimension of Macdonald's framework is relationship quality. Macdonald et al (2011) follows Morgan and Hunt (1994) when conceptualizing relationship as an on going process of interaction involving one or more value exchanges. Macdonald et al (2011) follows the conceptualization of value exchanges made by Vargo and Lusch (2004) and sees an relationship as an inter-organizational capability by which exchange partners identify value-in-use sought, construct a value proposition, and assess service quality and value-in-use achieved. Relationship quality is the perceived excellence or superiority of this capability

3. Frame of reference

In this chapter theories presented in chapter 2 are connected to each of the four research questions through frameworks in order to show how theories have contributed to answering the research questions.

To be able to answer the research questions, operationalization of all questions have been made and frameworks have been constructed for each research question. Through the operationalization, which means breaking the questions down and connecting them to sources from theories and thereby making the answers measurable, the research problem can be handled. The operationalization for each research question follows in this chapter. The frameworks for each research question consist of the RQ's goal, theoretical models that are used to reach the goal, reference for the methodology, and which components the theoretical model consists of.

3.1 Research question 1

Which are the problems with the existing business model for a product and technology supplier when OEMs start to offer PSS solutions?

A company is not independent from its customers and suppliers (Lockett et al., 2011) and therefore it is important understand how different stakeholders affect the business model. To build this understanding the principal agent theory is used. Problems within the supplier's current business model have been sought in a situation where the OEM starts to offer PSS solutions. PSS supply chain theory is used in order to understand which the differences between a traditional supply chain and a PSS supply chain are, but also to understand the challenges that actors could face when a traditional supply chain transforms to a PSS supply chain. The full operationalization framework for RQ1 is found in Table 5.

Table 5 - Operationalization framework for RQ1

	Goal	Theory	Reference	Components
RQ1	Identify problems with the existing business model for a product and technology supplier	PSS Supply Chain	Lockett et al. (2011)	Incentive alignment
				Information sharing
		Principal agent theory	Penttinen (2007) Eisenhart (1989) Garen (1994)	Differences in goals and desires
				Differences in attitudes to and perception of risk sharing
		Value theory	Grönroos (2008; 2011)	Value delivered
				Value received

3.2 Research question 2

How can the value creation in a PSS supply chain be characterized?

In order to characterize the value creation in a PSS supply chain knowledge about both value creation and PSS supply chains is needed as well as challenges for actors within a PSS supply chain. Discussion regarding value creation is made by Grönroos (2008; 2011). Furthermore, Grönroos has a discussion regarding different actors' involvement in the value creation, which allows mapping of the value creation in the PSS supply chain. Knowledge about PSS supply chains and how they differ from non-PSS supply chains is discussed by Lockett et al. (2011), who also found two main themes for successful PSS supply chains. These themes, incentive alignment and information sharing, are used to set requirements for how the supplier should act in the PSS supply chain. Different relationship forms, which suppliers and OEMs are involved in, might exist in the PSS supply chain. Different relationship forms are discussed by Ireland et al. (2009) The relationship between different principals and agents and also the problems and conflicts

that could arise in a supply chain is handled by the principal agent theory. The full operationalization framework for RQ2 is found in Table 6.

Table 6 - Operationalization framework for RQ2

	Goal	Theory	Reference	Components
RQ2	Characterize the value creation in a PSS supply chain	PSS Supply Chain	Lockett et al. (2011)	Incentive alignment
				Information sharing
		Value theory	Grönroos (2008; 2011)	Value delivered
				Value received
		Principal agent theory	Penttinen (2007) Eisenhart (1989) Garen (1994)	Differences in goals and desires
				Differences in attitudes to and perception of risk sharing
		Partner and business relationship forms	Ireland et al. (2009)	Joint venture
				Equity strategic alliance
				Non-equity strategic alliance

3.3 Research question 3

How can the value proposition in business model for a product and technology supplier in a PSS environment be characterized?

In a PSS environment there are different PSS dimensions described by Smith et al. (2011), where the balance between services and tangible products differ. These are used to categorize different value propositions in RQ3 depending on the balance between services and tangible products in a product-service spectrum (see Figure 1 on page 2). When designing a value proposition for a supplier in a PSS supply chain the main themes for a successful PSS supply chain by Lockett et al. (2011) are useful to have in mind as requirements for the new design. When designing a value proposition is value creation in focus and this is handled by value theory by Grönroos (2008; 2011). The full operationalization framework for RQ3 is found in Table 7.

Table 7 - Operationalization framework for RQ3

	Goal	Theory	Reference	Components
RQ3	Characterize the value proposition for a product and technology supplier in a PSS environment	Value theory	Grönroos (2008; 2011)	Value delivered
				Value received
		The different dimensions of PSS	Smith et al. (2011)	Asset
				Recovery
				Availability
				Outcome
		PSS Supply Chain	Lockett et al. (2011)	Incentive alignment
				Information sharing

3.4 Research question 4

How can the value proposition be sustained throughout PSS-contract duration?

In order to sustain value throughout PSS-contract durations a PSS quality framework for monitoring and measuring value over time is needed. Macdonald's framework provides PSS quality parameters as well as a framework for structuring attributes. The Kano model explains how customers' value perception shifts over time and different types of attributes. Furthermore, value theory by Grönroos (2008; 2011) is needed to create understanding regarding what value is and how customers or users percept value. Understanding of

customers' needs and expectations is vital when value is to be sustained over time. To decide which values that must be in focus for the supplier, the importance-performance analysis by Geng and Chu (2012) is used. The full operationalization framework for RQ4 is found in Table 8.

Table 8 - Operationalization framework for RQ4

	Goal	Theory	Reference	Components
RQ4	Sustaining value propositions throughout contract durations	Value Theory	Grönroos (2008; 2011)	Value delivered
				Value received
		Kano model	Kano et al. (1984)	Attractive attribute
				One-dimensional attribute
				Must-be attribute
				Reverse attribute
				Indifferent attribute
		Importance-performance analysis	Geng & Chu 2012	Performance
				Importance
		Macdonald's framework	Macdonald et al. (2011)	Service quality
				Relationship quality
				Usage process quality
				Value-in-use

3.5 Emerged frame of reference

To be able to answer the research problem the four research problems are constructed, which have been operationalized and connected to theories to make the answers measurable in the former sections of this chapter. The purpose of these research questions is to provide a systematic workflow for answering the research problem. Figure 12 visualizes how the research questions are connected to each other to be able to provide an answer to the research problem.

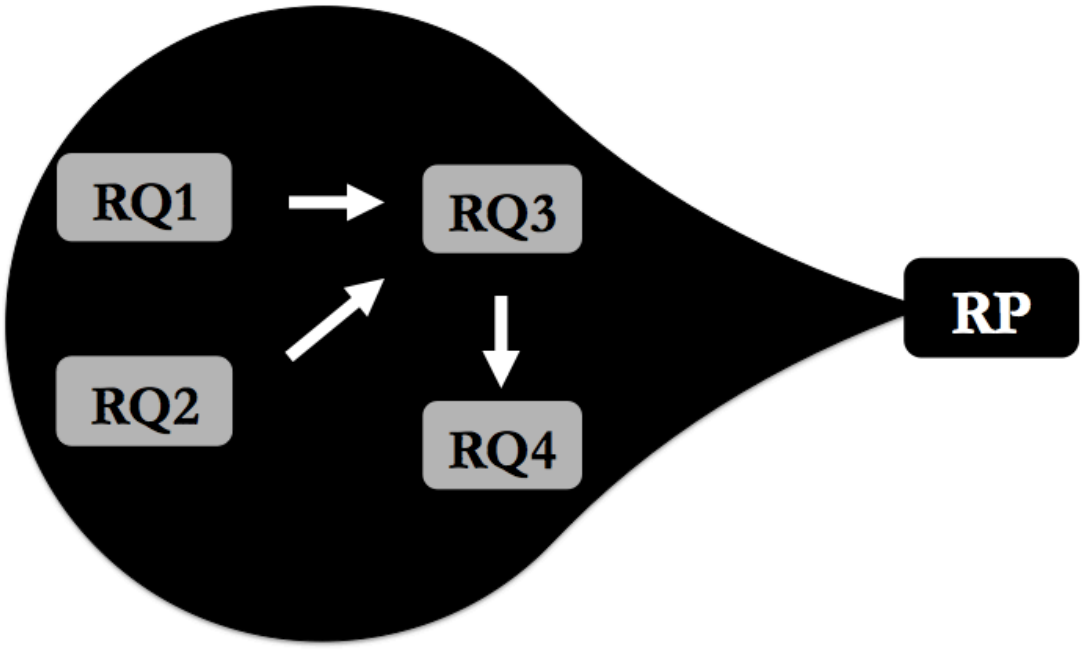

Figure 12 - Emerged frame of reference

The arrows in Figure 13 represents flow of information in this research. The workflow where the answers to RQ1 and RQ2 provides information for answering RQ3 and the answer to RQ3 provides information for answering RQ4 is further explained below.

To be able to design new value propositions for a product and technology supplier in a PSS environment the requirements for this new business model must be set. RQ1 investigates the problems with the existing business model and the drivers for the change of it. RQ2 investigates the value creation in a PSS supply chain and hence the value creation in a PSS environment which is the environment for the new business model. RQ1 and RQ2 together provide a set of requirements for what the new business model should be able to accomplish. In order to construct a new business model the value proposition is constructed first, since the value proposition affects all of the other business model dimensions.

The set of requirements found in RQ1 and RQ2 are used in RQ3, where new value propositions suitable for a PSS environment are constructed. Since the customers' perceptions of value can be changed throughout contract durations, especially in long-term contracts, a way to sustain the value is needed in order to make the value proposition correspond to what the customers want and need. Therefore, RQ4 investigates how the value proposition can be sustained throughout PSS contract durations.

In the methodology chapter more information about how the study in this thesis is conducted and how empirical data is used to provide answers to the research questions and the research problem.

4. Methodologies

This chapter describes how the thesis achieves the research objectives. It explains which and why different methods are chosen and how they are connected to the objectives. The different methodological possibilities are explained from theory first, and then follow a section where the choices made are motivated.

4.1 Research purpose

The classification of research purpose can be divided into exploratory, descriptive and explanatory. A research can have more than one of these purposes at the same time. Which purpose/purposes a research has is dependent on the way the research question is formulated. (Saunders et al., 2009)

An exploratory purpose is used to find out what is happening and to get insights in different real life situations (Robson, 2002). This purpose is specially used when there is little knowledge about what is actually happening in that specific situation (ibid). Using this purpose yields a flexible study that is adaptable to changes, which is necessary since an exploratory research may change direction as new data is presented (Saunders et al., 2009). Initially the focus is broad but will narrow as the study progresses (ibid).

A descriptive purpose is used to obtain an accurate profile of persons, events or situations (Robson, 2002). To be able to use a descriptive purpose it requires extensive previous knowledge of that persons, events or situations to be described (ibid). This is because there is a need for the knowledge of the appropriate aspects on which to gather the data for the study. A descriptive research should be thought of as a means to reach an end rather than the end of the research (Saunders et al., 2009). If the research is descriptive it is likely to be a precursor to an explanatory research (ibid).

An explanatory purpose is used to seek an explanation of a situation or problem that often is in the form of causal relationships. It is used to explain patterns relating to the situation or problem that is being researched as well as identifying relationships between aspects within that situation or problem. (Robson, 2002)

As described in the background and problem discussion product-service system is today a well-described area, but the supply chains upstream relations, such as between supplier and OEMs, in context of PSS are inferior described and studied (Lockett et al., 2011). In order to design value proposition and investigate if there is a need for a new quality approach inside this value proposition, this thesis has an exploratory purpose. The study concerns how the current business model function between the suppliers and OEMs and how a new value proposition could be characterized in order to fit the relationship between a product and technology supplier and an OEM that offers PSS solutions.

The study had initially a broad focus but got narrowed towards specific aspects and factors during the research process. The specific problem of the study was not completely known in the early stages of the research. This made a broad focus useable, since more specific needs arose when the research problem was completely defined. The study started by examining the whole business model concept but was after relevant data was presented specified towards value proposition aspects only. The research purpose does thereby match the research questions. When the research purpose was set the study approach could be determined.

4.2 Research approach

A study can be approached in different ways. Whether or not the researcher is clear about the theory, which is involved in the research project, at the beginning of the study will alter the research design. This determines if the study should have a deductive or inductive approach. The research approach also includes the method of how to analyze the collected

data. This determines if the study should use a qualitative or quantitative approach. (Saunders et al., 2009)

4.2.1 Deductive versus inductive

A deductive approach is when a theory and hypothesis is developed and thereafter tested through a designed research strategy. A theory is made then tested in the real life, e.g. a practical environment, in order to create a developed theory. An inductive approach is when data are collected before a theory and hypothesis is made. Data are collected in the real life and then a theory is created. For a deductive approach it's the data that follows theory while for an inductive approach the theory would follow the data. (Saunders et al., 2009)

As mentioned in the research purpose chapter, business models and product-service systems are explored in theory (see, for example, Goedkoop et al., 1999; Mont, 2000; Meijkamp, 2000; Manzini and Vezzoli, 2003). This is also true for customer value (e.g. Woodruff & Flint, 2006), value creation (e.g. Grönroos, 2011), and supply chain dependencies (e.g. Lockett et al., 2011). This thesis studies how value proposition could be designed for suppliers to OEMs in a PSS environment. Hence, data followed theory, which resulted in a research with a deductive approach.

4.2.2 Quantitative or qualitative

Quantitative is used as a synonym for any data collection technique or data analysis procedure that generates or uses numerical data whilst qualitative generates or uses non-numerical data (Saunders et al., 2009). Qualitative data is in the form of words, pictures, etc. which makes it subjective and able to provide deep knowledge while quality data is the form of numbers, which makes it objective (ibid). According to Silverman (2006) there is some differences between different methods concerning whether a quantitative or qualitative research is used (see Table 9).

Table 9 - Different use of methods (Silverman, 2006)

Method	Quantitative research	Qualitative research
Observation	Preliminary work, e.g. prior to framing questionnaire	Fundamental to understanding another culture
Textual analysis	Content analysis i.e. counting in terms of researchers' categories	Understanding participants' categories
Interviews	Survey research: mainly fixed-choice questions to random samples	'Open-ended' questions to small samples
Audio and video recording	Used infrequently to check the accuracy of interview records	Understanding the organization of talk, gaze and body movements

Comparing qualitative and quantitative research in Table 9 shows that random sampling, fixed choices, and numbers characterize quantitative research, while qualitative research is characterized by understanding of the subject.

According to Holme and Solvang (1997) there are several distinct features that determine the choice of quantitative versus qualitative research method. Quantitative is, for example, broad research, structured and focus on explaining, while qualitative is unique, unstructured and focus on understanding (ibid).

The research questions in this thesis are formulated to seek subjective answers that included knowledge building and interpretation of factors. How something can be

characterized was answered in words and not numbers, therefore a qualitative approach was appropriate for this research. Using a qualitative approach provided a deep knowledge towards the specific problem area. How to reach an answer to the problem for the study with an explorative purpose and a deductive and qualitative approach could then be determined.

4.3 Research strategy

Research strategy can be divided into five categories; experiment, survey, archival analysis, history and case study. All these strategies can be used for all purposes and no one is superior to another. Each strategy has different situations where they are suitable. While evaluating which strategy to use there are three different conditions that have to be taken into account; (1) Form of research question, (2) whether or not control over behavioral events is required, and (3) whether or not the research focuses on contemporary events. Table 10 shows the relationship between these conditions and the strategy that is suitable. (Yin, 2003)

Table 10 - The relationship between key conditions and the research strategy (Yin, 2003: p. 5)

Strategy	Form of research question	Requires control over behavioral events?	Focuses on contemporary events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes / no
History	How, why?	No	No
Case study	How, why?	No	Yes

The research strategy for this thesis was selected by comparing the three conditions in Table 10. The research questions used only the formulation of "how", which made experiment, history and case study possible choices. The research did not require control over behavioral events, which excluded experiment. This research examined how value propositions could be designed for suppliers to OEMs that offer PSS solutions, which means that the focus was partly on contemporary events. This research did thereby use case study as a research strategy.

4.3.1 Case study

A case study design can be described upon two dimensions, which can be seen in Figure 13. The case can either be single- or multiple-case design and holistic or embedded (Yin, 2003). Single-case is where one case represents the whole population. Single-case designs needs careful investigations to minimize the chances of misrepresentation (ibid). This thesis is based on a single-case study which will therefor need to take the misrepresentation under consideration and will hence have a lesser degree of generalizability. A study can involve more than one unit of analysis, which determine if it's embedded or holistic (Yin, 2003).

This thesis has one unit of analysis, which is how a value proposition could be designed for a supplier to an OEM that offers PSS solutions. Hence, a holistic single-case design was appropriate for this study. In order to find the case, the company (sample) had to be selected through a sample selection. The population for this thesis is, based on the

research questions, suppliers to OEMs that is offering PSS solutions. The data collection in this thesis has a limited time frame and therefore data cannot be collected from the entire population. Considering this and that the thesis is a case study with an exploratory approach and that no statistical inferences are needed, the technique for selecting a sample is non-probability sampling. The information, which is needed from the case, is very specific and it is likely that only a small number of cases will be able to provide and give us access to sufficient information. Hence, judgmental sampling is used. Judgmental sampling uses ones judgment in order to select a case that will best enable answering the research questions (Saunders et al., 2009). More information about the case company used in this research is provided in the next section.

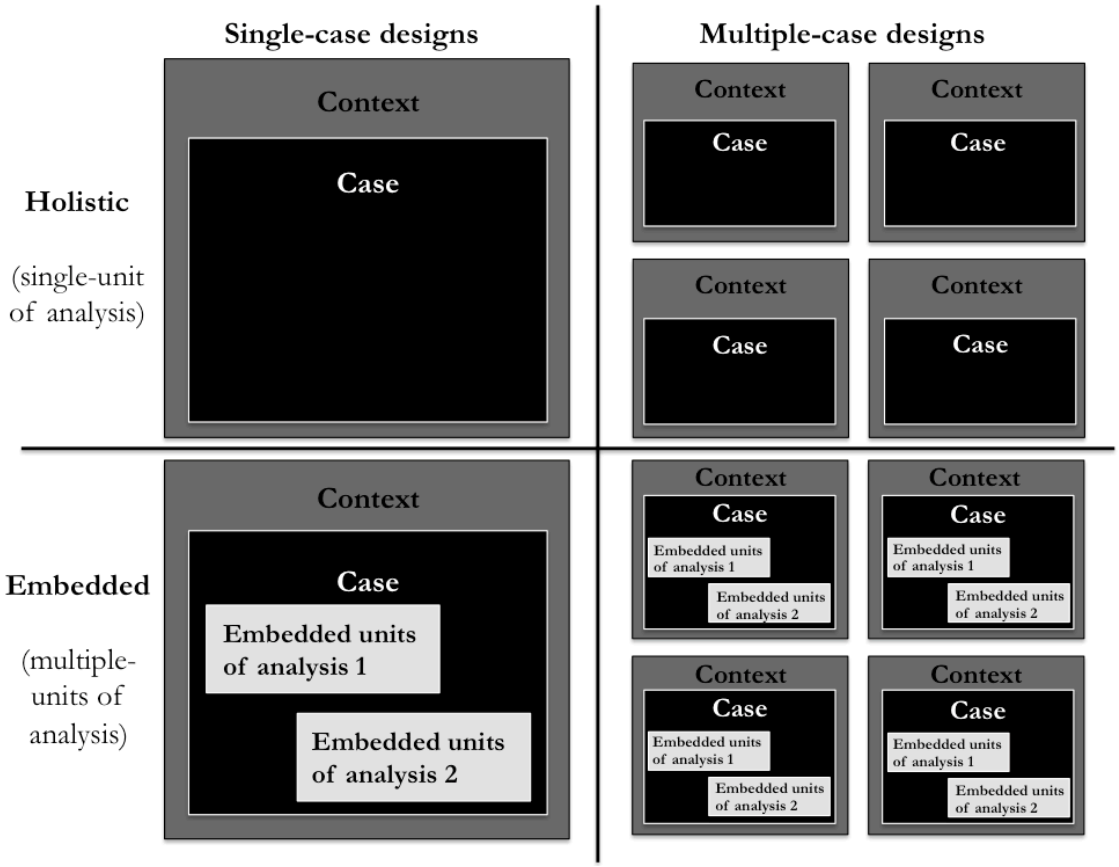

Figure 13 - Basic types of designs for case studies (Yin, 2003: p.40)

4.4 Case company: Volvo Aero Corporation

Volvo Aero Corporation (VAC) was chosen as the case company because of several factors. First, VAC is a provider (supplier/partner) to Rolls Royce, which was the first company to patent a business model used in a PSS environment, Power By the Hour. Second, the aero engine industry is one of the industries that first started to go through the servitization process (Lockett et al., 2011), which implies that this industry should be more mature in such an environment then other industries. Third, VAC operates as an OEM with a PSS business model in the military engine business, which shows that the company has experience of PSS business models.

4.4.1 Volvo Aero Corporation

The case study was executed at VAC in Trollhättan. Volvo Aero is a fully owned subsidiary of AB Volvo. In cooperation with the world's leading manufacturers, such as Rolls Royce, Pratt and Whitney, SNECMA and General Electrics, VAC develops and produces components for aircraft, rocket and gas turbine engines with a high technology content.

Service and maintenance are another important part of VACs business. VAC offer an extensive range of productivity-boosting services, including sales of spare parts for aircraft engines, maintenance, repair and overhaul of aircraft engines and gas turbines as well as industrial gas turbine engines.

VAC business philosophy is based on close cooperation with their aerospace partners. VAC has chosen to specialize in order to be truly competitive in each of their fields of operation. This is mirrored by their business concept "Specialized for Partnership" and vision "Best Partner". (Volvo Aero, Mission & Vision)[5]

VAC operates in four different businesses:

1. **Commercial engines**
   VAC develops and manufactures advanced components for aircraft and aero-derivative engines, and is a partner in several commercial engine programs. Their advanced components (complex structures, housing and rotating parts) are installed in 90% of all new aircraft engines.

2. **Space Propulsion**
   Volvo Aero is a world leader in the manufacture of rocket nozzles for commercial launch vehicles, and is the European Space Agency's Central of Excellence for rocket engine turbines and nozzles.

3. **Engine services**
   Volvo Aero maintains and provides multi-service solutions for operators of turbo-fan and turbo-prob engines in many of the world's most flown commercial and business aircraft, as well as for a number of industrial gas turbines providing heat and power.

4. **Military engines**
   Volvo Aero develops, assembles and provides integrated logistics support for military jet engines, especially the Volvo RM12 engine for the Gripen fighter. They develop and produce components for several other military engines, such as the F414 that powers the F18-E/F, and F135 for the Joint Strike Fighter.

   4.1 Additional technologies at VAC used in the military engines segment

   Life Tracking System, LTS, is an enabler for digital enhanced fleet uptime. The LTS software calculates consumption for the life limited parts based on data files and valid life models. Benefits with the LTS are that by coupling in-vehicle and back-office data analysis it provides decision makers with valuable information. This information helps the decision makers to take the correct action and optimizing the maintenance plan based on health assessment through condition monitoring of the vehicle system and functions.

4.4.2 Case approach

The commercial engines segment is the business segment in focus for this case. In the commercial engines business VAC acts as a provider of parts and technology to engine OEMs, described in Figure 14. Since the commercial engines segment and the actors that are related to aero engine manufacturing are in focus the industry is described as the aero engine industry. The research investigated which type of value proposition that is suitable for VAC in the commercial engine business. Today VAC vision is – "Best Partner". This is

[5] Volvo Aero, Mission & Vision. URL: http://www.volvoaero.com/volvoaero/global/en-gb/aboutus/vision_mission/Pages/Mission%20and%20vision.aspx (Collected 2012-05-22)

however not taken into consideration when investigating value propositions that are recommended for VAC, since that would be a delimitation of which types of value propositions that could be delivered to an OEM.

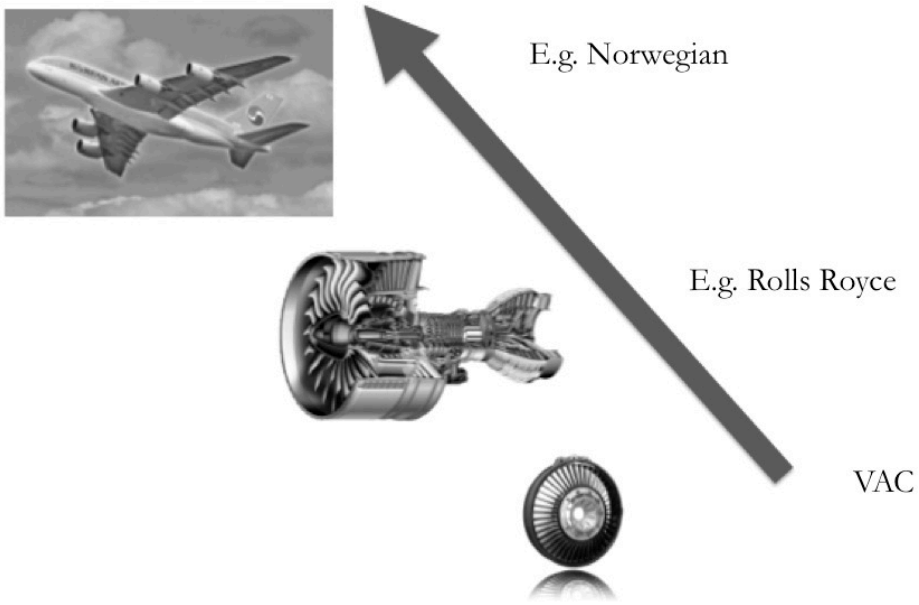

Figure 14 - Supply chain in the aero engine industry

The focus of this thesis has been on what VAC can deliver and how to package these offerings. The data collection has been performed internally at VAC only, because VAC need to know what they can or should offer before a customer dialogue can be started. The reason for this is explained below.

Before a company offer a value proposition to a customer they need to have an idea of which parts of this value proposition that affect the pricing. In order to know what parts of a value proposition that affect the pricing, they need to find out what the customer find valuable. One way to do this is to have a discussion with the customer, but that could lead to a conflict. The supplier wants to charge as much as possible but the customer wants to pay as little as possible, which means that the objectives of the customer and supplier in a value discussion differ. This leads to that a discussion with the customer at an early stage about what the customer find valuable could affect the supplier's possibility to charge as much as possible for their offerings negatively.

If a company enters a sales discussion without knowing what is valuable and how value is created for the customer it is difficult to draw up a contract that is suitable for both the delivering company and the customer, but also to set an appropriate price. Once a sales agreement, where certain products or services are included, is signed it could be hard to increase the price just because the delivering company found out that the number of valuable attributes were larger than expected from start. In order to prevent this, the supplier can try to obtain as much information as possible about what parts of the value proposition that could be valuable for a customer internally before a customer dialogue is started.

The conclusion of these arguments is that to be able to design a value proposition that creates value-in-use for the customer and generates sufficient revenue streams for the offering company the value proposition must initially be discussed and developed internally. The offering company can thereby get a better understanding of how they can charge for this value proposition and also how much. Hence, this thesis has used internal sources at VAC for discussing possible value propositions and how revenue could be generated from these. Once the value proposition has been developed as far as possible

internally at VAC, the value proposition could be discussed with the customers. This is not covered by this thesis though.

4.4.3 Unit of analysis

The problem that have been researched, in this thesis, is how VAC as a partner to an OEM creates and sustains value to the OEM and their customer, as a provider of products, technologies, technological development, and technical expertise.

This means that in a broad perspective, the unit of analysis is how suppliers/partners to OEMs that offer PSS solutions shall design their business model. Described in the problem background and discussion is that value offered is the centre of the business model (Magretta, 2002). The discussion continues to explain that there are nine dimensions in a business model, and that there are direct and indirect choices among these dimensions when designing a business model (Casadesus-Mansell & Ricart, 2010). Lastly, it is discussed how the writers of this thesis find value proposition not only to be the centre of the business model, but also that it is the direct choice and that the rest of the dimensions are affected by the choice of value proposition.

This thesis' approach is hence that the unit of analysis is how value propositions can be designed for a supplier/partner to OEMs and how these choices affect the other dimensions in a business model in order to evaluate what type of value that should be offered.

4.5 Data collection method

This chapter explains how the data, which was needed to answer the research questions, was obtained. It includes discussion about primary and secondary data as well as which collection method that was suitable.

When using a single case study both primary and secondary data can be used to describe the problem. In this thesis both primary and secondary data have been used.

4.5.1 Primary data

Primary data is new data collected to be able to answer the research questions (Saunders et al., 2009). Yin (2003) proposes six sources of evidence, from which information for case studies can be gathered. These are documentation, archival records, interviews, direct observation, participant-observation and physical artifacts (Yin, 2003: p. 86). Each collection method has its strengths and weaknesses and no single source has a complete advantage over another (Yin, 2003).

Primary data was obtained by examination of the case-company. The data that was needed in this study concerns quality systems, business models, customer values, and value creation in PSS. To obtain qualitative data about these areas interviews and workshops were held.

Interviews

The use of interviews is helpful when gathering valid and reliable data that are relevant to the research questions and objectives (Saunders et al., 2009). Different types of interviews can be used depending on the application. Semi-structured interviews are best suited for a research with an exploratory purpose (Saunders et al., 2009). Since this thesis has an exploratory purpose, semi-structured interviews with individuals and groups were held to gather primary data.

The interviewees for the semi-structured interviews were chosen based on recommendations by the thesis tutors. Recommendations for new interviewees were also collected during the interviews to create a snowball sampling effect. The basic idea when interviewees were chosen was to get a general picture of the topics that were discussed.

The chosen interviewees were from different departments at VAC in order to give this general picture. Since the interviews were semi-structured, the discussions were quite different with different interviewees. Hence, all interviewees could not provide information that would contribute to answering the research questions. However, the sum of all information that came out of the interviews contains information that is suitable for all research questions.

The 12 interviews were conducted over a span of 7 weeks. The interviewees' position at VAC, the duration of the interview and the date the interview was held is presented in Appendix I.

Workshop
A workshop was held with seven participants from three different departments (market department, product development and cold structures design). The workshop consisted of three assignments. Assignment 1 was a to construct a map of the aero engine supply chain as it looks today with actors and value flows. The second assignment was to draw up a "dream scenario" from VAC's point of view, where actors and value flows were present. The third assignment consisted of an analysis of the previous assignments. A further explanation of the workshop method and a list over participants is found in Appendix II.

Use of primary data
The interviews and the workshop that have been described are used for collecting data to answer the research questions and finally the research problem. The data collection methods that have been used to answer each research question are described in Table 12.

RQ1 was not a part of the workshop, which made the interviews the source of information for RQ1. RQ2 was handled by assignment 1 in the workshop. Hence, the workshop was the main source of information but the interviewees did also provide some information that was used to answer RQ2. Information for answering RQ3 is found both in the interviews and assignment 2 and 3 in the workshop. The source of information for RQ4 was covered by interviews only.

Table 11 - Use of primary data for answering research questions

RQ	Data collection method
RQ1	Interviews
RQ2	Workshop with input from interviews
RQ3	Interviews and workshop
RQ4	Interviews

4.5.2 Secondary data
Secondary data is data that have been collected for another purpose but still can help answer at least one of the research questions fully or partially (Saunders et al., 2009). Secondary data may be biased and the ability to locate or access as well as the cost differs for each source (ibid).

Secondary data, which reflects occurrences up to today, are needed to provide information that contributes to answering the research questions in this thesis. The first step when planning to use secondary data is to establish that relevant data are available to use (Saunders et al., 2009). The next step is to locate the precise data that are required (ibid).

The secondary data that have been collected for this thesis are mainly internal documents such as internal case studies, articles, and Powerpoint presentations. This kind of material

contains data that had been collected for other occasions but it was also usable for this thesis. The material was provided by VAC to no cost for this thesis.

4.5.3 Review of secondary data

All secondary data have to be viewed with caution (Saunders et al., 2009). To be able to create validity and reliability Saunders et al. (2009) argue the research must be sure that:

- The secondary data will enable to provide an answer to the research questions and meeting the objectives.
- The benefits associated with their use are greater than the costs.
- It's accessible.

As mentioned before, the second and third paragraph has been partly proven. However, the first paragraph is important to evaluate since it include validity, reliability and measurement bias as well as relevance to the research questions. The evaluations have to be done on factors as source, collecting method and measurement bias (Saunders et al. 2009).

4.6 Data analysis method

Yin (2003) suggests five different methods for analyzing data from case studies. These are pattern matching, explanation building, time series analysis, logic models, and cross case analysis.

In order to answer the research problem and draw conclusions and make recommendations, the data gathered need to be analyzed in a way that results in a desirable outcome. For case study analysis, one of the most desirable analysis techniques is pattern matching (Yin, 2003). Pattern matching means that an empirically based pattern is compared to a predicted one (ibid). A specific form of pattern matching is the use of logic models, which is used in this study. The use logic models means that empirically observed events is matched against theoretically predicted events (Yin, 2003). If the patterns coincide, the results can help strengthening the internal validity (ibid).

The study research problem is broken down in four research questions and when these are answered it will have collected sufficient data and analysis to answer the research problem. To answer the research questions theory are gathered and data collected. The data collected have, when presented, been structured and analyzed separately for each research question. The overall analysis method is, as mentioned, pattern matching, where empirical findings are compared with relevant literature. The literature that is related to each research question and that is used in analyzes is explained by chapter 3, frame of reference. Since theory is presented in the background and problem discussion as well, parts of these chapters will be used in order to answer the research questions.

RQ1: *Which are the problems with the existing business model for a product and technology supplier when OEMs start to offer PSS solutions?*
The problems that were found with the current business model were presented in data presentation for RQ1. In the analysis chapter the problems presented in the data presentation were categorized in order to find the causes of these problems. The categories of problems were compiled from problems that had a connection to each other. The problems that were addressed by the largest amounts of interviewees were then put into a list of considerations. The findings from RQ1 were compared to requirements and challenges found in literature presented in Table 6 on page 29.

RQ2: How can the value creation in a PSS supply chain be characterized?
To describe the value creation in the supply chain in the aero engine industry today, two data collection methods were used, interviews and workshop. The workshop was used to collect empirical findings regarding how the actors in the supply chain worked together and

which values flowed from whom to whom. A list of consideration for new value propositions was then constructed from the information about the value creation in the supply chain and the competitive advantages. The interviews were used to find VAC's competitive advantage in order to investigate what resources and capabilities VAC uses when they create value for its customer today. The findings from RQ2 were compared to literature presented in Table 7 on page 30.

RQ3: How can the value proposition in business model for a product and technology supplier in a PSS environment be characterized?
All business model problems from RQ1 and the considerations from RQ2 were compiled into a list of requirements for what the new value propositions should be able to achieve. Data from the workshop about what VAC wants to deliver in the future were put into a list, which was used as input for the construction of new value propositions. These were then divided into four PSS value proposition categories as suggested by Smith et al. (2011). The findings from RQ3 were connected to PSS value propositions and requirements for these found in literature presented in Table 8 on page 30.

RQ4: How can the value proposition be sustained throughout PSS-contract duration?
The current quality activities at VAC were mapped in empirical findings to see how the quality work is functioning today. This was compared to literature in terms of Macdonald's framework (Macdonald et al., 2011), the Kano model (1984), and the importance-performance analysis (Geng & Chu, 2012), in order to see which changes that might be need to be done to the quality activities. Since no data or information from customers was obtained the answer to RQ4 was a quality measurement method compiled from theory. The literature framework for RQ4 is presented in Table 9 on page 31.

How this study is conducted to create valid and reliable data is explained in the next chapter.

4.7 Method problems

This chapter discusses different validity and reliability tests and how to judge the research design. Validity and reliability have to be achieved for all data, when producing new as well as evaluation of secondary data (Saunders et al. 2009). Validity is whether the findings are what they appear to be about or if other factors have altered those findings (ibid). Reliability is the extent to which data collection techniques will provide consistent findings (Saunders et al., 2009).

Kidder and Judd (1986) suggests four tests for judging the quality of the research design, which are construct validity, internal validity, external validity, and reliability. Table 13 contains different tactics by Yin (2003), which can be used in the four tests, and also a cross reference to the phase of study when the tactic is to be used. The tests and related tactics were performed in this study to the extent that was possible. Each test has its own chapter, where more information is found.

Table 12 - Tactics for research design tests (Yin, 2003: p. 34)

Tests	Case Study Tactic	Phase of study in which tactic occurs
Construct validity	• Use multiple sources of evidence • Establish chain of evidence • Have key informants review draft case study report	• Data collection • Data collection • Composition
Internal validity	• Do pattern-matching • Do explanation building • Address rival explanations • Use logic models	• Data analysis • Data analysis • Data analysis • Data collection
External validity	• Use theory in single-case studies • Use replication logic in multiple-case studies	• Research design • Research design
Reliability	• Use case study protocol • Develop case study database	• Data collection • Data collection

4.7.1 Construct validity

The construct validity test has three tactics suggested by Yin (2003) and they are use of multiple sources of evidence, establish chain of evidence, and have key informants review draft case study report. The use of multiple sources of evidence was done in this thesis by combining data from interviews with data from internal documents and theory. A chain of evidence was established to the extent that was possible, since some material is classified. The tutors at both LTU and VAC reviewed the case study material, in order to ensure that the actual facts are correct.

4.7.2 Internal validity

The internal validity test has four tactics suggested by Yin (2003) and they are pattern matching, explanation building, addressing rival explanations, and use of logic models. Explanation building and addressing rival explanation are more suitable for explanatory than exploratory purposes (Yin, 2003). The tactics that were used to strengthen the internal validity in this thesis relates to both pattern matching and logic models. One of the tactics was a value proposition test with an internal business case, where the new value proposition was tested against an existing one in order to review the improvements that have been achieved. The other tactic that was used, which relates to logic models, is matching empirical facts from case studies with theory in literature overview.

4.7.3 External validity

The external validity test has two tactics suggested by Yin (2003), use of theory in single-case designs and replication logic in multiple-case designs. Since this thesis has a single-case design, the basis for generalizing is typically poor. In order to strengthen the external validity, analytical generalization can be used (Yin, 2003). In analytical generalization the results are generalized by connecting them to a broader theory (ibid). This was done in this thesis to the extent that was possible, but the lack of theories that cover the relationship between a supplier and an OEM that offer PSS solutions made the connection to broader theories difficult.

4.7.4 Reliability

The last test is reliability, which is done to minimize the errors and biases in the research (Yin 2003). Two tactics for the reliability test are suggested by Yin (2003), which are use of a study protocol and develop a study database. The study protocol in this thesis consists of this methods chapter. A great part of this is the rigorous explanation of how the case studies were conducted including explanation of the data collection and analysis (found in

chapter 4.4-4.6). Development of a study database means that all evidence from case studies, regardless of whether the evidence is used in the report or not, are kept in a separate place. By having a study database all evidence are easily accessible during and after research. The study database for this thesis was kept as a whole in a separate place and it includes all interview material, articles and other documents that were used.

5. Empirical findings

The collected data are in this chapter presented to provide an understanding and form a foundation for the analysis and conclusions presented in chapter six and seven. The data has been collected through interviews with key personnel at the different departments at Volvo Aero Corporation and a workshop with key personal at VAC.

5.1 Presentational approach

The data collection methods in this study have been unstructured interviews with personnel at VAC and a workshop with key personnel at VAC. The data that is presented in this chapter is structured in categories that reflect the research questions in order to be able to analyze the data and answer each research question in the sixth chapter.

The data presentation consists of information conducted during the interviews, which is followed by summarized tables where the essence of the interviews and the workshop is brought up. This is done to make it easier for the reader to get an overview and to create a basis for analysis. Tables and figures mainly visualize the data from the workshop.

5.2 Data presentation

The data that has been collected through the interviews and the workshop has been categorized depending on which of the four research questions the data belongs to and where the data is useful for answering the research question. The four categories that the data is structured in are presented below:

1 RQ1. Issues with the business model used today and drivers for change

The first research question regards issues with the current business model. Therefore, this category handles which problems and issues the interviewee realizes with the business models used today at VAC. The issues with the current business model are also used as drivers for change, since problems often act as basis for why a change is needed. Therefore, this category does also handle why VAC is in need of changing their business model.

2 RQ2. Value creation in the aero engine supply chain

The second research question regards the value creation in a PSS supply chain. Most of the data for answering this research question is covered by the workshop, but some things that regard value creation came up during the interviews. Assignment 1 from the workshop provided information about how the supply chain looks like today and hence the situation that VAC needs to adapt to. In order to dig deeper into VAC's value creation was their competitive advantages investigated through interviews.

3 RQ3. Thoughts about a future business model

The third research question regards what a value proposition should look like in a PSS environment. Therefore, this category handles what the interviewee thinks of the future, how VAC can compete, what type of competitive advantage can be formed, and how the business model can be reformed in order to meet the future. The information is provided by thoughts that were expressed during interviews, but also by assignment 2 from the workshop where the values that VAC wants to offer in the future were investigated. The business model expression is used in this category since the presented data not only refer to the value proposition part of a business model but rather various parts of a business model.

4 RQ4. Quality work at VAC

The fourth research question regards how a value proposition could be sustained through quality management. This category does therefore handle information about how VAC looks upon quality and what activities that are done to keep a high quality level today in order to provide a starting point.

5.2.1 RQ1 Issues with a business model used today and drivers for change

The interviews have shown that the industry was driving the change towards PSS solutions and that one of the OEMs, Rolls Royce, was the first to move towards PSS solutions. The industry was not mature for this change and neither were the customers, but when the customers became mature they started to demand these solutions from the whole industry. Interviewee I explains that the industry moves towards a state where the actors needs to take more responsibility and risks.

When the customers were mature enough they started to demand PSS solutions from the rest of the OEMs, which had to develop new business models (Interviewee L). The risk that OEMs were exposed to grew larger when the business situation transferred towards PSS (Interviewee E). The risks were increased since OEM usually took over some responsibility for the product's functionality, which lead to costs when dysfunctions arose. Hence, OEMs wanted to share this risk with partners (Interviewee E). The OEMs push their suppliers to be part of the PSS solutions because of the risk sharing needs in the very capital-intensive market (Interviewee L).

Interviewee L explains another reason for the transition towards PSS contracts, which is that at the end of the day everybody wants to make more money. To be able to be competitive against the low cost economies services must be added to the tangible products. These services are mainly connected to aftermarket activities, such as inspections, maintenance and repairs. In order to make a stronger connection to the customers, these aftermarket activities are a part of the PSS contracts. The business model needs to change towards PSS solution partly because the OEMs wants to lock in the aftermarket and also because it is a customer demand.

One form of partnership between VAC and OEMs today is risk and revenue sharing program (RRSP). The interviews have shown that there is a problematic situation with risk and revenue programs, since VAC cannot really influence the revenue streams generated form the aftermarket in these programs.

Risk and revenue sharing programs (RRSP)

RRSP is a partnership between a number of actor, companies, where both risk and revenue are shared between the companies within the program. To be a part of RRSP the company needs to buy in through an entry fee, which is a contribution to the program. The entry fee can for example consist of available funds, technology development and/or tangible products. The entry fee acts like a share in the RRSP and decides what percentage of the total revenue stream a party is entitled to. The revenue for a company in a RRSP is generated from the percentage of the profit from all goods and services sold by the entire program, regardless of which company within the program that provides the specific good or service. Since all parties in the RRSP are entitled to a certain percentage of the revenues, each company is also put at risk in proportion to their revenue share. Under these conditions risk and revenue are shared between the parties in a RRSP. (Interviewee D)

VAC is active in RRSP programs today. The revenue streams and cost structures in these programs are formed as follows. Initial technology and product development and manufacturing of goods are a part of the entry fee in the RRSP and hence a cost for VAC. The engine assembler (OEM) puts the engine together and sells it to the customer (e.g. an airline), often with large discounts caused by competition. These discounts make the

revenue stream from the actual transaction low. In the program the engine is sold together with a maintenance and repair contract, which ties the customer to use the OEM for maintenance and repairs. This is called the aftermarket and this is also where the revenue streams are, because the airline pays for all the services done in the aftermarket. Hence, a predominant part of the revenues that the RRSP-parties can share comes from the aftermarket. The revenue is distributed amongst the partners in the program depending on the percentage the different partners have in the engine program. (Interviewee D)

Implications of RRSP on VAC

VAC has started to investigate what type of value propositions they can deliver in RRSPs, but it is very hard to determine what type of value propositions VAC can deliver in these programs. (Interviewee I, E)

Interviewee L explains that the way RRSP programs function creates problems for VAC in a couple of ways. First, VAC's products are supposed to be functional during the entire lifespan of the engine, hence the products are not in need of any maintenance or overhaul. Second, the engine and maintenance data that is shared within the programs is limited. The OEM becomes owner of the engine data that is crucial for determining how much maintenance and overhaul that is needed. Since this data is to very low extent shared by the OEM to other partner, the partners have troubles in affecting the aftermarket services. It is hard for VAC to affect the revenue streams that they are entitled to when VAC cannot take part of the engine data, information that regards maintenance and inspections, or prices for these activities.

Repair shops that perform aftermarket services can be owned and controlled by the OEM. Since the OEM then sets the internal prices for how much the different maintenance and overhaul services cost they are in control of what is accounted as revenue, which is the basis for what VAC gets a share of (Interviewee D). This implies that VAC is partly controlled by the OEMs when it comes to affecting the revenue or the cost streams during the RRSP.

The need for engine data is a key to a new and better business situation but it is at the same time one of the core problems with the business model as it is today. The lack of information makes the goals in terms of product features and product requirements hard to control and it is very hard to deliver on goals that are hard to control. VAC has until today accepted that the revenue streams are generated on parameters in which are hard for VAC to affect. With control over the data flow there are possibilities to predict needs and hazards, which leads proactive development in terms of adjusting the products and the program.

Interviewee C agrees with the problems with information and data sharing and explains that VAC's information accessibility and insight in other partners' businesses today is low, which makes risk-taking in such partnerships hazardous. Further on, interviewee C explains that it is hard for VAC to visualize what the course of events in a contract with the OEM will look like, which is a risk. It is also hard to calculate the costs for that risk.

Another challenge with the RRSPs is the cost structures of the programs. Interviewee C explains that a lot of the activities that VAC performs, such as technology development, product development and manufacturing, are costs that are included in the contract with the OEM. But since the circumstances within the contract can change after the contract details have been set there is a risk that extra work, and hence costs, that wasn't in the initial calculations will arise. Therefore difficulties exist in calculating the amount of work that VAC should perform in a contract in relation to what they get paid for.

Other challenges with today's business model

Another challenge that arose during the interviews was the cultural aspect. Interviewee A explained that in the past VAC sold a tangible product. That is not the case anymore, since both services and tangible products are sold. The product-based culture is still left in some parts of VAC. This means that all parts of VAC are not equally mature when it comes to product and service bundled solutions. Interviewee B also takes up this topic and explains that there are different views of what type of value VAC offers to its customers. Some people at VAC don't like the term of service, since it is too intangible. Instead these people want to focus on VACs tangible products.

Interviewee L explains that the engineering culture at VAC creates problems when adapting to PSS solutions, as well. VAC is used to meet customer's needs through and charge for the products that are delivered, called time and material contracts. When it is the function of the product instead of the product itself that is delivered, the value of the product and development of this value will shift. The whole organization needs to understand what type of value is offered to the customer. This is important because the engineering culture at VAC has created a culture where they accept changes in the product throughout the whole development phase, without any changes in neither the cost nor the revenue stream. But when this is done the value that is delivered might differ from what was offered and paid for. There is a need to identify this in order to get paid for what is delivered. Today VAC realizes a problem with how some of the contracts that VAC is active in are formed. Since conditions in the contract can change after the contract is set, VAC can be obliged to perform more work than expected. Because of this, VAC sometimes delivers value that they don't get paid for. This is partly because they don't know what value they deliver and to whom and partly because of the engineering culture.

Interviewee G presented another problem with today's business model, which is that different departments have contradictory goals. This leads to internal competition and other difficulties. For example, the development department is transferring into using a new raw material because of some specific features. Meanwhile, the buying department has goals to reduce the purchase of this material, since they just wrote a long contract with another supplier on some other raw material, which is a substitute but without the specific features that the other raw material had. As a result of this the production unit and construction unit will have to make a lot of changes, which lead increased costs and additional problems.

Interviewee G explained that the list of requirements from the customer fluctuates, which most leaders within VAC aren't used to. The customers can come with new changes in the product during the development phase. This does often lead to that VAC delivers and designs things they don't get paid for. This is because the value of the deliveries are set before the development phase begins and changes of the deliveries during this phase lead to other costs that were not taken into calculation from start.

Interviewee G continued to explain problems related to product development. The product development department does mostly work with projects from clients, which could be additional features to an engine or problem solving. Since the projects are given the needs or problems are already identified by the client, which makes the development reactive. Interviewee G wants to give the product development department more time to work with their own issues and identify needs and problems in order to be more proactive.

Interviewee D explained that the technology development in the aero engine industry drives the products towards longer lifespans and also longer intervals between inspections of life limited components in order to increase the availability of the aircraft engines for the airlines. Since this decreases the repairs, maintenance and spare parts sales, the revenue streams in RRSP contracts are also decreasing. The OEMs have found another way to

generate revenue and have started to charge for their products per availability hours. This affects the partners and suppliers business models as well.

Summary of interview material

The first category consists of two parts, issues with the current business model and drivers for change. The headline has been split up to these two parts to structure the summarization. The summarizations are presented in Table 13 and Table 14.

Table 13 - Summarized table of findings: Issues with the current business model

Issues with the current business model	Explanation	Source
Limited information and data availability	VAC's access to information and data from OEMs is typically limited.	A, B, C, D, I, L
Precarious risks	The lack of information and data makes risk taking hazardous for VAC since predicting what happens in the future is hard without information and data, especially when conditions within a contract can change anytime.	C
Low revenue stream control	VAC has limited control over the revenue streams that are created in RRSP-programs since the revenues are generated from after market, which VAC is not a part of.	D, E, I
Changing contract conditions	The conditions within a sales contract can change after the contract is signed. The changes lead to unexpected costs for parties in the contract, such as VAC.	G, L
Some activities does not generate revenue	After a contract is signed an actor can be obliged to make changes due to changed contract conditions and some of the activities that regards the changes may not generate additional revenue, only additional costs.	C, G, K, L
Reactive behavior	The development activities that VAC performs are mainly done on behalf of a client, who has declared specific needs. The behavior where development is made on behalf of needs expressed by client are considered as reactive.	D, G
Product based logic	Historically, VAC offered tangible products. The cultural characteristics of some parts of VAC's workforce are still in tangible products only. This means that the maturity of the workforce is not equal when it comes to offering services or product-service bundled solutions instead of tangible products only.	A, B, L
Sub optimization	Departments within the company do not always strive for the same objectives, which leads to sub optimization.	G
Difficulties in calculating costs for contracts	Since contract conditions can fluctuate after a sales contract is signed, there are difficulties in calculating the costs for activities within the contract.	C
Incomplete consensus	The view of which value VAC creates for their customers differs within the organization.	H, L

There are many indications on which business model problems that exist, but the ones that are most common based on the amount of interviewees that address them are limited information and data availability, some activities doesn't generate revenue, and product based logic.

The summary of the drivers for change follows in Table 14.

Table 14 - Summarized table of findings: Drivers for change

Drivers for change	Explanation	Source
Competitiveness against low cost economies	Adding services to tangible products to create product-bundled solutions is a way to defend companies from competition from low cost economies.	L
Changes are industry driven	The OEMs are the actors that drive the changes towards PSS in the aero engine industry. The rest of actors need to follow the industry trend.	D, E, I, L
OEM demands risk sharing	The OEMs are exposed to great risks in PSS contracts. Hence, the OEMs want to share risk with risk sharing partners.	E, I, L
Development leads to reduced revenue possibilities from aftermarket	Development in the aero engine industry goes towards longer inspection intervals and less maintenance. It is possible that this will lower the revenues over time, since the revenues stream in some engine contracts rely on revenues from aftermarket.	E, I
Difficult to develop value propositions suitable for PSS	VAC finds it difficult to develop a value proposition that is suitable for the market when the OEMs are shifting towards PSS and availability based business models.	E, I

Looking over the drivers for change it can be concluded that the most common view on why change is needed is because of that the industry is driving the change towards PSS.

5.2.2 RQ2. Value creation in the aero engine supply chain

The findings that regard value creation are presented under this headline. First, the findings about value creation in the aero engine supply chain from the workshop are presented and then findings about VAC's competitive advantages from interviews are presented to dig deeper into VAC's value creation.

Findings from workshop

The first step in assignment one where that the groups should describe which actors are in the commercial aero-engine supply chain and after that map the value streams in-between these actors. Both groups drew up a picture where VAC was a centre actor of the supply chain, which presents a viewpoint where VACs offering is a centre point of the aero engine supply chain. The actors that the two groups identified and how they presented them in relation to each other is presented in Figure 15 and 16.

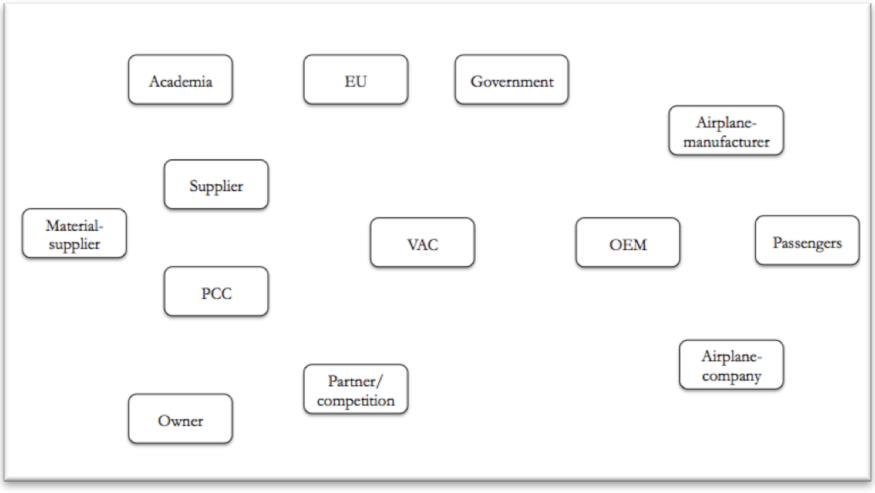

Figure 15 – Actors in aero engine supply chain from workshop assignment 1 by team 1

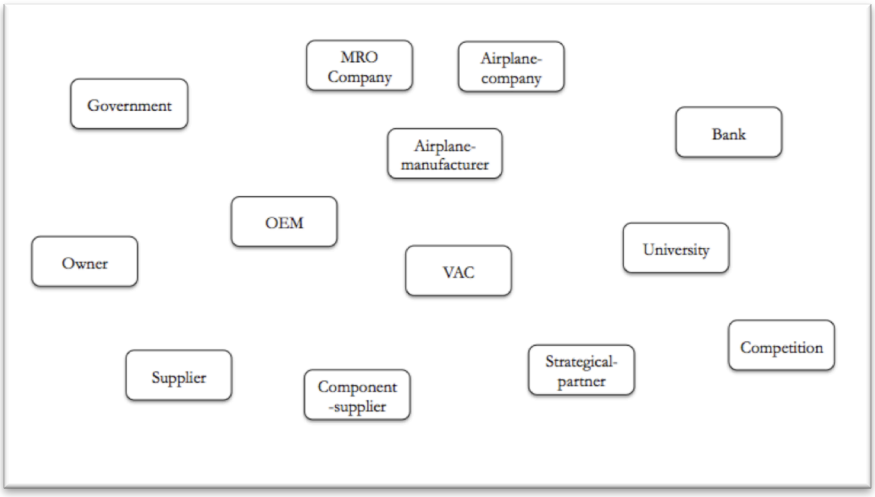

Figure 16 - Actors in aero engine supply chain from workshop assignment 1 by team 2

When producing these pictures there were a lot of different value streams between the different actors. This thesis is focusing on how VAC can design and develop their value proposition and that is why the data presentation is focused on value streams that are connected to VAC but also between other actors that are in contact with VAC's products and services. These actors are OEM, MRO company (maintenance & repairs), airline, airplane developer, and passenger. Both group presented solutions where the following values were delivered by VAC to different actors in today's engine programs.

The value streams that the two groups identified between the actors in the supply chain are presented in Table 15. There are many value streams between VAC and OEM and in order to explain the value streams more in detail a summarized text is presented beneath the table.

Table 15 - Value streams, as is, assignment 1.

Value delivered from	Value delivered to	Value delivered	Value received
VAC	**OEM**	Risk sharing	Requirements
		Flexibility	Money
		Product support	
		Component (product)	
		Product development	
		Entry fee (motor engine programs)	
		Knowledge	
		Partnership	
		Lightweight technology	
		Creates competition with strategic material suppliers	
		Good integrator	
		Engine mount developer and integrator	
VAC	**Owner**	Revenue	Requirements
VAC	**University**	Case-studies	Competency
		Challenging tasks	Capability
		Recruitment needs	Research

Value delivered from	Value delivered to	Value delivered	Value received
VAC	**Airplane developer**	Integration and installation of engine mounts	
MRO-Company	**OEM**	Maintenance and overhaul	
MRO-Company	**Airline**	Maintenance and overhaul	
OEM	**Airline**	Engine	
		Availability	
		Performance	
Airplane developer	**Airline**	Airplane	
Airplane developer	**Passenger**	Movement from A → B	Revenues from tickets

Value streams between VAC – OEM
VAC delivers components to the OEM via RRSP programs. Because of the RRSP program VAC is a risk-sharing partner that buys into the program via an entry fee. In the program VAC delivers parts, product development, knowledge, and product support. The technological knowledge and development is a basis for that VAC can deliver lightweight products, which is valuable for the OEM because weight is a very important factor in engine performance. Because of the fact that VAC is a small company they can be very flexible and can to a large extent meet new demands from the customer in the development phase. Since VAC produces components that many of the OEMs also produce VAC helps to create a larger competition for producers of moulding goods.

Findings from interviews
Interviewee L explains that today VAC is competing with nearly all the actors in the aero engine value chain. They are competitors to their customers as well as suppliers. The direct competitors are all on a higher system level than VAC, which means that they are taking responsibility for a greater part of the engine than VAC.

The viewpoints of VAC's competitive advantage differ within the company. For example, Interviewee I explains that VAC has today competitive advantage in their technology development that are in the front of the industry where lightweight of the components is one of the strongest competitive advantages. VAC is also a great risk-sharing partner and has several different risk and revenue programs that have worked out for all of the involved entities. This creates evidence for experience in theses type of programs. VAC has core competencies within the products that are produced at VAC and this is crucial in order to be in the technological cutting edge. (Interviewee I)

The most common description of VAC's competitive advantage is; here explained by interviewee H. Today VAC is risk and revenue sharing partner where VAC offers (except for the tangible product): Risk sharing, risk reduction, finance, and development. The capability to offer a full solution to VAC's customers is probably the greatest competitive advantage. VAC is not competitive enough in pure manufacturing with respect to costs to be able to offer that service alone. Interview J explains it as: A great competitive advantage that VAC has is that they are capable of taking responsible for the whole development and producing stages for the parts that they produce in a program by themselves.

Interviewee J continues to explain that another competitive advantage is the size of the company. Since it is a relatively small company VAC has the ability to handle projects effectively. The interviewee argues that VAC doesn't have a competitive advantage in low cost manufacturing. It is the whole solution, partnering, that is VAC's competitive advantage.

Another common view of VAC competitive advantage is its ability to produce lightweight products and to some extent enhanced performance of the engine because of the parts. Since lightweight is extremely important in the aero engine industry because a few extra kilos on the engine can result in that the aircraft in the end can't transport any load at all.

Interviewee L explains that VAC is economical capable to be a risk sharing partner because partly of their product mix which creates possible revenue streams from different products in different stages of the product life cycle. Interviewee L continues to explain that VAC is a strong actor because of their capabilities and competencies around their products. VAC is in the industry cutting edge. This is because that VAC has a well-established infrastructure and is capable of taking care of development and production of the parts of the engine they get in the program.

Summary of interview material
There are many viewpoints on what competitive factors may be. This is visualized in a summarization table for the competitive advantages in Table 16. What can be concluded of this is that there are not only tangible products that make the competitive advantage, there are services as well.

Table 16 - Summarized table of findings: Examples of competitive factors

Competitive advantages	Explanation	Source
Development, technologies and manufacturing	• Cutting edge technologies • Technology knowledge • Lightweight constructions • Responsibility for the whole development process, from idea to manufacturing • Industry experience	G, H, I, J
Risk sharing partner	• Risk sharing • Risk reduction • Finance	H, I
Full solution	• Development, technologies and manufacturing • Risk sharing partner	H, J

5.2.3 RQ3. Thoughts about a future value proposition
The findings about thoughts regarding future value propositions are collected from interviews and assignment 2 from the workshop.

Findings from interviews
Interviewee I argues that another way of doing business in the aero engine market, except for RRSPs, is joint ventures. This is something that VAC not is involved in today but the industry is starting to mature to the thought of creating joint ventures around engine programs in order to make for example information transferring easier. Interviewee L continues on the same topic and describes that VAC are discussing a joint venture together with one of the OEMs as a solution for a future business alliance. This would simplify a lot for VAC. A joint venture would create opportunities to actually be part owner of the engine data, which is crucial for being proactive and to have a well-established PSS

contract. At the same time as a joint venture should create opportunities for VAC it would create obstacles since they are partners to all of the OEMs in the aero engine industry. If VAC would be part of an joint venture around an engine they would be a direct competitor to their customer, another OEM that sells engine to the same aircraft that the joint ventures designs engines for. Is this possible at all? When setting up a joint venture VAC needs to decide which OEMs they can work with and which they can't? This will increase the risk, since the risk is very low today when they deliver parts to all of the competitors in the market.

If data could be shared interviewee D explains that proactive product development could be offered as a service in a future business model. Instead of making development when a task is provided by a client or partner, which is considered as a reactive behavior, development could be made through making own investigations on possible potentialities. These potentialities could then be sold to the OEM, but in order to do this a way to charge for the development must be found.

The interviewee I recommends that VAC needs to be better in developing technologies for the market and just because it can be made. VAC has great competencies but they are not always market focused. (Interviewee I)

Interviewee L explains that the information streams are a key to PSS solutions. The necessity to have control over the engine data is crucial in order to offer PSS contracts in the aero engine industry. A problem that arises for a supplier in risk and revenue programs is that VAC is not in control over the data and information streams. In order to be an efficient PSS actor you need to have control over data streams, which leads to that the supplier can be proactive and not reactive. A PSS contract cannot be based on reactive solutions.

Interviewee L thinks that the key to a better business situation is a culture change at VAC from engineering to a sales culture. Capabilities around the soft products and product-service solutions needs to be developed in order to sell what VAC can produce. VAC needs to identify what value they deliver and to whom. VAC also needs to identify whom they are competing with and on which grounds.

Interviewee E argues that one alternative is to expand the product portfolio and be able to take a greater share of the RRSP. Another alternative would be to develop methods to be able to offer higher system solutions and as a result be able to take larger shares of the RRSP programs. The interviewee sees great possibilities in offering LTS as a service in the engine programs. With the LTS service it is possible to have longer intervals between the maintenance and overhauls and hence less cost of these services. A revenue stream structure could be that VAC takes a percentage of the reduction in cost.

Interviewee A argues that to be able to share data between different actors is very important for establishing contracts. This is also a factor when a PSS relation in the commercial engine sector is about to be entered. It is important that the information that all partners involved in the program need to be able to make the product features sustainable during usage is defined already by the formation of the contract. Furthermore, information about how to use the products (e.g. user manuals, maintenance plans, surveillance and overhaul) needs to be provided to the customer, since the product must be used as it was supposed to in order to maintain the features that have been promised in the contract. There must also be clear interface between provider and customer.

Interviewee K argues that it does not matter what type of business model the OEM has with its customers, since it does not affect the relation that VAC has with the OEM. The revenue streams between VAC and the OEM are set up in different contracts and even if there is an availability-based contract between the OEM and the customer there can be a

RRSP deal between the OEM and VAC and the other suppliers. Interviewee K means that what matters is whether or not VAC is a part of the aftermarket or not, this mean that the question is about if VAC should be a part of the lifetime deal in the motor program or not.

Summary of interview material

A summary of information about employees' thoughts about future business models is presented in Table 17.

Table 17 - Summarized table of findings: Thoughts about a future business model

Thoughts about a future business model	Explanation	Source
Joint ventures	• Joint venture is a form of partnership that is discussed in the aero engine industry as a future form of business alliance. • Joint venture would make it easier for VAC in terms of information and data sharing, since the joint venture owns all engine data and information instead of the OEM alone. • A joint venture could possibly make the competitive situation even more complex, since taking part in a joint venture for a commercial engine would make VAC a direct competitor to other OEMs.	I, L
Data and information access	• Improved information and data access through sharing between different actors is crucial in PSS contracts. • A PSS contract could mean that suppliers, partners and OEMs could be responsible for inspections, maintenance and repairs. Access to information and data is important to be able to minimize risks and to be proactive.	A, D, L
Proactive development	• Proactive development is a way to minimize issues and complications with engines. This is because proactive means developing solutions for possible sources of problems before the hazard. • Proactive development does also mean developing solutions for the customer's demands that have not been realized by the customer yet.	D, G
Market driven development	• Market driven development means that development activities should be performed with a market focus. Development should not be made because the company can. Instead development should be made since a possible customer could make use of the product.	I
Cultural changes	• The strong company culture where tangible products are in focus is changed towards product and service development.	L
Decision about being a part of the after market or not	• A decision must be made regarding if VAC should be a part of the aftermarket or not.	K

Findings from workshop

In the second step in the workshop the participants drew up a "dream" scenario around future engine programs. The two groups started of with identify which the actors were in this "dream" scenario and then how they collaborated. New types of relationships as well as new possible value propositions between different actors were identified in assignment 2. The result is presented separately for the two groups in Figure 17 and 18.

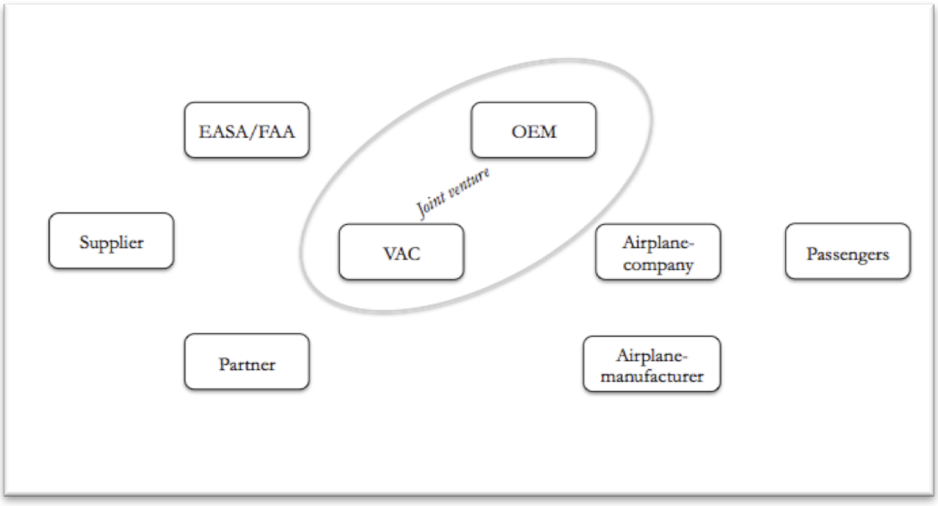

Figure 17 - Actors in "dream" scenario in aero engine from workshop assignment 2 by team 2.

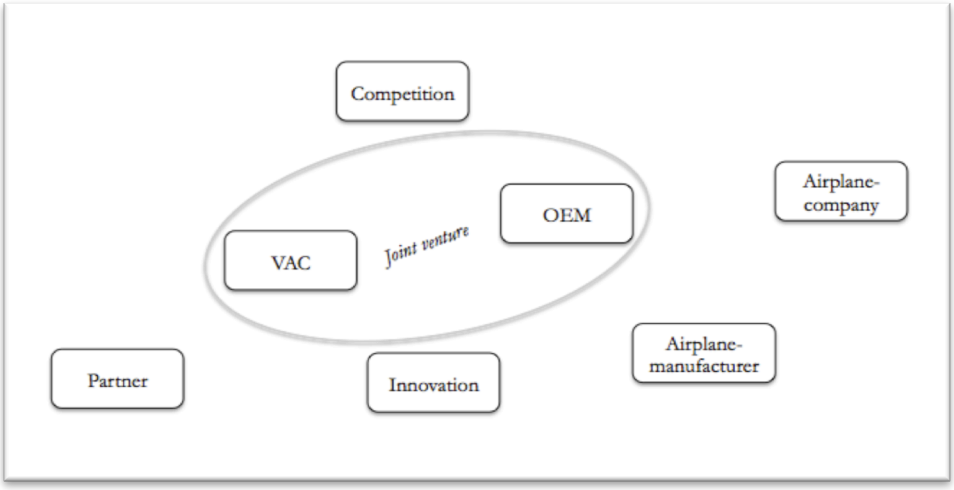

Figure 18 - Actors in "dream" scenario in aero engine from workshop assignment 2 by team 2.

When the actors were set up the participants started mapping the value streams. The values are presented group wise Table 18.

Table 18 - Value streams in "dream" scenario, assignment 2

Value delivered from	Value delivered to	Value delivered	Value received
VAC	OEM	Life Tracking System (LTS)	Increased information
		Joint venture	Joint venture
		Greater information sharing	Larger share of program value
		Welding technology	
		Licenses	
		Composite technology	
		Low cost product	
		Module design	
		Joint venture	
		Integration (system supply)	
	Airline company (via Joint venture with OEM)	Volvo inside	In service information about VACs parts
		Differentiated value offerings	Recycling of parts/engines
		More flight hours (via LTS)	
		Better product optimization	
		New product development possibilities (Open router)	
		Life cycle cost optimization	
		Life cycle responsibility	
	Airplane developer	Acoustic technology	
		Engine mounts	
	Partners (suppliers)	Risk sharing	
	Passengers (via Joint venture with OEM)	"Volvo inside"	
		Travel/fly greener	
	New innovations towards various stakeholders	Upgradability	
		Change management	

The values that the two groups identified would stream between the actors in the supply chain in the "dream scenario" are presented in Table 18. Many values streams were identified between some of the actors and a describing text is presented below to provide understanding of these values in terms of what they mean.

*Value streams between VAC – OEM/*Innovation *(In a joint venture)*
In short the participants believed that a joint venture would create a platform where information could be shared. When VAC can be a part of the information sharing to a greater extent this would create opportunities for product development where upgradeability and functionality could be developed. The platform would also create

opportunities for VAC can use their capabilities within welding and composite technology to a greater extent.

Value streams between Joint venture – Airline Company
A joint venture would present opportunities for VAC like better product optimization due to greater information about the products when in use. It would also create possibilities for the joint venture to do life cycle cost optimizations through life cycle responsibility. This could for example reduce fuel costs for the airline. One service that VAC could offer, which would contribute to life cycle cost optimization, is the life tracking system (LTS). LTS monitors the engine usage sophistically, which allows extended lifetime of components and more accurate suggestions to when maintenance is needed. This would result in more flight hours for the airline, since it would extend inspection and maintenance intervals.

One of the groups presented the idea of marketing VAC parts and service towards the Airline as "Volvo inside" in the engine programs. If VAC could communicate that engines with VAC parts have certain advantages that others haven't, it would result in a market pull strategy where the customer could demand engines that contain parts from VAC.

Another communication issue that was brought forward was the difficulties around presenting what VAC actually is delivering. Today issues exist in that VAC don't get paid for everything that is done. VAC feels that a lot of development and extra features are delivered to the customer without receiving anything in return for the added value. A solution to this would be to communicate differentiated value offerings where the product portfolio is offered through a number of value propositions. This was visualized as the difference between the two cars Volvo 240 L and Volvo 240 GLS, where the 240 L was a standard model without any extra features and the 240 GLS had all optional extra that was available. Similarly, VAC could differentiate their product portfolio where a standard offer includes less development and extra services to a lower cost while a more expensive offer includes more development and extra services.

Value streams between VAC (through JV) - Airplane developer
VAC has the ability to deliver acoustic technology to airplane developer. There are many airports that have noise requirements during certain hours during the day. Can the aircrafts start and land while making noise that is under the restrictions it creates great value for the aircraft developer and the airline.

The workshop groups recognized that delivering engine mounts to aircraft developers would be included in a dream scenario. They saw possibilities in that VAC could act as a mount supplier for both aircraft developers, who deliver aircrafts, and OEMs/joint ventures, who deliver the engines for the aircraft. This would result in greater integration between the actors in the supply chain. The engine mounts could also be standardized, so that different engines could be mounted on an aircraft during the aircraft lifetime. An airline would hence be able to change the type of engine on the aircraft without making extensive changes on the aircraft.

Value streams between Joint venture – Passengers
"Volvo inside" was previously described as a market pull strategy towards airlines. With the same arguments, VAC could create the same pull demand for their parts if they would communicate towards passengers as well.

One of the groups identified that the environmental awareness among people could make an application where passengers can monitor their environmental footprint interesting for the airlines. The application could be called "Fly Greener", as a further development of Volvo's environmental community "Commute Greener" (Volvo Group, Commute

Greener)[6], and could be displayed in the aircraft's existing entertainment system in order to show the passenger that this airline is particularly environmental friendly.

Innovation
Change management is an activity that could be introduced in the aero engine industry and could be useful for various actors in the industry. Change management means handling the changes that are needed when the type of engine is exchanged, which could mean everything from identifying needs for change or developing products needed for the change to setting up contacts with other actors that are needed after the change, such as a new maintenance and inspection provider.

Through products like standardized engine mounts and change management could upgradability be introduced to the industry. Today, the same type of engine is usually used during the whole aircraft lifetime. This would not be necessity with standardized engine mounts and change management, since it would enable engine changes.

5.2.4 RQ4. Quality work at VAC

The quality work at Volvo Aero is very product focused, since the business at VAC traditionally has been focused on manufacturing. A quality management system is under development, where routines for how work activities should be performed are defined. But evaluating value proposition and if the value delivered to customers corresponds to the customer's expectations. (Interviewee B)

The objective of the quality management system, under development at VAC, is a product development process that is performed systematically, but without inhibiting the creative development with rules and bureaucracy. (Interviewee C)

Summary of interview material
Table 19 summarizes the interview material from RQ4.

Table 19 - Summarized table of findings: Quality work at VAC

Quality work at VAC	Explanation	Source
Product focused quality	The view of quality at VAC is very product focused right now. The methods for ensuring that products meet the requirements set by customers and industry regulations are well developed.	B
Quality management system	A quality management system is under development to secure the quality of different departments and functions at VAC, for example product development.	C

[6] Volvo Group, Commute Greener. URL: http://www.volvogroup.com/GROUP/GLOBAL/EN-GB/PRODUCTSANDSERVICES/INDUSTRIALITSOLUTIONS/COMMUTE_GREENER/Pages/commute_greener.aspx (Collected 2012-05-22)

6. Analysis

This chapter includes the analysis of the empirical information in relation to the theoretical framework presented earlier. The analysis chapter is divided into one section for each research question, where RQ1, RQ2, RQ3 and RQ4, respectively, are examined.

The aim with this analysis chapter is twofold. First, data is analysed and compared to theory according to the pattern matching analysis method described in chapter 4 in order to provide answers to the research questions. Second, the analysis section for each research questions ends with a summary where the question is answered. The answers to the research questions are a basis for the answering the research problem, which is done in chapter 7.

6.1 RQ1: Which are the problems with the existing business model for a product and technology supplier?

The problems identified with the existing business model that are presented in data presentation chapter 5.2.1 are analysed in this section. These problems have been categorized into four different categories in order to bring problems that are connected to each other together. The categorization is also made in order to build a basis for a list of requirements, which is the answer for RQ1 and from which a new value proposition could be designed. The categories are:

Drivers for change
Drivers for change are researched in order to find information on why suppliers need to change their business models. This is done by finding problems with the business model today, but also by investigating what drivers for change that are realized at VAC. Issues related to why the VAC needs to change their BM are categorized here.

Lack of information
The problems that were categorized into the lack of information category were in some way connected to lack of information between the supplier and their customers.

Contract structure
The way that contracts are formed in today and what the contracts include create problems for VAC. The problems related to contractual issues are categorized in this section.

Need for internal consensus
There is a challenge to unify the aims and goals through the whole organization. Problems related to this topic are categorized in this section.

6.1.1 Drivers for change

One application of finding the problems with the existing business model is to understand why a change is needed. This provides valuable information for upcoming analysis chapters.

The drivers for change in the aero engine industry are most commonly described as that the industry has driven the change. The first actors to move towards PSS solutions did it to gain competitive advantage against low cost economies. The rest of the actors followed, which makes the change industry driven. One conclusion is that the suppliers to OEMs are moving towards embracing PSS solutions because they have to since the OEMs demand it.

This demanded change from the OEMs' side is related to the principal-agent theory, where the principal needs to be accounted for the actor's behalf in the agreement against the end customer. In order to be in control the OEM demand the supplier to become an RRSP-partner in order to share the risks to be able to offer the customer what is promised.

Figure 19 shows how many interviewees who have addressed the different drivers for change that were identified.

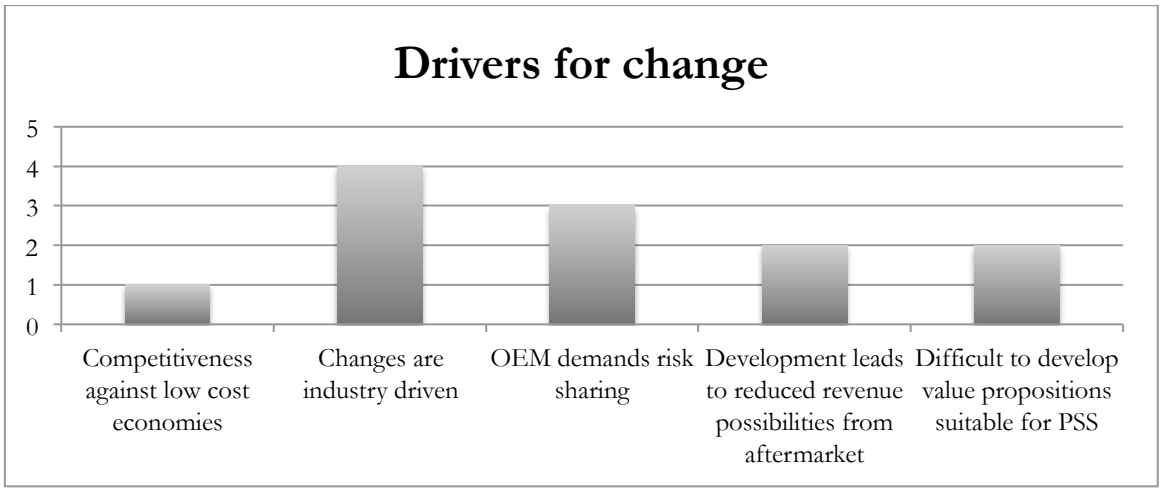

Figure 19 - Drivers for change in the aero engine industry

The principal agent dilemma in the aero engine industry

Buxton and MacCarthy (2005) present the principal-agent problem in the aero engine industry. They describe that trust amongst the aero engine industry partners is a complex concept. The number of prospective partners is normally limited and suppliers can be contracted to each of the main OEMs and may even be supplying similar parts to all OEMs. Studies show that aero engine industry collaboration is operating in a low trust environment (Jordan & Lowe, 2004) and is therefore paradoxical to the 'optimal' environment for successful collaborations to develop (Faulkner, 1995). Buxton and MacCarthy (2005) continues to argue that collaboration is essential both due to the cost and risks of the aero engine industry and due to the complex technologies involved which means that it is unlikely that any OEM could undertake engine development by themselves, lacking the expertise (Jordan & Lowe, 2004).

Buxton and MacCarthy (2005) means describes the necessity of understanding and building high performing value chains in the aero engine industry because of the collaboration necessary, both because of the technological complexity and the necessity of the risk sharing.

The principal-agent problem in the aero engine industry relates to the complications that arise when the OEM partners with a supplier. The OEM will control the information stream in order to control the business relationship towards the customer. This affects the information that the supplier can access, which affects the level involvement for the supplier in the business relationship. As long as a principal-agent relationship is between the supplier and the OEM it is hard for the supplier to develop a successful PSS business model in this environment.

This last statement leads us in to the problems with the business model used toady.

6.1.2 Lack of information

The problems that were categorized into the lack of information category were in some way connected to lack of information between the supplier/partner and their customers. What the needed information regards and also the origin vary between the different problems.

The most commonly described problem within the lack of information category is 'limited demand and data availability'. This problem is an overall problem that addresses typical limitations in information access for VAC. Information does in this case mean all kinds of

information and data that is connected to an engine program, without any further definitions. This means that the OEM owns all of the information and data in an engine program and want to share information to a minimum extent.

The need for information is also supported by PSS theory. Lockett et al. (2011) found in their study that information sharing between actors in a PSS supply chain is crucial when PSS business models are embraced and also that closer relationships require higher information sharing levels. In markets with high-technology products, like the aero engine industry, is information sharing even more important (Johnson & Mena, 2008; Wuyts et al., 2004).

Figure 20 shows how many of the interviewees who have addressed the problems that are categorized into this category.

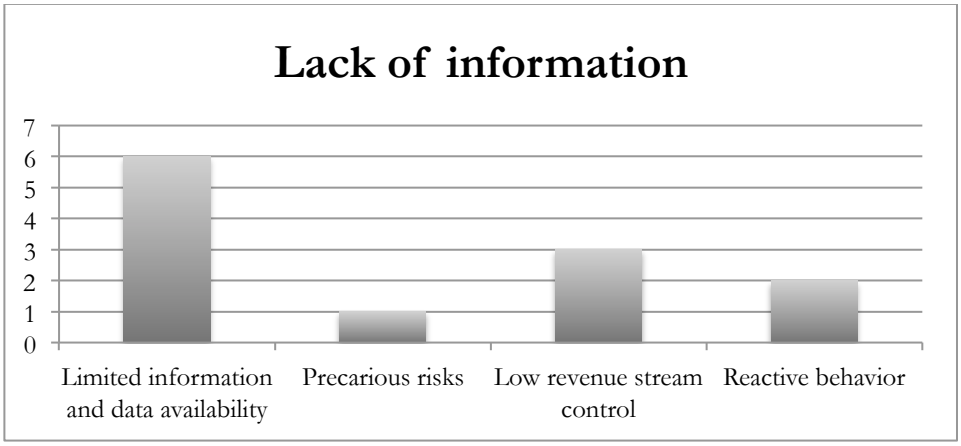

Figure 20 - Lack of information in the aero engine industry

Since 'limited information and data availability' was most commonly occurring in the interviews, the issue is also in focus in this category. The three other topics can be addressed as concerns but are not as commonly recognized. Nevertheless, the rest of topics' connection to this category is explained below.

Precarious risks
Precarious risks are an effect of lack of information, since information is a precondition for anticipating risks and also avoiding them. The information in this matter regards all kinds of information from any actor that affect VAC in some way.

Low revenue control
Low revenue stream control is connected to lack of information since it prevents VAC from contributing to the aftermarket to the extent that is possible. With unlimited information supply VAC could for example identify needs, monitor engine health or develop various solutions that would improve engines that are already running.

In RRSP-programs VAC's revenue stream is dependent on the OEM's and the whole programs revenue stream. In programs like this there is of great interest for all actors involved to ensure that the program's revenue stream is functioning, since the program's revenue stream also generates revenue for reach actor. For example, since development in aero engine industry, which were discussed in section 6.1.1, leads to decreased revenue streams in the long run there is of interest for all involved actors to ensure that the payment method is sufficient and also to modify it if needed in order to make it fit new circumstances like changed technological conditions.

Reactive behavior
Reactive behavior means that VAC only performs development activities on behalf of a client who has declared specific needs. With more information VAC could initiate

developments projects on their own to prevent issues from creating hazards for the user. Information could in this matter mean engine usage statistics, error messages, repair statistics, et cetera.

6.1.3 Contract structure

The way that contracts are formed right now and what the contracts include create problems for VAC. Why the problems that are categorized under contract structure fit under this headline and also how they are connected is explained below. Figure 21 shows how many interviewees who have addressed these problems and the issue that was most commonly described is the "Some activities does not generate revenue one". Two other issues were found in two separate interviews and these have been handled as concerns rather than concrete problems because of contract structures.

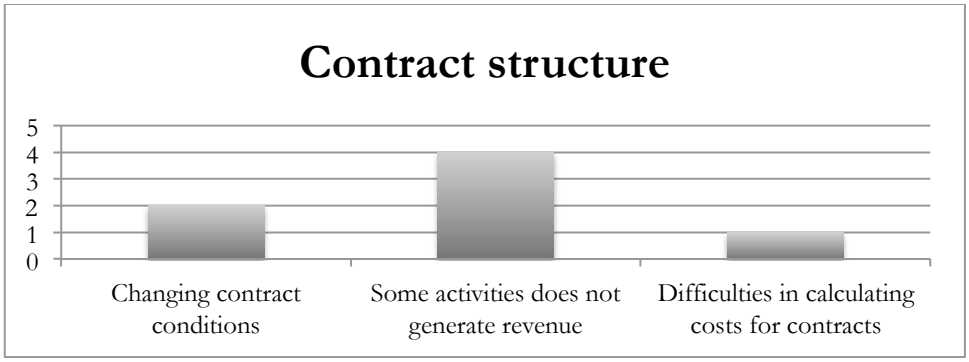

Figure 21 - Contract structure analysis

Changing contract conditions

All conditions in a contract are not completely set when contracts are signed. Conditions and customer demands can change after contracts are signed, which leads to extra activities in order to meet these demands. Interviews have shown that far from all extra activities that occur when contract conditions change leads to additional revenue, which leads into the next problem.

Some activities does not generate revenue

When an actor is obliged to make changes and hence extra activities, the costs are increased. When additional revenue for extra activities is missing but the costs are still present, the profitability for the delivering company is decreased. VAC realizes that they "only" get paid the value for the parts they deliver even though a lot of extra work and value added activities are put in to the program. For example, the value of the parts is set up early in a development program. During VAC's product development phase new restrictions could be added to the contract, which increases the value delivered to customer and the costs for VAC but with little or no revenue in return.

Difficulties in calculating costs for contracts

Calculation the costs for a contract is difficult when contract conditions can fluctuate and costs caused by these fluctuations may be present.

Summary

These three problems are connected to how contracts are structured and that changing conditions and demands are a part of contracts as they look right now. When changes in contracts occur there is a need for weighing the costs for a fulfilled demand against the increased satisfaction to see if the increased satisfaction are worth the costs. VAC is busy with fulfilling customers' changing demands and less busy with calculating business cases on the activities that are connected to these changes. This could lead to that VAC puts a large workload on fulfilling a demand that only makes the customer a little more satisfied.

6.1.4 Need for internal consensus

There is a challenge to unify the aims and goals through the whole organization. In addition, the strong product based company culture makes some people believe that tangible products are in focus, but in reality product based focus belongs to the past and customer values achieved by products and services combined are in focus instead. When the company works as one unit towards the same objectives is internal consensus reached. Why the problems in this category are connected to internal consensus is explained below. Figure 22 shows how many interviewees who have addressed these problems.

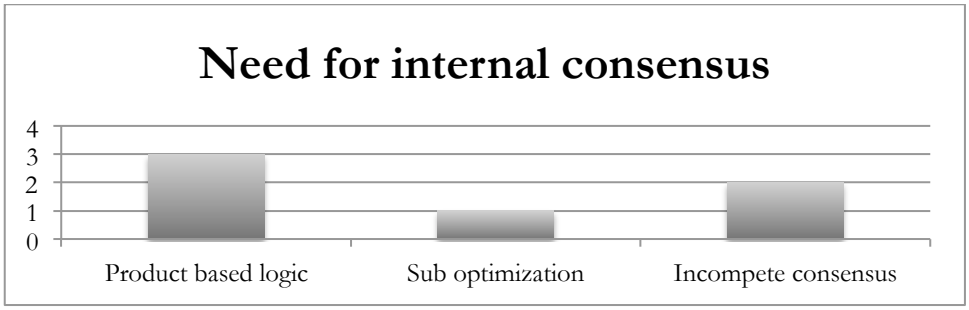

Figure 22 - Need for internal consensus analysis

Product based logic

Focus on tangible products belongs to the past, which some parts of VAC have realized but not all of them. Hence, the whole company does not have a unified focus and there is a need for internal consensus.

Sub optimization

Interviews have shown that all departments within VAC do not always strive for the same objectives, which means that sub optimization exists. Hence, there is a need for internal consensus in order to make all departments strive for the same objectives.

Incomplete consensus

A unified view regarding which values that VAC creates for their customers is not present through the whole organization.

Summary

The interviews have shown that both the internal culture and the objectives within separate departments make it hard for VAC to follow the strategy that has been set. In order to follow the strategy that has been set, the company needs to unify and thereby create internal consensus.

Lockett et al. (2011) ascertains that there is a need for incentives alignment in a PSS supply chain. But in order to do this, the actors within the supply chain need to align their incentives internally first. In order to do this, internal consensus needs to be reached at VAC.

6.1.6 List of requirements and answer to RQ1

This section aim to summarize the analysis of data for RQ1 in order to provide an answer to RQ1:

Which are the problems with the existing business model for a product and technology supplier when OEMs start to offer PSS solutions?

The objective of first research question is to identify the issues with the business model used today in order to find which obstacles that needs to be overcome when designing a new one. The issues found in this section that most interviewees have addressed are presented below.

1. VAC is in need of sufficient information and data about their products and the engine programs they are in.
2. VAC needs to find contractual structures that allow them to get paid for the value they deliver and only parts of it.
    a. Contracts need to be formed so that VAC can utilize their competences and also receive revenue for the activities performed.
3. VAC needs to address and change their product based logic and adapt to a more business based logic and culture.
    a. Internal incentives for the whole company need to be aligned towards the same objectives.

How these issues are addressed in the designing of new value propositions is explained in the analysis of RQ3.

6.2 RQ2: How can the value creation in a PSS supply chain be characterized?

The second research question handles how value creation in a PSS supply chain can be characterized and this is done from a supplier's point of view. To be able to design a new value proposition the supplier needs to understand which values that are delivered to their customers today, but they do also need to know what other value streams that are downstream in the supply chain in order to know how and in what way their value proposition can be developed.

In this section VACs competitive advantage is analysed first and after that assignment 2 from the workshop. These analyses end up with a list of findings that characterize the value creation in the aero engine supply chain. This characterization is also the answer for RQ2, which acts like a basis for VAC when new value propositions that are suitable for PSS supply chains are designed. The analysis of RQ3 handles suggestions for how new value propositions should be designed.

6.2.1 Competitive advantages

During the unstructured interviews many different opinions and suggestions were expressed regarding VAC competitive advantages. All of the different views have been categorized into three categories, which are shown below. The third category, full solution offering, is a collaboration of the other two categories. This data is collected from section 5.2.2.

Development, technologies and manufacturing
- *Cutting edge technologies*
- *Technology knowledge*
- *Lightweight constructions*
- *Responsibility for the whole development process, from idea to manufacturing*
- *Industry experience*

Risk sharing partner
- *Risk sharing*
- *Risk reduction*
- *Strong financial structure*

Full solution offering
- *Development, technologies and manufacturing*
- *Risk sharing partner*

When looking at the competitive advantages, it becomes obvious that the product-based logic that exists in VAC does not reflect the reality of their competitive structure. Pure manufacturing is rather a part of the full solution than a main competitive advantage.

However, their products and capabilities to construct their technological advanced products are one of the parts that build their competitive advantage.

Risk sharing, which is the other part of the full solution offering, is an offer that OEMs have shown an increased demand for due to increased risks for OEMs when PSS is embraced. Even though VAC has a manufacturing tradition and a great experience from aero engine components and technologies, the shift towards PSS means that risk sharing and full solution deserve more attention.

6.2.2 VRIN analysis

A VRIN analysis is used to examine which of the resources that have been identified as competitive advantages that actually are core competences for VAC. The core competency is found by classifying resources on four different criteria. These criteria are valuable, rare, inimitable and, non-substitutional.

Company specific resources and capabilities are crucial in explaining the company's performance. The VRIN analysis helps to understand what makes the company unique, why some customers buy from the company, and most important, what the key success factors are that the company has. It is also a good model to have as an input to the strength and weaknesses in a SWOT analysis.

The evaluation is made from the VAC's point of view with help from interview and workshop data and regards the specific components, technologies and services that VAC offer. The four criteria are explained below:

- **Valuable** – The resource is outperforming the competitors or reducing our own weakness. Since all resources that are brought up here are identified by VAC as competitive advantages the resources can also be looked upon as valuable resources that the customer appreciates from the suppliers point of view. All resources are thereby classified as valuable. The resources that do not fulfill any other criteria than valuable are described as 'competitive parities', but such resources don't exist in this analysis.
- **Rare** – Customers are seeing benefits from the resources, which are possessed by few competitors if any. The resources that do not fulfill any other criteria than valuable and rare are described as 'temporary competitive advantages'.
- **Inimitable** – Other firms cannot obtain the resources or must obtain them at significantly higher costs than we did. The resources that do not fulfill any other criteria than valuable, rare, and inimitable are described as 'temporary competitive advantages'.
- **Non-substitutable** – The resources cannot be substituted. The resources that fulfill all criteria are described as 'sustainable competitive advantages'.

All competitive advantages that were presented in section 6.2.1 were used as resources for evaluation in the VRIN analysis. Motivations to why resources have received certain criteria are given below. It is worth noting that since this study is made from VAC's point of view, the analysis is based on opinions expressed by VAC. The opinions are collected during interviews and workshop. Motivations for each resource are presented below followed by a summary, where all resources together under each headline are classified.

Development, technologies and manufacturing

Technology knowledge – The technology level of companies in the aero engine industry is typically high, which prevents this resource from being rare. Hence, it is valuable.

Cutting edge technologies – Even though the general technology level in aero engine companies is typically high there are few companies that have cutting edge technologies within VAC's area, which makes the resource rare. But the fact that making technology research in order

to reach cutting edge technology is both resource consuming and costly makes the resource inimitable as well.

Lightweight constructions – Few actors possess cutting edge technologies and almost none are competing in VAC's specific product segment. Therefore, there are few companies that can reduce the component weight in VAC's component segment to the extent that VAC can. This makes this resource inimitable.

Responsibility for the whole development process, from idea to manufacturing – Few companies possess capabilities for driving the whole process from development to manufacturing of components in VAC's segment with the same quality and technological level as VAC. Other companies could develop or purchase capabilities that are missing in the process, but it would lead to significantly increased costs.

Industry experience – Most actors have been active in the industry for a long time and have thereby got industry experience. This prevents this capability from being rare and industry experience is hence valuable.

Summary – The mix of capabilities within development, technologies and manufacturing that VAC has is not only rare, but also inimitable. This is mainly because VAC is an established and rather lonely actor within their products segment. Other actors could start competing with similar products but probably to higher costs, since VAC has advantages in both technology and experience.

Risk sharing partner

Risk sharing/Risk reduction – Most actors in the aero engine industry can share the risks in an engine program as well as other companies like banks, etcetera. The risks reduction capabilities are also present in most companies in the aero engine industry, since industry experience is widespread. These capabilities are hence valuable, but not rare.

Strong financial structure – VAC has a strong financial structure, which allows them to participate in large engine programs where large financial muscles are required. Our knowledge about other companies' economy is not extensive, and therefore is an assumption made that few companies has the financial muscles since the total amount of companies sized as VAC or larger within the aero engine industry is low. Since a strong financial structure is both time and resource consuming to build, the resource is classified as inimitable.

Summary – Even though the risk sharing and risk reduction capabilities are rather common, there seem to be few companies that OEMs see as potential risk sharing partners with both risk-sharing and risk reducing capabilities combined with strong financial muscles. Risk sharing partner is therefore classified as rare.

Full solution offering

The amount of companies that actors like OEMs would see as potential risk-sharing partners, where risk-sharing activities, product development, and manufacturing are included, are limited. First, 'development, technologies and manufacturing' were found to be inimitable, which makes the amount of companies that could offer this resource very limited. Second, possible risk sharing partners were found to be rare. Finding a company that can offer both these all-embracing resources is hence impossible. This makes the combination of all resources together unique and non-substitutable.

Table 20 visualizes the VRIN analysis and the classification of all resources. Obviously, making a competition with help from only one party does not provide a complete and generalizable picture of the competitive situation. Making this VRIN analysis with the data that is available does however provide rough picture of the competitive situation, from which some conclusions in fact can be made.

Table 20 - VRIN analysis

Resource	**Valuable**	**Rare**	**Inimitable**	**Non-substitunional**	*Competitive implications*
Development, technologies and manufacturing	**+**	**+**	**+**	**-**	**Temporary competitive advantage**
Cutting edge technology	+	+	+	-	Temporary competitive advantage
Technology knowledge	+	-	-	-	Competitive parity
Lightweight constructions	+	+	+	-	Temporary competitive advantage
Responsibility for the whole development process	+	+	+	-	Temporary competitive advantage
Industry experience	+	-	-	-	Competitive parity
Risk sharing partner	**+**	**+**	**-**	**-**	**Temporary competitive advantage**
Risk sharing availability	+	-	-	-	Competitive parity
Risk reduction availability	+	-	-	-	Temporary competitive advantage
Strong financial structure	+	+	+	-	Temporary competitive advantage
Full solution offer	**+**	**+**	**+**	**+**	**Sustainable competitive advantage**
Risk sharing partner	+	+	-	-	Temporary competitive advantage
Development, technologies and manufacturing	+	+	+	-	Temporary competitive advantage

After the VRIN analyze it can be concluded that none of the resources alone is a core competence, since none of the competitive advantages could fulfill all attributes, but the mix of the resources that VAC delivers could be classified as a core competence. Buxton and MacCarthy (2005) describe that it is crucial to have collaborations in the aero-engine sector due to two factors, the technological complexity and the necessity of risk sharing. To conclude this, VAC's competitive edge is the mix of products and services that they offer. It is not just the value of the products they deliver that the customers realize as value in the transaction.

The full solution is valuable since the customer (e.g. OEM) needs to share the risk and get the technologically complex products. This is rare, since the market is oligopolistic with very few competitors. VAC's lightweight technology together with its ability to be a risk sharing partner and their strong financial structure makes their offer inimitable and non-substitutional. OEMs must use actors like VAC to be able to enter the capital-intensive engine programs.

6.2.3 Value creation

The results from the workshop's assignment 1 show that the majority of the value streams that were drawn out were placed between VAC and the OEM. The absence of value streams between the OEM, airplane manufacturer, airline, and passenger is noteworthy, since VAC's products and services are part of their value creation or value-in-use. The absence of value streams could be caused by the attendees' lack of information regarding the actors, but also by their lack of understanding of how they interact with each other to create value. Information about the actors and understanding of how they interact with each other are important to have to be able to develop products and services that create value to these actors or enable them to create value-in-use. This is also confirmed by Lockett et al. (2011), who argue that information sharing is essential in PSS supply chains.

Some of the workshop attendees did also confirm that information and understanding the concerns airplane manufacturers, airlines, and passengers is missing. This is most likely caused by lack of contact with these actors, according to interviewee participants.

Lockett et al. (2011) found in their research that not all actors in a PSS supply chain are positively affected by this system. The actors that had a negative effect were actors that weren't part of the information stream and hence actors that couldn't affect their situation. The degree of information between organizations should be similar to that of the products and services they provide (Slack et al., 2004).

In the workshop and in the interviews there were identified that VAC felt that they weren't in control over the data flow and hence weren't in control over their own situation in the engine programs. In order to have a position that gives VAC the opportunities to be more in control over their own situation in the supply chain the actor who is a supplier needs to be part of the information flow. Furthermore, they conclude that it is important to align the interests of the actors in the supply chain in order to fully deliver what is promised to the customer. In order to go towards a successful PSS supply chain in terms of information exchange Lockett et al. (2011) argue that three things must be recognized by the OEM:

- Suppliers that support the PSS offering should have access to relevant information
- Increased levels of information exchange require changed nature of relationships within the supply network
- Information exchange and the nature of relationships are mutually reinforcing

Lockett et al. (2011) ascertains that there is also a need for incentives alignment in a PSS supply chain. Incentives alignment is in this case needed for all parties within the PSS relation, including partnerships and alliances. The incentives alignment affects both how should be contract designed and information sharing routines as well as main objectives for the PSS relation.

So for VAC to proactively be a part of a PSS relation they need to be integrated into the information flow and all incentives need to be aligned within the actors in the PSS relation. In the workshop during assignment 2 both of the groups identified that to form a joint venture with the OEM would solve the information flow problem and hence put VAC in a position were they proactively could be a part of the PSS relation.

During the workshop the two groups mapped the value flows in the supply chain as it is today. It could be found that all values delivered from VAC were to and through the OEM, which is visualized in Figure 23. Concluded from this is that is the OEM is in control over the value flow and hence are in control over the business situation. With this taken into consideration and that VAC isn't in control over the data information flow makes VAC dependent on the OEM. Since the contractual structures are formed so that VAC doesn't feel that they get paid for all that they deliver shows that the incentives are not aligned in the supply chain as it is formed today.

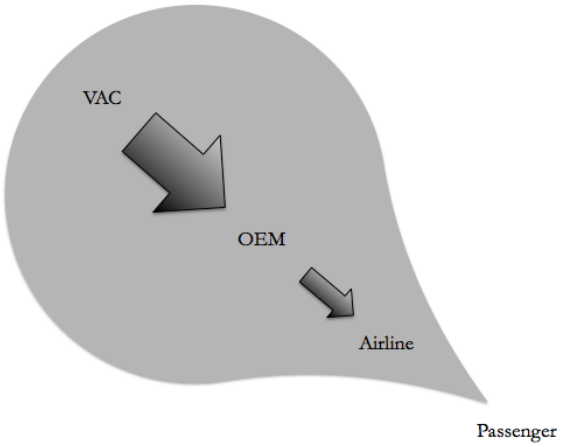

Figure 23 – Value streams in Aero engine industry today

6.2.4 Summary and answer to RQ2

This section aim to summarize the analysis of data for RQ2 in order to provide an answer to RQ2:

How can the value creation in a PSS supply chain be characterized?

It has been shown that the OEM is an important part of the value creation and also managing actor or a driver in the PSS supply chain. A driving OEM is hence a great part of how the value creation is characterized. The OEM is a driver in the supply chain since communication, information flows, value streams from suppliers to customers, and revenue from customer to suppliers flows through the OEM. Which is visualized in Figure 23. OEMs cannot create value by themselves though. Several suppliers and partners are part of the value creation and they act as enablers for the OEM. The suppliers enable OEMs to create value for the customers, which make the suppliers a part of the OEM's value creation.

In drivers for change it was found that the industry is moving towards PSS solutions and hence PSS supply chains. It is also found that OEMs demand risk-sharing activities to a greater extent as a result of PSS supply chains. To make the value creation effective in PSS supply chains are incentives alignment and information sharing needed.

For the OEMs to be able to offer PSS solutions with reasonable risks they need to share the risk with partners, which result in RRSP. Hence, the OEMs are dependent on other actors, which are part of the OEM's value creation process towards customers. It can be said that the OEMs are the owners of the business cases in this industry, since OEMs were found to be the drivers in the industry. But for the business cases to continue to evolve, lower the risk for the OEM and create greater opportunities for the rest of the actor's new alliance forms need to be introduced in the supply chain. As it looks today, all of the suppliers upstream from the OEMs enable them to offer their solutions to customers. All actors in such a supply chain doesn't have their interests aligned, which in many cases prevents the value chain and supply chain from being optimized. Therefore, partnerships that keep all actors involved motivated are needed in order to get a successful PSS supply chain.

The VRIN analysis showed that the most competitive resource for VAC to offer towards OEMs is the full solution with risk sharing partnership, development, technologies and manufacturing.

To summarize how value is created in a PSS supply chain in terms of the aero engine industry:

- The OEM is the driver and the controller of the business models and value creation.
- Most of the upstream actors in the supply chain are enablers for the OEM.
- Value creation through PSS supply chain gets more common in the aero engine industry.
- Activities connected risk sharing occur more frequently in PSS supply chains.
- Information sharing and incentives alignment is crucial in PSS supply chains.
- VAC's strongest competitive advantage is the full solution.

6.3 RQ3: How can the value proposition in business model for a product and technology supplier in a PSS environment be characterized?

RQ3 handles how value proposition for a product and technology supplier in a PSS environment can be characterized. In order to characterize such a value proposition the problems found in RQ1, the possibilities and consideration from RQ2, and theories are taken into consideration.

6.3.1 List of considerations when characterizing new value propositions

Problems found in RQ1:

1. VAC is in need of sufficient information and data about their products and the engine programs they are in.
2. VAC needs to find contractual structures that allow them to get paid for the value they deliver and only parts of it.
    a. Contracts need to be formed so that VAC can utilize their competences and also receive revenue for the activities performed.
3. VAC needs to address and change their product based logic and adapt to a more business based logic and culture.
    a. Internal incentives for the whole company need to be aligned towards the same objectives.

Possibilities and considerations found in RQ2:

- The OEM is the driver and the controller of the business models and value creation.
- Most of the upstream actors in the supply chain are enablers for the OEM.
- Value creation through PSS supply chain gets more common in the aero engine industry.
- Activities connected risk sharing occurs more frequently in PSS supply chains.
- Information sharing and incentives alignment is crucial in PSS supply chains.
- VAC's strongest competitive advantage is the full solution.

To summarize the possibilities and consideration it can be said that in the supply chain when PSS offerings is delivered today the OEM is in control over the business situation and the upstream actors are enablers for the OEM to deliver their PSS solutions to their customers. Found were also that VAC felt that they were in need of information sharing in order to deliver and be a part of the PSS offerings, which points towards that stronger relationships need to be formed. What also points in this direction is that risk sharing is of the great importance when delivering PSS offerings and that it is a high risk to be a part of the risk sharing with low information availability. This points towards that the actors that jointly deliver PSS solutions need to have their incentives inline on order to deliver PSS solutions together.

Information sharing and strategic alliances
Ireland et al. (2009) describes that joint ventures suit uncertain and complex environments where the cooperation should be over a long period of time and the transfer of tacit knowledge is of essence.

Since both theory and empirical findings confirm that joint ventures are suitable for securing sufficient information sharing, it can be concluded that joint ventures should suit VAC when high degrees of information sharing are needed. Empirical findings have also showed that high degree of information sharing is needed for VAC to be able to take part in engine programs where the higher dimensions of PSS value propositions (availability or outcome) are offered. The PSS value propositions by Smith et al. (2011) are presented in Table 21.

Table 21 - Value proposition dimensions Smith et al. (2011: Appendix A)

Value propositions	Attribute and definition
Asset	*Equipment performance*
Recovery	*Technical query resolution, technical variance, equipment repair service*
Availability	*Equipment maintenance service, component forecasting & provision, through-life and obsolescence forecasting & planning recommendations, capability forecasting & planning, equipment operation advice*
Outcome	*Equipment configuration advice for operational and contextual capability*

6.3.2 New value proposition design
In RQ1 problems with the business model used today have been identified and the analysis of RQ2 has been taken up possibilities and consideration when designing a new value propositions.

The analysis of RQ3 focuses on how value propositions could be designed and developed for a product and technology supplier in a PSS environment. As described in the previous section one of the first things that has to be considered when designing new value propositions is that if not stronger relationships between actors in the supply chain are formed, where information can be shared between the actors, the actors can only deliver the lower forms of value propositions in a PSS. The Asset and the Recovery propositions can be offered if data is shared to a low extent, since the needs for deep partnerships is lower. To be able to offer the higher forms of value propositions, Availability and Outcome, data has to be shared in order to proactively develop offerings to customers and to sustain the values that are promised to the customer. Actors that suffer from lack of information can only have a reactive behavior and hence not deliver co-created value.

In order to design value proposition that fit a PSS environment for a product and technology supplier in a PSS environment it was found that one of the larger problems found with the business model today were that VAC realized that they didn't get paid for all the activities that they produced. A first step to get paid for what is produced is to firmly communicate a differentiated product mix where it is clear for the customer what they are buying. Smith et al. (2011) presents four dimensions of value propositions in a PSS environment (Table 21).

Theory to consider when designing new value propositions
When offering PSS offerings the customer realize the value when using the function of the offering, the customers Value-in-use. Value-in-use is defined as the customer's outcome,

purpose or objective that is achieved through service (Macdonald et al., 2010). Smith et al (2011) argues that a company can only offer value propositions, and its realization can only be done through co-creation with the customer. Therefore a company cannot "satisfy" a customer; they can only collaboratively support value co-creation.

Value is co-created in a PSS environment (Smith et al., 2011) and to co-create value the interests in the supply chain needs to be inline (Lockett et al. 2011). The actors also need to be equally in control over the information flow in order to deliver the co-creational value, also to co-create product development and deliver an outcome value proposition to the customer tacit knowledge needs to be shared in the relationship. To be able to get the interests aligned and to be equal parts of a program, some kind of strategic alliances need to be formed.

The importance of higher data flow integration and that the incentives need to be inline were also found empirically. A combined conclusion of the ideas from the two groups in the workshop is presented in Figure 24, which shows that most of the ideas were based on stronger relations between the actors. These relations between the actors were drawn up when a "dream scenario" was visualized, a situation where the attendees identified that VAC wanted and could be a part of higher forms of PSS offerings. This was visualized by workshop attendees through that joint ventures were needed to be formed between the OEM and VAC. Ideas about that joint ventures should be formed between VAC and the upstream actors where also identified.

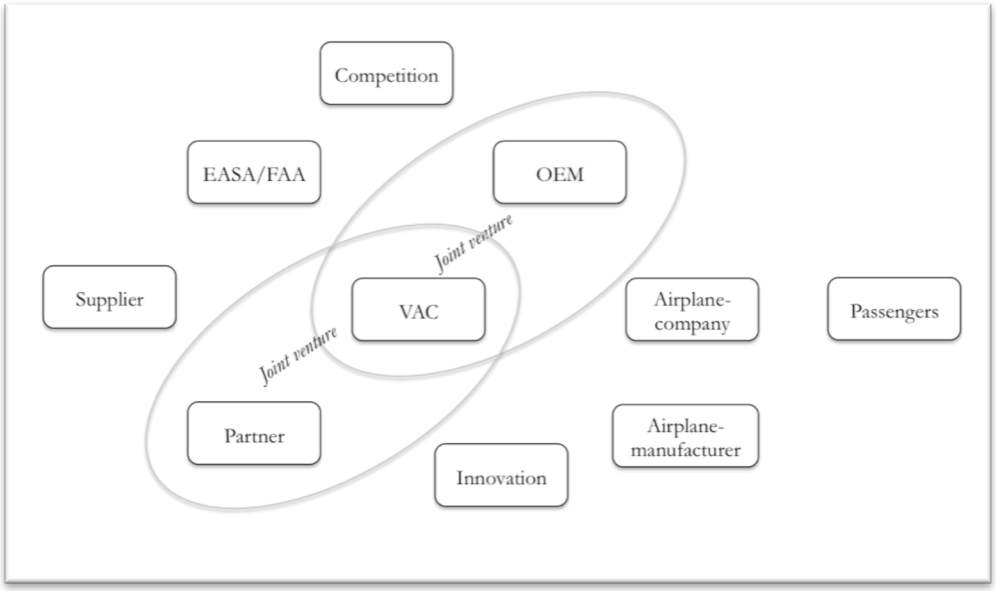

Figure 24 - Combined actors relation from the workshop

In the workshop the values, which the two groups identified in the "dream scenario", that VAC could offer to actors in the supply chain are presented in Table 22. The values are here also categorized in the four different value proposition dimension to show that the values that VAC wants to offer belongs to the full spectrum of value proposition. With this the authors wants to show that for VAC to be able to deliver the values that they want they need to be able to offer the higher forms of value propositions.

Table 22 - New value opportunities in value proposition categories

Value propositions	Value delivered	Value delivered to
Asset	Travel/fly greener	Passengers
	Engine mounts	Airplane developer
	Better integration	Airplane developer
	Composite technology	OEM
	Low cost product	OEM
	Volvo inside	Airline
Recovery	Functionality	Innovation
	Product optimization	OEM
	Integration (system supply)	OEM
	Module design	OEM
	Welding technology	OEM
Availability	Upgrade ability	Innovation
	New product development possibilities	Airline (via JV)
	Change management	Innovation
	Acoustic technology	Airplane developer
	Reduced fuel costs	Airline (via JV)
	Better product optimization	OEM
Outcome	Life cycle cost optimization	Airline (via JV)
	Life cycle responsibility	Airline (via JV)
	Life Tracking System (LTS)	OEM
	More flight hours (via LTS)	Airline (via JV)

Table 22 presents the values that VAC wants to deliver in a "dream scenario". These values are spread over the whole PSS-spectrum. The values are hence in need of different access of information and the values do also fulfill different customer needs. The analysis of Table 22 shows that VAC need to deliver the higher forms of value propositions to adapt to the PSS environment and be able to deliver the values that they want to in order to get paid for the activities they can and want to deliver. The need for co-creation of value is higher the further down in the value proposition dimensions values are plotted. In order for VAC to deliver life cycle responsibility they need a high level of integration with the OEM and full availability of the engine data in order to succeed with that stronger relationships forms are needed.

To visualize how VAC could be able to deliver the values that they want to deliver in a PSS and at the same time differentiate their product mix, in order to get paid for the values delivered, and to a larger extent be in control over the business situation the following four examples of value propositions have been constructed.

1. Asset – The make-to-print offer (Manufacturing partner)
The asset proposition is a pure 'time and material contract', where components are manufactured on a make-to-print basis. The client or customer sets the specifications and conditions whilst VAC is producing on behalf of the client. The information need is low since all specifications and conditions are provided from the client, which makes the need for an alliance low. VAC is in this scenario a manufacturing partner.

2. Recovery – The engine parts and support offer (Developing partner)
In the recovery proposition some additional services are added to the asset proposition. Manufacturing is included on the same make-to-print basis as in the asset proposition. But in recovery VAC adds their expertise and technology to the conditions and specification given by the client in order optimize these conditions and specifications. In the asset value proposition VAC is delivering what is stated when the customer is ordering the parts. The difference in the recovery value proposition is that VAC accepts to be part of the development phase when designing the parts. The customer can change the conditions and VAC, with their technology expertise, is in this value proposition a developing partner that looks after that the part ordered is optimized during the circumstances given. The customer pays in this scenario for the development of a new product.

3. Availability – The engine availability offer (Developing and availability delivering partner)
To be able to offer values that are categorized as availability the actor needs to have closer relations to its key partners to be able to offer what is wanted to the end customer. In this case for VAC to be able to offer "Better product optimization" or "New product development possibilities" they need to have access to the same information as the OEM and they are in need of close co-operation with the OEM to be able to co-create this value to the Airline.

4. Outcome – The "We make you fly" offer (Optimization partner)
The outcome is a further development of the availability proposition. For VAC to be able to offer Outcome value proposition they are here also in need of working more closely with its partners and in this value proposition the need for working closer to the end customer is also needed. For example for VAC to deliver LTS together with the OEM in order to reduce the amount and time of maintenance and overhaul stops for the Airline. They need to co-create this value with the Airline because of this even stronger relationship forms need to be formed with the OEM as well as with the end customer.

Table 23 shows a summarization table of the example value propositions.

Table 23 - Value proposition through/with OEM in the aero engine industry

Value propositions	Offering	Customer	Relationship
1. Asset – *The make to print offer*	- Manufacturing of specific engine components on specifications provided from customer	OEM	No alliance needed
2. Recovery – *The parts and support offer*	- Development and manufacturing of specific engine components on specifications provided from customer - Optimization of developed engine components with help from VAC's expertise - Product support method development for components, such as repair methods	OEM/ Airline	Non-equity strategic alliance
3. Availability – *The Engine, availability offer*	- Identification of customer needs - Development of customer tailored solutions - Identification of changes in customer demands and conditions - Additional development in order to fulfill changed customer demands and conditions - Product support method development for components, such as repair methods - Risk sharing and risk reduction - Financial resources	Airline	JV/Equity strategic alliance
4. Outcome – *The "We make you fly" offer*	- Identification of customer needs - Development of customer tailored solutions - Identification of changes in customer demands and conditions - Additional development in order to fulfill changed customer demands and conditions - Product support method development for components, such as repair methods - Risk sharing and risk reduction - Financial resources - Engine operation monitoring through LTS - Inspection and maintenance optimization - Life cycle responsibility	Airline	JV

Table 23 visualizes an example of how VAC could communicate a differentiated product mix. In order to offer availability and outcome based value propositions are however joint ventures with the OEM required, since the information access and incentives alignment need to be secured. Since the full solution was found to be VAC's strongest competitive advantage and OEMs demands more risk sharing in PSS supply chains availability and outcome based the ones that should be in focus for VAC.

With Table 23 the authors wants to show that for the supplier/partner to an OEM in a PSS systems it is needed to identify what type of values they want to deliver. It is then needed to identify what type of conditions that are necessary for the partner/supplier to be able to deliver these values. In VACs case they need to form relationships in all the PSS value dimensions in order to deliver and get paid for the values that they want to deliver.

6.3.3 The requirements from RQ1 & 2

In RQ2 it was determined that the full solution offer is the most competitive offer that VAC has and hence their core competency. Found in the analysis of RQ3 was the VAC wants to be able to deliver values that are categorized as outcome PSS value propositions which are in need of a full solution partnership. In order to deliver the full solution, which means much more than just tangible products, information and data from the engine program is needed. In order to obtain this information new strategic alliances need to be formed.

Solution to business model issues, from RQ1, and adaption to the value creation in the supply chain, from RQ2

This section aim to clarify how the suggested value proposition solves the problems with the current business model, which are presented in section 6.1.6, and improving the value creation process in the supply chain, which is described in section 6.2.4.

Business model problems

VAC is in need of sufficient information and data about their products and the engine programs they are in

In availability and outcome propositions are joint ventures suggested as a relationship form. This strategic alliance means that information and other assets are owned by the joint venture, and hence all parties involved in the joint venture. This makes information exchange easier.

VAC needs to find contractual structures that allow them to get paid for the value they deliver and only parts of it.

VAC's resources and activities are structured in four explicit value propositions where different resources and activities are included to different prices. By using these four propositions for packaging values VAC can be clear towards customers about which resources and activities are included in each offering and to what price. This makes it easier for VAC to enter contracts with certain activities and also to receive revenue for them.

VAC needs to address and change their product based logic and adapt to a more business based logic and culture

Replacing the product-based logic with a business based logic and culture is important to get these new value propositions to work. The differences between the value propositions aren't in the goods delivered, the differences are in the services and other value adding activities. Therefore, the whole organization need to agree in that the value of the total solution that is delivered is what customers appreciate.

Value creation in the supply chain

Value creation through PSS supply chain gets more common

Through the four new value propositions are developed to fit the PSS supply chain. Four different value propositions enables value creation four customers with different needs and also different extents of information access. Strategic alliances like joint ventures are used in cases where information access and incentives alignment (requirements for PSS supply chain recognized by Lockett et al., 2011) are needed to a great extent.

Values connected to risks and risk sharing occur more frequently in PSS supply chains

Even though four different value propositions are developed to be able to fulfill different customer needs, the availability and outcome proposition that is a full solution offering is in focus. The focus is set to be able to fulfill the OEMs' increased needs for risk sharing.

Information sharing and incentives alignment is needed in PSS supply chains

Information sharing and incentives alignment is improved by using joint ventures as the relationship form for the offerings that require information sharing and incentives alignment. These offerings are the availability and outcome propositions.

The most competitive offering from VAC to OEMs is the full solution

The full solution offering, which was found to be VAC core competency, is embraced by the outcome and availability offerings.

6.3.4 Barriers to overcome

However there are also some risks identified with theses possibilities. For VAC to move towards, foremost, value propositions for other customers than the OEM there is a large risk that the OEMs will interpret these new value propositions as direct threats to their businesses. If the OEMs recognize these new value propositions as threats it will most likely affect VAC's business relations with the OEMs. These threats could be seen as competition inside an on-going business relation between VAC and an OEM, since VAC possibly could deliver value proposition directly to actors that are customers to the OEM. Internal competition is also recognized by Locket et al. (2011) as a known barrier in PSS relations.

6.3.5 RQ3 Conclusions

When delivering different PSS dimensions of value propositions different levels of information and different relationships need to be formed in order to fulfill the different customer needs. In order to fit different levels of information access and also different customer needs value proposition on different PSS levels should be designed. What resources and activities the value propositions contain differ as well as the need for information, need for deep relationships, and revenue possibilities. One problem with the current business model that was addressed in empirical data was that VAC does not receive revenue for all activities that they perform in an engine program. By having separated value propositions where certain activities are included VAC can make their customers aware of which activities they can get and to which cost. The amounts that VAC can charge for each value proposition is partly decided by the volume of activities that are included. Hence, outcome generates more revenue for VAC than asset.

This can be related to what was presented in chapter one where it was described how the choice of value proposition affects the rest of the eight dimensions by Osterwalder and Pigneur, 2010 business model description. For example if VAC wants to deliver Life cycle responsibility (categorized as an Outcome PSS value proposition dimension) they need to have a different relation to their partners, they will have different customers, their cost structure will be different, how they get paid differs, what type of key activities that are used is different, the channels that are used is different and the key resources that are used is different from when delivering for example composite technology directly to the OEM (categorized as an Asset PSS value proposition dimension).

6.3.6 Summary and answer to RQ3

This section aim to summarize the analysis of data for RQ3 in order to provide an answer to RQ3:

How can the value proposition in business model for a product and technology supplier in a PSS environment be characterized?

The analysis has shown that VAC wants to offer different types of values to the PSS providers, both tangible products, services, and a combination of products and services. To be able to deliver these different types of products differentiated value propositions that suit different kinds of PSS offerings (Asset, Recovery, Availability, Outcome) are needed.

Communicating these explicit offerings that consist of both tangible products and services both internally and externally enable internal consensus as well as customer understanding. This understanding makes constructing contracts that suit both actors easier. Some requirements that must be fulfilled to be able to offer and deliver the different types of value propositions were found in terms of securing sufficient information access and aligning the incentives of all actors involved. A solution to this is to engage strategic alliances through joint ventures.

6.4 RQ4: How can the value proposition be sustained throughout PSS-contract duration?

The analysis of RQ1-3 have described how value propositions can and should be designed for suppliers to OEMs that has started to offer PSS solutions. Needs for the suppliers to change their value proposition towards PSS solutions are also discussed and when this is done new quality measurements is needed. This last statement will be elaborated in this analysis.

6.4.1 PSS offerings from a product and technology supplier

Today VAC feels that they don't get paid for all activities and resources that are delivered to customers. This is partly because the communication of what value that they actually deliver is insufficient. The insufficient communication has its basis in lack of understanding of the customer needs. In the interviews and the workshop there has been identified that some parts of VAC want to start offering PSS solutions as a supplier, in order to fulfil customer needs completely. Theory and empirical data have shown evidence of that this creates a new situation for VAC. Especially in the way that VAC deliver value to their customers.

If such offerings were to be offered by VAC, many new things need to be considered. Empirical data from interviews have shown that there is a lack of quality work regarding services within VAC and to be able to offer e.g. outcome value proposition and life cycle responsibility several new concerns in terms of quality will come into play.

In the problem background it was described that quality is so much more than just product quality. Quality is in this thesis defined as:

> *The ongoing processes of building and sustaining relationships by assessing, anticipating, fulfilling, and preferable exceed the stated and implied needs and expectations of the customer.*

In this thesis Macdonald's framework (Figure 25) is used to embrace all quality dimensions.

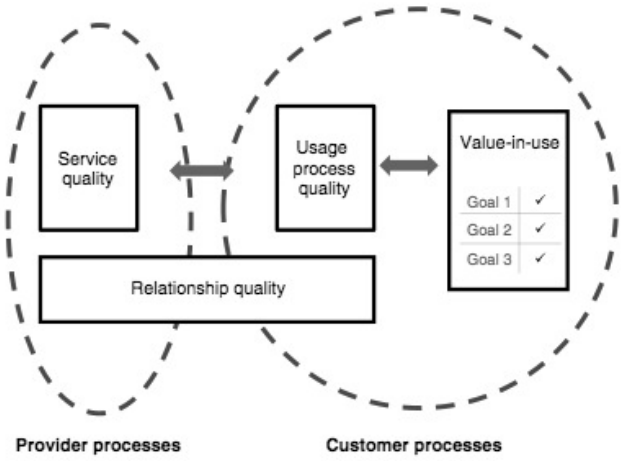

Figure 25. - Macdonald's Framework (Macdonald et al. 2011: p. 673)

The full framework that is used to sustain attributes under these categories is presented in Appendix III. The dimensions in Macdonald's framework are as follows:

- Service quality; Services that are included in the full delivery to the customer. Examples are product development, repairs and manufacturing. Product quality is actually included in this category, since manufacturing of high quality products can be seen as a service.
- Relationship quality; The relation between provider and customer. Attributes that are listed under relationship quality are needed to be sustained in order to keep a functioning relationship. Examples are communication and incentives alignment.
- Usage process quality; Activities that needed to be sustained during the usage process. Certain activities need to be sustained during the customer's usage process in order to keep usability for the customer. Examples are that analyses of usage data need to be functioning is order to keep engines running efficiently, the information exchange between customer and provider needs to be functioning in so that the provider can be aware of the e.g. an engine's functionality, and the customer's usage routines need to be investigated continuously to make the usage process as good as possible.
- Value-in-use; this is about attributes that the customer perceive during use and hence the values that are connected to the delivered solution. Examples can be continuity of operation, which means that e.g. an engine is available for use. Other examples could be that retention of certain characteristics that were promised or that the fuel consumption is kept on the level that was promised.

These attributes that were used as examples are from VAC's value propositions and are used to show how the framework should be used. However, the attributes that are used in real life needs to be determined together with the customer when the actors engage in a contract.

The Kano model, which is described in chapter 2.6, describes that how customers perceive attributes shift with time. An attribute that is seen as attractive in year 1 can year 10 be seen as a must-be attribute. This is because the attribute has become a commodity and the user is now used to this type of service/product. The attribute has thereby shifted from attractive to a basic requirement. In order to monitor the shifts is the importance-performance analysis used.

6.4.2 Importance performance analysis (IPA)

Attributes that have been plotted in Macdonald's framework can be plotted in the importance-performance analysis grid (IPA matrix) by Geng and Chu (2012) (Figure 26). By doing the importance-performance analysis continuously the delivering actor can obtain information about which of the attributes that are shifting over time and which are not as well as the ability to put focus on activities and resources that deserves attention. The IPA does also generate information about which attributes that are performing under or over what is expected from them. This is important in order to keep customer satisfaction high over time.

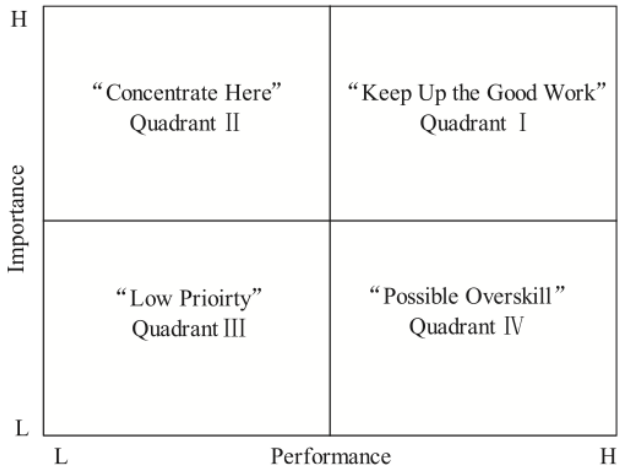

Figure 26 - IPA matrix

To plot attributes in the IPA-matrix is customer contact needed in order to obtain information about the importance of the attribute and also the performance of the attribute by the provider. Information about how important an attribute is for the customer is used to plot activities on the importance-axis (y-axis) in the IPA-matrix.

Information about how well the attributes are executed by the provider is used as input for the performance axis (x-axis), since the customers are the only ones that can answer on how they valuate an activity and how satisfied they are. When the activities are plotted in the importance-performance grid, it can be decided which activities that deserve most attention and money. The decision is made by which quadrant an activity is plotted in.

An attribute that is plotted in the first quadrant is high performing and of high importance, which indicates that the customer valuates the attribute high and that the customer is satisfied with the execution of the attribute. The attention needing attributes are the ones plotted in the second quadrant because these are of high importance for the customer but the attribute performance is low, which means that the customer isn't satisfied with the execution of these attributes. Focus on these attributes is needed in order to improve the attribute performance and hence raise the customer satisfaction. Attributes plotted in the third quadrant are low performing and the customer doesn't emphasize on these attributes. Since the attribute is not of great importance for the customer, the attribute doesn't deserve major focus either. If attributes are plotted in the fourth quadrant they are still performing high but the importance for the customer is low, which means that too much recourses are used at this attribute.

When doing an IPA it is visualized which of the attributes in the offering that are performing well and which are not as well as which deserves major focus and which are not. It can also be identified which attributes that has been shifted from attractive to must be attributes by performing analyses continuously. This would be visualized as that the customer expects more out of this attribute when they have found it to be a commodity in the offering.

This is one way of measuring value-in-use in a PSS offering. This chapter is a theoretical description of how value could be sustained since it has been found to very important to actually be able to measure the value that is delivered to the customer in a PSS. Most of these analyses require customer data regarding customer satisfaction and how customers valuate different attributes. This is missing in this study, which makes a real evaluation impossible at this stage.

6.4.3 Implementation

In order to use this quality measurement tool these attributes needs to be drawn up when the engine program starts. When setting up the list of requirements for the program for the first time, it should be communicated which of the different value proposition dimensions that are to be delivered. Then attributes of the products-service bundled offer should be drawn up. These attributes should then be used as the measurement points. These should be measured when the engines are delivered and then on a yearly basis. In order to measure the same attributes every year it is possible for the delivering company to keep track of the value that is delivered. This methodology is similar to the SERVQUAL methodology, which is a well-known and used quality measurement methodology. The criticism that was presented against SERVQUAL when measuring PSS quality regarded the dimensions in SERVQUAL, which didn't take value-in-use into account. This is solved since the dimensions used to measure quality are constructed from the actual offering with this method.

6.4.4 Summary and answer to RQ4

This section aim to summarize the analysis of data for RQ4 in order to provide an answer to RQ4:

RQ4: How can the value proposition be sustained throughout PSS-contract duration?

Value propositions and their components can be measured by using the Macdonald's framework and the importance-performance analysis. Macdonald's framework provides quality dimensions under which activities and resources can be categorized.

Since customers' attribute perception shifts over time is the IPA used to monitor attributes over time. Performing these analyses continuously allows detection of attributes that shift over time by comparison of IPA matrix over time.

A real evaluation of value is not possible in this thesis, since customer satisfaction data is missing. The answer to RQ4 does therefore consist of the theoretical explanation of how value is sustained through Macdonald's framework and the IPA matrix, which is explained throughout the RQ4 analysis in section 6.4.

7. Findings and conclusions

The analysis chapter has provided answers to all of the four research questions. In this chapter, the findings and conclusion chapter, an answer to the research problem is presented. This answer is based on the answers of the four research questions. Moreover, recommendations for Volvo Aero Corporation as well as further studies that could be conducted are also presented.

This chapter aim to provide an answer to this study's research problem:

How can a sustainable value proposition be designed for a product and technology supplier/partner to an OEM offering PSS solutions?

The four research questions have been answered throughout the analysis chapter. The answers to the research questions together build a basis for answering the research problem. In the first RQ, where problems with the existing business model were identified, it was discussed why suppliers needed to change their business model when OEMs started to offer PSS. The answer to the first RQ was a list of problems with the current business model used by suppliers. The second RQ handled value creation in a PSS and how value is created in the supply chain today. This analysis ended up with an explanation of the situation, where it was described that the OEMs were driving the business model towards PSS and were in control over the business cases. The third RQ handled how value propositions could be characterized for suppliers to OEMs, who have started to offer PSS. The answer to this RQ was a list of different value propositions. What was new with these value propositions from VAC's point of view was that several of them were PSS offerings that VAC aren't delivering today. It was concluded that VAC needs to engage in some kind of strategic alliance to be able to start offering these PSS offerings. Lastly, the fourth RQ described how these value propositions designed in RQ3 could be sustained over contracts duration by using PSS quality dimensions suggested by Macdonald et al. (2011) and measuring the value-in-use over time with the importance-performance analysis.

A SWOT analysis has been compiled to summarize and describe how VAC can design value proposition suitable for a PSS environment, get in control over their business situation, and get paid for all the products and services they deliver.

7.1 SWOT-analysis

A SWOT analysis has been drawn up in order to summarize VAC's situation and explain what obstacles VAC has to overcome, which assets that are to be used in order to overcome these and at the same time how to take advantages of the opportunities identified when designing the value proposition. The analysis of RQ1 and the VRIN-analysis has given data to the internal side and the analysis of RQ2 and 3 has given data to the external parts of the SWOT. The SWOT analysis is visualized in Figure 27.

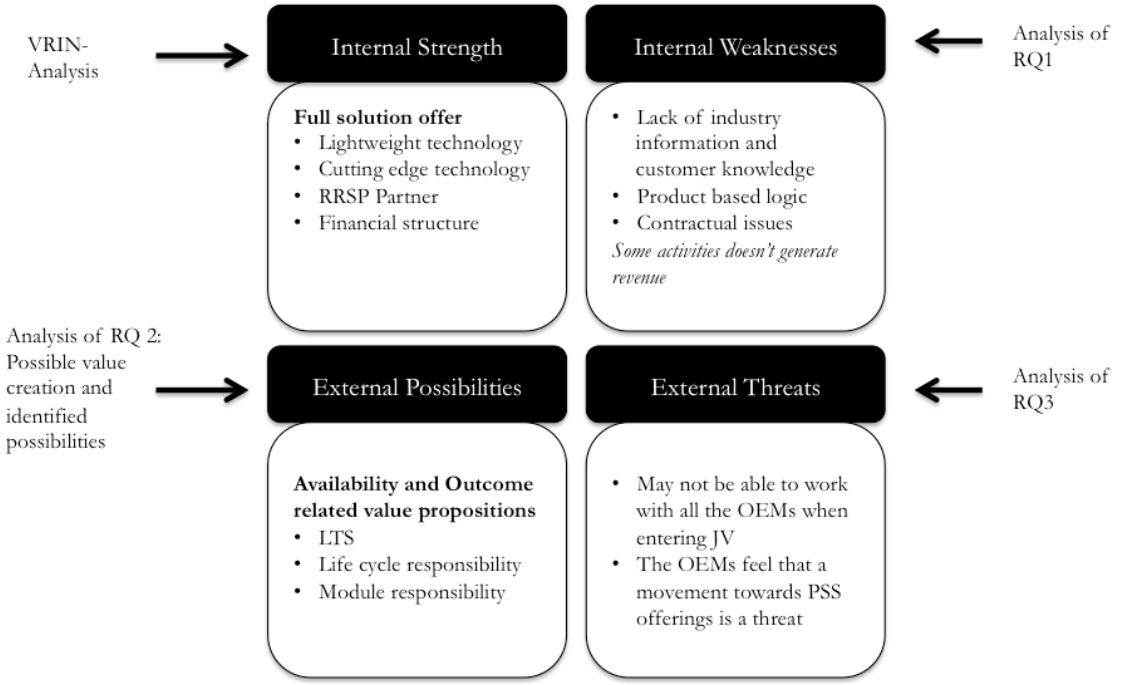

Figure 27 – SWOT analysis

To be able to offer value propositions suitable for a PSS environment VAC needs to:

- Find out what values that VAC wants to deliver
  - Create value propositions that suit the values that they want to deliver
  - Create relationships to fit the value propositions that they want to offer, and by this solve the contractual issues
  - Focus on the higher forms of value propositions, Availability and Outcome in order to fully use their potential. The strongest competitive advantage is their full solution offering and to be able to get paid for everything
- When different value propositions are set up it can be communicated internally and externally what VAC produces in form of PSS offerings
  - This solves the internal consensus of what is produced to change the product-based logic within the company.
  - It also solves that VAC has a better possibility to get paid for what they deliver because they are communicating a differentiated product mix.

When these issues are solved it will create opportunities for fulfilling the "dream scenario" for VAC that was identified during the workshop, where VAC can provide offerings suitable for a PSS environment and produce and get paid for the values that they want to deliver.

The threats that are identified in the SWOT are not further investigated. They are in this study brought up to show what threats that are realized. However, this study has throughout the report presented the importance for the actors that produce PSS offerings together to align their incentives and share the information needed for these offerings. This reasoning would show that the OEMs would embrace this kind of change of value proposition from the upstream supply chain actors.

7.2 Case conclusions

This thesis has studied the suppliers' situation in a supply chain where OEMs have started to offer PSS. It has been investigated how the suppliers should design their value propositions in such an environment. It was found that for the suppliers to contribute to the PSS they need to be a part of the program and need to take part of the information flow. If the suppliers are kept outside the information flow they cannot contribute to the program fully and will realize negative effects. As Lockett et al. (2011) concluded: The interests of the actors in a PSS need to be in line in order to get a functional system.

In VAC's case they need to communicate a differentiated product mix to their customers in order to get paid for all of the different activities that are delivered. Constructing value propositions based on dimensions of PSS value propositions by Smith et al. (2011) makes the communication towards customers easier and more explicit. Communicating what difference it would be for a customer to buy an asset proposition instead of an outcome can make the customer aware of what VAC can deliver but also what they are in need of. The amount of activities and resources included in each value proposition make it clear for the customer why outcome is the most expensive and the asset proposition the least.

Joint ventures together with OEMs are recommended for suppliers/partners to OEMs that offer PSS solutions to be a part of the information flow and hence be able to be proactive in their business case. This allows the suppliers/partners to offer the higher forms of value propositions.

Theory (e.g. Macdonald et al., 2011 and Vargo & Lusch, 2004) has shown that service and product quality dimensions alone are insufficient for measuring value-in-use. In order to sustain the value in the value propositions, VAC need to embrace the measurement dimensions provided by Macdonald et al. (2011) (service quality, relationship quality, usage process quality and value-in-use). Since value-in-use can shift over time, the importance-performance analysis by Geng and Chu (2012) needs to be used to monitor the customer's perception of value-in-use over time.

7.3 Generic conclusions

The findings of this study agrees with previous studies (e.g. Lockett et al., 2011) on the PSS area in that communication between all actors involved in PSS is needed, since their incentives need to be aligned towards the same objectives in order to make a competitive PSS offering. The findings does also show that the aero engine supply chain is in some contracts very alike the PSS supply chain described by Lockett et al. (2011). But all engine contracts do not look the same way, which makes different value propositions with different contents useful.

The findings of this study points to that only product focused quality measurements are insufficient for measuring value, which is in line with what both Macdonald et al. (2011) and Vargo and Lusch (2004) have found. Measurement methods for measuring value need to be constructed with the actual offering as a basis. The PSS offering can consist of much more than only tangible products. In order to measure the value of the offering the value that the offering creates for the customer needs to form the parameters that are measured. Using these parameters create as a basis for measurement that is value centred and that can be used for monitoring the customer satisfaction connected to the value over time.

7.4 Discussion

Value proposition as the direct choice in business model design

In RQ 3 four different value propositions are described as examples of how VAC could develop their value propositions. These value propositions are described as that they are in need of different resources. For example, the value proposition in the availability dimension is in need of a deeper involvement with the customer than the asset and recovery but less than the outcome proposition. This shows that the discussion that was brought foreword in the problem discussion where the authors showed their viewpoint on how value proposition is the strategic choice and the rest of the business model dimensions are affected by the choice of value proposition was correct.

Barriers for value proposition development

It has been shown that the changes towards PSS value propositions entail increased risk sharing activities upstream in the supply chain, which increases the control of the business cases for suppliers and other actors. All the involved actors except for the OEMs would most likely see these changes as positive, since the suppliers' control are increased at the cost of OEMs' control. How this will affect the industry and the supply chain is not clear, but the OEMs will most likely take actions to keep their control over the business cases. This implies that implementing the changed value propositions is not only VAC's choice. The OEMs are in most cases the direct customer or partner to VAC and therefore the OEMs need to accept that these value propositions are developed. But it has been described through out the thesis the importance of the co-creation when delivering PSS value propositions. So for the OEM to actually be able to offer good PSS solutions to its customer it is most likely that they will need to accept and promote these changes.

7.5 Further studies

Business model design for a partner/supplier to an OEM that delivers PSS offerings

As described in the discussion, only value proposition design is studied in this thesis, but other business model dimensions are affected by the PSS transition as well. This implies that there is need for further studies on design of the rest of the business model in PSS. The authors would suggest that studies in business model design for suppliers/partners would be executed with the business model dimensions by Osterwalder & Pigneur (2010) as a basis. Such a study would preferably start of with the conclusions drawn about value proposition in this thesis in order to design new business models for product and technology suppliers in PSS.

Customer validation and integration in value proposition design

This study is made from VAC's point of view, where all empirical data collection and analyses are made with VAC as a base, which means that value propositions that are developed in this study are designed from VAC's knowledge and opinions. In the case approach it is described that a company needs to have a good idea of what the customer valuates and what they can charge for before a sales dialogue is started. If not, the customer could receive valuable activities and resources for free. The value propositions that are designed in this thesis correspond to VAC's idea of what the customer valuates, which means that the next step is to initiate customer contact. With customer contact more accurate data about customer valuation can be obtained, which can be used to develop these value propositions even further. The next step is to initiate customer contact in order to develop the value propositions further with help from first hand information about customer valuations. This would make it possible to develop more customer focused value propositions and also to test the model for sustaining value over time. Further studies about customer valuations are hence suitable.

PSS quality

This study has described the importance of monitoring the value that is offered to the customer when delivering PSS offerings. Since this study hasn't gathered information from the customer it has only been able to theoretically show the authors thoughts on how such quality measurements could be executed. Therefor it is suggested that the quality measurement method that is proposed in this study is tested and evaluated.

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Appendix I – Interviewee list

A list of the persons that have participated in semi-structured interviews is presented below, where the position of each interviewee is presented together with the interview duration and date.

Inter-viewee	Position	Duration of interview	Date of interview
A	Chief Engineer	1h	20120130
B	Process Management	30 min	20120201
C	Quality	1h	20120201
D	Key Account Manager	30 min	20120209
E	Business Development and Marketing	1 h	20120221
F	Strategy and Business Development	45 min	20120221
G	Design Team Manager	35 min	20120222
H	Business Development and Management	30 min	20120222
I	Manager Customer Support and Development	1 h	20120306
J	Manager Product Support	30 min	20120306
K	Business Development and Management	30 min	20120307
L	Business Development and Marketing	1,5 h	20120315
SUM		9h 20 min	

Appendix II – Workshop method

The workshop was held with seven participants from three different departments (market department, product development and cold structures design). The group was split up in teams of four and three, where employees from different departments as well as men and women were mixed. A list of attendees is available in Table 1 (Appendix I) together with the attendees' the positions and groupings.

Table 1 (Appendix I) - List of workshop attendees

Attendee	Position	Team
A	Key Account Manager	1
B	Senior company specialist	1
C	Business Development and Management	1
D	Business Development and Marketing	2
E	Design Team Manager	2
F	PhD Student at VAC	2
G	Marketing manager	2

The goal with the workshop was to get employees within VAC to start thinking creatively to be able to draw up a picture of how VAC could fit in to the PSS business environment. Today's business models around the aero engine programs are driven by the OEMs and they are for the most in control over the business model. This workshop had as a goal to get VAC to identify what and how they can contribute to these aero engine programs. This was done in three steps.

The group where divided in to two groups and the groups preformed these three steps separately too lastly present their results for each other and discuss it.

The steps executed in the workshop were the following:

Step 1: What does the value creation in the aero engine industry look like?
In this assignment the workshop attendees mapped the value streams within the aero engine industry. The attendees also drew up the actors that existed in the aero engine industry.

Step 2: What would a new business situation in the aero engine industry look like from VAC's perspective?
In this assignment the workshop attendees drew up a new business that would fit VAC and their current abilities.

Step 3: Why does not the business situation look like the outcome of assignment 2 and what would the consequences be if the business situation would look like the outcome of step 2?
In this assignment, the workshop attendees were asked to analyse the material from step 2 by using gap-analysis and consequence-analysis.

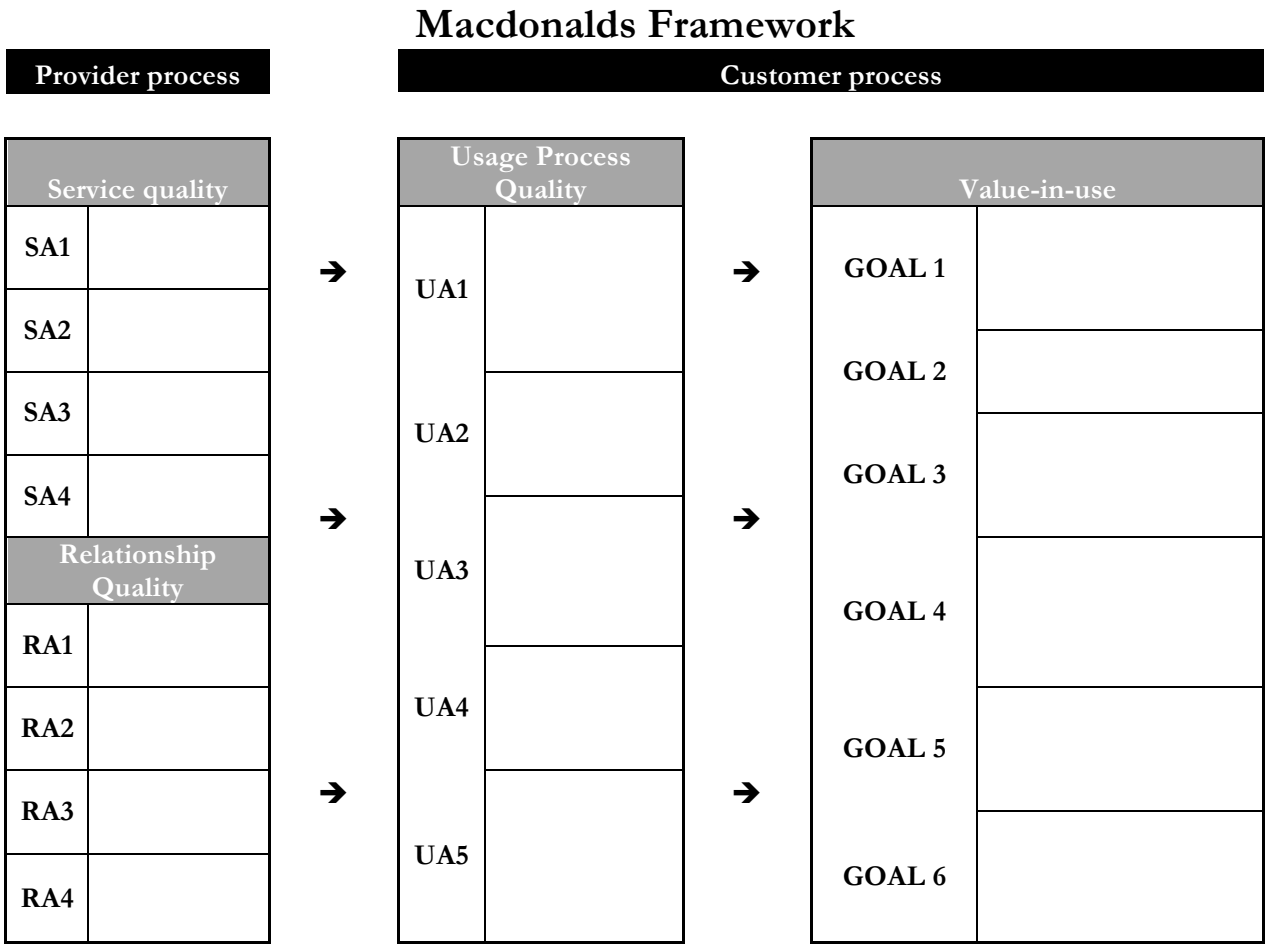
a) Gap-analysis: Why does not the business situation look like the outcome of assignment 2?

b) Consequence analysis: What would the consequences be if the business situation would look like the outcome of assignment 2?

The time schedule for the workshop was limited to 3 hours because it would be difficult to find suitable participants that are available for a longer session. The workshop handled value creation in the aero engine industry and was primarily aimed for RQ 2 and 3. The value creation mapping in RQ2 was suitable for a group activity, since a consensus completes individual thoughts from the interviews. This was handled by step 1. Value proposition design in RQ3 was handled through step 2 and 3, where a "dream" scenario was illustrated from VAC's perspective and then an analysis of why the industry doesn't look like that and what the consequences would be if the industry would look that way.

The workshop session ended up with a presentation of the findings that each team had came up with and also a discussion of what the group had received from the workshop.

Appendix III – Macdonald's framework



SA = Service Quality Attribute
RA = Relationship Quality Attribute
UA = Usage Process Quality Attribute