BUSINESS MODEL INNOVATION IN THE AEROSPACE INDUSTRY: STRATEGIC OPTIONS FOR MAINTENANCE, REPAIR, AND OVERHAUL FIRMS

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Abstract

Aircraft Maintenance, Repair, and Overhaul (MRO) is a $76bn industry in which established service firms such as Lufthansa Technik, Delta Tech Ops, and AFI KLM Engineering & Maintenance come under increasing competitive pressure by aircraft, engine, and system manufacturers such as Rolls-Royce, Airbus, and Thales. Increasing price pressure on asset sales and the opportunity to generate profitable service-based revenue streams in the aftermarket makes servitization an imperative for manufacturers, who pursue this type of Business Model Innovation (BMI) aggressively. Traditional MRO service firms do not only play a vital role for shareholders and employees but also let airlines benefit from competition in a contracting MRO market that is in danger of being monopolized. Furthermore, MRO services represent 15-18% of airlines' direct operating costs (compared to 8% for aircraft financing) and are paramount to ensure safe, reliable, and punctual airline operations.

This study explores how MROs can successfully innovate their business model when faced with competition from manufacturers that offer product-service bundles to their customers. While academia has made significant advancements on how manufacturers can successfully add services to their business model, we know very little about how traditional service firms can navigate in such a servitized environment. By conducting three case studies based on 50 in-depth interviews with MRO and airline managers, I identify a portfolio of four business model configurations that MROs can employ to offer solutions and create value in solution networks. My findings indicate that MROs can use a contingency-based approach to innovate their business model through solution-specific and relational dynamic capabilities. When competing with manufacturers, MROs can gain a competitive advantage by leveraging the unique elements of their service-based business model. However, when alliancing is the more promising option, MROs need to innovate their business model to successfully add and appropriate value in these complex, coopetitive relationships.

My intention is to make three academic contributions: The principal contribution is clarifying the role of pure service firms in servitization research and the development of strategic options for MROs to cope with servitization practices of manufacturers through business model innovation. Second, this study takes a first step in unveiling the "dark side of servitization", uncovering the currently obscure less favorable aspects of this phenomenon. Third, I outline business models of MRO firms that have been overlooked in the efforts of describing changing airlines' and manufacturers' business models, even though they represent a central link in the supply chain.

This study also claims to make three managerial contributions: first, managers of MROs can make use of the findings to drive the innovation of their business model and ensure long-term competitiveness when faced with servitization. Second, the results inform airline managers about significant environmental changes in the MRO market relevant for technical airline operations, make-or-buy decisions, and MRO procurement. Third, aerospace manufacturers can benefit from the insights developed in this work to either build a positional advantage against MROs or rely on these specialized players to complement their service offers.

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Oliver Wirths
Zurich
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List of Acronyms

Acronyms are defined in accordance with The Economist Style Guide (The Economist, 2015), conventions in the Aerospace Industry, and conventions in the scientific fields covered in this thesis.

A/C Aircraft

ACS Airbus Catalog Supplier

AD Airworthiness Directive

ANSP Air Navigation Service Providers

AOG Aircraft on Ground

ARC Airframe-related components

ASK Available Seat Kilometer

B Billion

BFE Buyer-furnished equipment

BM Business Model

BMC Business Model Canvas

BMI Business Model Innovation

C&E Consumables and Expendables

CAGR Compound Annual Growth Rate

CRS Computer Reservation Systems

DC Dynamic Capability

DMC Direct Maintenance Costs

DOC Direct Operating Costs

EASA European Aviation Safety Agency

FAA Federal Aviation Administration

GB Giga Byte

GDS Global Distribution System

ICA Instructions for Continued Airworthiness

LBA Luftfahrt Bundesamt

LLP Life-limited parts

m million

MB Mega Byte

MRO Maintenance, Repair, and Overhaul

MTBUR Mean time between unscheduled removal

n.d. not disclosed

NSD New Service Development

OEM Original Equipment Manufacturer

OES Original Equipment Supplier

OTP On-time-performance

PSA Product Support Agreement

PSS Product Service System

ROIC Return on invested capital

RPK Revenue Passenger Kilometer

RRSM Risk-and-Revenue-sharing model

RRSP Risk-and-Revenue-sharing partnership

SB Service Bulletin

SFE Seller-furnished Equipment

SME Small and Medium Enterprises

t&m time and material

T Trillion

TAT Turn-around-time

TB Tera Byte

TDR Technical Dispatch Reliability

TMS Transition Management Services

TSP Total Support Package

WACC Weighted average costs of capital

1
Introduction

Contents

1.1 Motivation: Servitization in the Aerospace Industry

Finding appropriate business models that allow for adapting to dynamic changes in the competitive landscape has received increasing academic attention (Johnson et al., 2008; de Reuver et al., 2009; Foss & Saebi, 2017), particularly in the aerospace manufacturing (Kastalli et al., 2013; Ferreira et al., 2016) and airline industry (Daft & Albers, 2013; Daft, 2015). It has never been so important to examine business model innovation (BMI) as an enabler of sustained firm performance in dynamic competitive environments due to the underlying systematic changes in the current airline and manufacturing business models. This is especially true for traditional service industries, which have received less academic attention. In particular, the aircraft maintenance, repair, and overhaul (MRO) sector has come under increasing pressure from aerospace manufacturers that add services to their business model:

"Aviation's Maintenance, Repair and Overhaul (MRO) sector is undergoing a seismic shift as original equipment manufacturers (OEMs) win more and more long-term after care contracts from airlines. The aggressive strategy is a threat to the bottom lines of global maintenance providers" (– Ballantyne, 2015, p. 1).

As this quote in an aviation periodical indicates, the entry of the Aerospace manufacturers into the service market represents a dramatic increase in competition for established MRO firms that has not gone unnoticed, neither in the press nor in the MRO providers' balance sheets. The downstream movement of manufacturers into the service market is commonly known in the academic community under the term "servitization" (Oliva & Kallenberg, 2003). Kowalkowski et al. (2017, p. 8) define servitization as a "transformational processes whereby a company shifts from a product-centric to a service-centric business model and logic". In this process, manufacturers offer increasingly complex bundles of products and services to add value to their products (Vandermerwe & Rada, 1988), which are typically referred to as "solutions" in business to business industries (Hakanen & Jaakkola, 2012). MROs are pure service firms that need to compete against this new type of competitor with different business models including unique resources and capabilities resulting from their manufacturing background (Ulaga & Reinartz, 2011) on a global scale. Increasing competition is generally welcomed by customers, as it improves their bargaining position (Porter, 1979). However, airlines increasingly address their concerns regarding possible monopolization of the MRO market, as manufacturers place rising if not insurmountable barriers to hinder MROs from competing (Schneider et al., 2013; Hygate, 2013b; IATA, 2015).

Despite servitization being practiced since the early 1960s, the academic conceptualization of the concept started only in the late 80s (Vandermerwe & Rada, 1988), and only recently have relevant servitization terms been synthesized in a more systematic manner (Brax & Visintin, 2017). While literature provides evidence regarding barriers to successful servitization, such as re-centering the company's culture from products to services (Sawhney et al., 2004; Gebauer & Friedli, 2005), research and empirical evidence on competition with pure service firms remain surprisingly thin and mostly anecdotal. The general implicit assumption is that manufacturers can gain competitive advantage and improve firm performance by venturing into hybrid product-service offerings; however, empirical evidence shows mixed results (Neely, 2008; Benedettini et al., 2015). While most servitization studies explicitly or implicitly focus on competitive advantage gained against other manufacturers, only little (and mostly) anecdotal evidence about competition with pure service firms exists (e.g., Davies et al., 2007; Finne et al., 2015). Therefore, established literature cannot fully explain the phenomenon, and MROs as pure service firms possess no academic guidance of how to cope with the emerging competition.

Against a common misconception of solution offerings, the asset ownership is not retained with the manufacturer but transferred to the customer or aircraft leasing company through purchase of the asset (Baines & Lightfoot, 2014). Hence, solution offers in the aerospace industry are bundles that are comprised mostly of services that support the product (e.g., maintenance services) or the client (e.g., training services, Mathieu, 2001a) which are sold debundled from the product. Debundled pricing enables pure service firms to continue providing services and solution bundles directly to the airline customer. Another essential characteristic is that solutions are output-based, which means that airlines pay a fee based on aircraft usage, not manhours and material required for repairs, which shifts the risk of exceeding maintenance costs and lower aircraft utilization partly back to the provider.

The aerospace industry is characterized by mature servitization practices, especially by engine manufacturers. The "power-by-the-hour" offering by Rolls-Royce, in which airlines pay a fixed usage-based fee per flight hour for engine maintenance, has even become one of the most cited examples for servitization (Baines & Lightfoot, 2013). Engine manufacturers were the first and the most effective of the aerospace companies to capture the service market with their solution offerings. While on legacy engines, manufacturers held around 30% of the service market, they are expected to gain between 65% and over 90% of all maintenance contracts on new engine types (Bourke, 2018). In response, traditional service providers were forced to established alliances with engine manufacturers to ensure competitive survival in the engine maintenance segment. Even though these alliances have secured the MROs' survival, manufacturers can secure much of the profit potential and pin MROs in a dependent position. Currently, other aerospace manufacturers such as the airframers[1] Airbus and Boeing, as well as system suppliers such as UTAS, Honeywell, and Messier Goodrich, take the engine OEMs as a boilerplate to drive their own servitization strategies. By adding services to their business model, manufacturers aim to capture shares of attractive MRO service market in which firms are able to earn double-digit instead of single-digit profit mar-

[1]Airframers define the requirements for structure, systems, and cabin of the aircraft and integrate the mostly subcontracted components groups during aircraft assembly (Krol, 2011).

gins (Pearce, 2013). Besides revenue and profit growth, servitization allows aerospace manufacturers to establish closer and longer-lasting ties to their customers, which results in additional marketing opportunities.

Simultaneously, airlines increase their outsourcing in an industry that is rapidly evolving and is anything but stable (Hsu & Liou, 2013). Against the background of globalization and intensifying competition, many major carriers are going through a process of de-integration. They now outsource large parts of their business such as catering and pilot training to networks of suppliers in search of greater efficiency and improved competitiveness (Rieple & Helm, 2008). The main reasons for this trend towards outsourcing include cost savings, a focus on core competencies, and flexibility in management (Hsu & Liou, 2013). This also applies to aircraft Maintenance, Repair, and Overhaul, where many airlines focus on their core business, requiring guaranteed aircraft availability, maintenance costs, and cost models based on aircraft utilization (Ward & Graves, 2005; Schneider et al., 2013). Besides, the availability of manufacturers' complete, integrated, seamless solution packages has increased this demand even further (Schneider et al., 2013).

This study takes the perspective of MRO service firms that need to seize opportunities and mitigate threats resulting from the manufacturers' push into the service market, while simultaneously catering to the airlines' demand of risk-limiting, availability-based service offers. As of today, academia provides only minimal guidance for MROs in particular and service firms in general on how to deal with these changes.

The managerial importance of this research gap becomes evident, considering the size of the affected service firms. Three of the largest MROs are Lufthansa Technik with annual revenues of $5.6bn, AFI KLM Engineering and Maintenance ($4.6bn), and the HAECO Group with $1.2bn revenue (Shay, 2017d). Besides, service firms play an essential role in functional service markets and typically possess substantial market shares. One example is the German car manufacturing and repair industry, in which 51% of all car repair shops are traditional, independent service firms, whereas 49% of repair shops are manufacturer-owned (Boston Consulting Group, 2012). These independent service firms play a vital role in ensuring competition in the service market and preventing manufacturers from charging monopoly prices. For these reasons, the European Commission has repeatedly taken mitigation actions to prevent manufacturers from driving out independent repair shops of the car maintenance market. In particular, *"The resulting reduction in competition between car repairers could lead to less choice and higher prices for consumers: independent repairers are often cheaper than authorised outlets, sometimes by over 50%."* (European Commission, 2007, p. 1).

In the aerospace industry, the competitive survival of independent MROs plays a similarly important role for airlines and indirectly passengers. The reason is that independent service providers prevent monopolization and ensure that airlines have competitive choices in their maintenance decisions. Assuring a competitive MRO market is especially vital in this industry in which more than half of lifecycle costs emerge for MRO during the 25-year lifecycle of aerospace equipment.[2] Besides, airlines face significant exit barriers, once they have decided which aircraft type to operate.

One example of a solution offer with severe implications on airlines and MROs is the engine manufacturer Rolls-Royce. Rolls sells its Trent engine exclusively in combination with a power-by-the-hour agreement, which has gained them a 92% share in the maintenance market (Hygate, 2013a). For airlines, this contractual arrangement is highly problematic, as it leaves the airline locked-in with Rolls-Royce during the 25 years operation. Here, the airlines become dependent on this single supplier, which reduces their bargaining power. The situation is aggravated by the fact that typically 70% of the lifecycle costs of the engine result from operation and maintenance, while only 30% from the initial purchase of the asset. This position leaves airlines vulnerable to difficult negotiations with Rolls-Royce, once the initial service contract and warranty period of the engine has expired.

Unlike in the early times of aviation, the technical operations function of airlines is not considered as a pure cost factor anymore. Instead, technical operations is a value-creating core function of airlines that aims to optimize aircraft availability, reliability, and costs. In this context, the proper management of MRO services is one of the critical factors in determining the punctuality of airlines. Although technical problems only account for a small percentage of delays, technical delays have a long duration, a high impact on punctuality, customer perception, profitability, customer loyalty, and ultimately, airline performance (Knotts, 1999; Niehues et al., 2001; Al-kaabi et al., 2007a; Rieple & Helm, 2008). The effect of aircraft maintenance, repair, and overhaul services on airline punctuality stems from the fact that aircraft are maintained overnight and need to be ready for service in time before the first flight in the morning. This task involves the management of millions of different parts that need to be maintained in airworthy conditions or exchanged promptly upon failure to avoid disruptions. Also, aircraft are regularly maintained during operation in between flights aiming to troubleshoot problems quickly and avoid delays (Kinnison & Siddiqui, 2004).

On the other hand, MRO services also accumulate to the considerable proportion of 15-18% of airlines' direct operating cost. This is significantly more than aircraft financing (depreciation or leasing) that only accounts for 8% of these costs (Berger, 2014). For commercial engines, even 70% of the lifecycle costs occur in the aftermarket, not the initial purchase. Tapping into this lucrative aftermarket represents a vital opportunity for manufacturers to pursue additional Revenue Streams and profitable growth. For airlines, options for lowering operating expenses besides MRO are limited, since the primary cost factors fuel, taxes and fees for e.g., landing or air traffic control are mostly non-negotiable. Thus, airlines consider MRO services as an essential field to achieve a

[2]As explained further below, MRO costs accrue to 1.5 to 2 times the aircraft financing costs over the aircraft lifecycle.

competitive cost-base, whereas Knotts (1999, p. 336) even argues MRO costs to be one of the two *"major yardsticks of airline and civil aircraft performance"*.

In summary, servitization and the inherent increase in competition may severely threaten the competitive survival of independent aerospace MRO service firms with according effects on employees and shareholders. Besides, the market concentration has the potential to inflict considerable price increases and performance decreases of MRO services with negative implications on airline performance, and ultimately, passengers. Also, the relevance of this topic will likely increase in the future in many industries, as servitization is a rising practice amongst a wide array of capital goods manufacturers (Dachs et al., 2014).

The need to study how MRO service firms can cope with servitization does not only stem from a managerial but also from an academic interest. As of today, servitization literature has focused on manufacturers and overlooked the role of pure service firms and ramifications on service industries almost entirely (Raddats et al., 2019). Thus, current research possesses only minimal power to explain how service firms can master the challenges and reap opportunities caused by servitization successfully.

An exception and conceptual basis for this study is an article by Schneider et al. (2013) who have taken the first step in this field by suggesting two generic BMI paths for MROs to cope with servitization. One option is to develop outcome-based solutions to compete with manufacturers in serving airlines that focus on their core business. The second option is to ally with manufacturers to become part of their solution networks. However, these generic BMI paths offer minimal guidance to MROs and other service firms. For example, academia cannot explain, which type of BMI is the most appropriate in any given situation. Additionally, we do not know whether both paths are mutually exclusive or can be implemented simultaneously. Consequently, we lack knowledge of the types of business models that evolve by implementing these paths.

Another limitation of our current knowledge is that we do not know, how service firms can adapt their business model to compete and collaborate. How can service firms, for example, leverage their business model to differentiate their offers against manufacturers successfully? Alternatively, what transformations can service firms perform to ally with manufacturers ensuring their business performance successfully? To narrow these blind spots, this investigation takes the concept of business models and their innovation as a conceptual lens to explore the strategic options that MROs have at their disposal to cope with servitization.

Business Model Innovation as Conceptual Lens Due to the systemic changes in the aerospace industry, it is not sufficient for MROs to change single elements of the business model such as the Value Proposition. Instead, MROs need to consider the entire business model as the subject of innovation adapt to the multifaceted changes and achieve sustainable firm performance.

Business model frameworks are a suitable analytical lens for describing and understanding how MROs can cope with servitization. One principal reason is that they use various strategic management constructs, such as the value chain (Porter, 1985b), strategic positioning (Porter, 1996), the resource-based view (Barney, 1991), strategic network theory (Jarillo, 1988), cooperative strategies (Dyer & Singh, 1998), boundary decisions, and transaction cost economics (Williamson, 1981; Barney, 1999) (Morris et al., 2005). This allows researchers to analyze the core logic of firms, changes in this logic, and competitive advantage on a strategic (corporate core logic), structural (value chain activities), and resource level, through a systemic, multi-level approach (Daft & Albers, 2013). Another reason is that the business model concept is widely used throughout servitization literature due to its capacity to explain the manufacturers' shift towards services (Baines et al., 2017). These studies have unearthed different typologies of solution business models, and the business model innovation process required to add services to a product-focused business model (Kowalkowski et al., 2017). However, the process of business model innovation and the resulting business model configurations of service firms caused by servitization remain close to non-existent.

To avoid ambiguity in the use of the concept, two connotations of business models need to be discerned. On one hand, the term "business model" describes the inherent core logic on which a firm operates. On the other hand, the business model concept is also used as an analytical instrument to dissect and analyze the business models pursued by companies. To do so, *business model frameworks* such as the Business Model Canvas (Osterwalder et al., 2005) are used to abstract the complex reality of firms into comprehensible models that enable the description and understanding of the firm's core logic of creating value (Rentmeister & Klein, 2003; Zott & Amit, 2010).[3]

To explain the transformation of business models, this study relies on the dynamic capabilities view (DCV). Dynamic capabilities are the capacity of an organization to purposefully create, extend, or modify the tangible, intangible, and human assets/resources as well as capabilities, which the company owns, controls, or has access to on a preferential basis (Helfat et al., 2007, p. 4 and 66). Firms require dynamic capabilities to develop their business model, exploiting chances and avoiding risks posed by dynamic markets, in order to achieve a competitive advantage over time (Teece, 2007; Demil & Lecocq, 2010). Furthermore, the DCV has emerged as one of the most influential strategic management lenses over the last decade (Di Stefano et al., 2014; Schilke, 2014). For these reasons, the DCV is an appropriate theoretical lens for servitization and the

[3] The term business model is often used interchangeably to refer to the core logic and the analytical tool. To avoid ambiguity, I refer to the core logic of value creation by firms with the term "business model", e.g., "Ryanair operates a low-cost business model". In instances in which I use the business model concept as an analytical tool, I refer to "business model framework", e.g., "The Business Model Canvas is a business model framework that describes the core logic of firms operating a specific business model through nine elements."

adaption of business models in its context (Kindström & Kowalkowski, 2014). The DCV suggests that manufacturers require a set of service-specific dynamic capabilities to successfully add services to their business models (den Hertog et al., 2010; Kindström et al., 2013; Gebauer et al., 2013). This is due to intangible and fuzzier nature of service values (Grönroos, 2007) and the fact that service innovation requires the sensing of local customer needs and problems (Kowalkowski et al., 2012).

Developing Solutions The first generic BMI path for MROs is to compete with manufacturers by developing solutions for their airline customers. To create solutions, pure service firms need to bundle services (targeting both the asset and the client) to achieve a competitive position on the market. Because MROs have offered solutions only to a lesser extent, they need to reconfigure their business model to make new, more encompassing, Value Propositions. Recent publications in the sector, such as the Engine Yearbook 2019, underline the continuous urgency of this need: *"it is clear that in order to survive independent MROs must continue to be highly adaptable and it is this that sets them apart — their ability to provide tailor-made solutions for the customer and to bend and stretch with the evolution of the engine market."* (Horwitz, 2019, p. 19).

However, the manufacturer-centric literature is of only little help to MROs. One main reason is that MROs come from a base in services and that the trajectory towards solutions is different from the product-side of the continuum (Tukker, 2004). As service providers already possess more service-focused elements in their business model, the shift is likely to focus on how to reconfigure the existing elements to create outcome-based offerings.

On the other hand, an absence of manufacturing-related business model elements will increase challenges associated with the underlying technology in the product. For example, assuming the risks inherent in outcome-based products may represent a challenge. In conclusion, MROs and other pure service firms possess different traditional business models that need reconfiguring and face different challenges than manufacturers. Considering these specific circumstances, previous manufacturer-focused servitization studies have only limited explanatory power.

A second aspect that underlines the need to study pure service firms stems from the fact that it is unclear whether they can reach a competitive position by developing solutions. The common assumption is that manufacturers possess product-related strengths that put them in a more competitive stance compared to pure service competitors (Johnstone et al., 2009; Ulaga & Reinartz, 2011) and thus, may gain at the expense of intermediaries (Baines & Lightfoot, 2013). However, it is unclear, to what extent this assumption is true (Story et al., 2017), as pure service firms may possess other sources of competitive advantage such as extensive local service infrastructure (Oliva & Kallenberg, 2003). They may also perform a crucial quasi-purchasing role for their customers, e.g., by providing advice in product acquisition and use (Olsson et al., 2013).

Alliancing The alliance option of MROs stems from the phenomenon that servitization does not occur in isolation at manufacturers, but instead in the form of solution networks where traditional service firms play a vital role. As a general agreement, manufacturers face limitations in performing all tasks associated with solution-provisioning themselves (Baines et al., 2007; Gao et al., 2011), a stand-alone approach is often less economically viable (Gebauer et al., 2013). Therefore, manufacturers tend to outsource non-core services to third-party service providers (Cohen et al., 2006; Helander & Möller, 2007), who possess greater experience in service provisioning (Beuren et al., 2013). As a result, a network with these third-party service providers is formed by the "solution integrator", which is usually referred to as service or solution network (e.g., Windahl & Lakemond, 2006; Gebauer et al., 2013; Eloranta & Turunen, 2016). In the service networks, each actor contributes to the offering (Vargo, 2011), focusing on their core competence and cooperation with other network actors (Basole & Rouse, 2008). In this context, service firms should reconfigure their business model to become network partners in these manufacturer-led solution networks. This would change the existing relationships with manufacturers that enter the service market.

However, academia has traditionally focused on manufacturers and their integrator role in the field of solution networks. Only recently, scholars have only recently taken a broader focus on capabilities that other actors, such as customers and intermediaries require in the context of servitization (Story et al., 2017). Hence, comparatively little scholarly attention has been paid to the needs of service firms to navigate in a servitized environment, despite their vital role.

Subsequently, a gap exists in understanding the reconfigurations of business models that service firms require to become network partners and the dynamic capabilities needed to do so. This gap is especially critical in the light that the performance of the solution offer depends on the actors in the network, even to a point where the brand image of the manufacturer can suffer, if service providers fail to deliver services adequately (Jaakkola & Hakanen, 2013; Nenonen et al., 2014).

Besides, most literature assumes that manufacturers are the central integrating actors of the solution network, while service firms play only a peripheral partner role (Paiola et al., 2013; Gebauer et al., 2013). Practice, however, shows that also pure service firms can integrate manufacturers and other vendors into a seamless solution and even assume responsibility for the manufacturer's service business. This phenomenon has only recently emerged under the label de-servitization and is not well understood, especially in regards to the increasingly blurring and changing responsibilities between the different actors in solution networks (Kamp & Parry, 2017; Kowalkowski et al., 2017). Specifically, literature remains unspecific regarding the different types of alliances between manufacturers and pure service firms, the associated benefits and sacrifices for service firms, and the factors that influence the alliance decision from a service provider side. Consequently, MROs as pure service firms cannot rely on literature when innovating their business model to cope with servitization.

The networked collaborations formed by manufacturers and service firms require fairly developed relational operational and dynamic capabilities (Gebauer et al., 2013; Story et al., 2017). These are, however, particularly challenging to create (Brax & Jonsson, 2009; Gebauer et al., 2012). For example, manufacturers are known to require relational dynamic capabilities to build, manage, and reconfigure their service networks from a central integrator position (Kowalkowski et al., 2011b; Salonen & Jaakkola, 2015). Traditional service firms occupy a decentral network position which requires reconfiguring the business model towards the manufacturer. The reconfiguration can be accomplished by developing specific offerings that build on resources and operational capabilities inherent in the service firm's business model. Hence, the business model innovation process of becoming a network partner differs considerably from the process of integrating actors in a solutions network. Therefore, the distinct dynamic capabilities require an empirical investigation to be understood.

In the Aerospace MRO market, alliancing with the manufacturer has been suggested as the second viable BMI to cope with servitization, mainly due to the manufacturers' ability to limit the MRO's access to repair manuals, licenses, and the required tooling (Schneider et al., 2013). However, there appears to be ambiguity at a strategic level about decisions on collaborative approaches and on how to actually perform this type of business model innovation. This is amplified by the fact that in practice different kinds of alliances exist that differ in the role that manufacturers and service firms take in the collaboration. Hence, the necessity to perform empirical research on different approaches for the formation of solution networks stems from both, an academic and managerial interest.

In summary, academia provides a limited explanation of how traditional service firms can reconfigure their business model to develop solutions and form partnerships with manufacturers. Additionally, we do not know which different types of alliances exist and the contingencies to their creation. As both are essential strategic options of pure service firms to cope with servitization and ensure competitive survival, further investigation in this field is paramount.

To understand the transformations of their business model that MROs should perform, an understanding of the very object of innovation is required. While business model innovation of manufacturers and airlines in the commercial aviation value chain has been or broad academic interest, MRO business models have received considerably less research. The various innovations that aircraft and engine manufacturers have undertaken in their business model to gain a competitive edge have been broadly examined. This includes establishing risk-and-revenue partnerships in the 1990s (MacPherson & Pritchard, 2007), and servitization since the 2000s (Ng et al., 2013; Batista et al., 2015;

Ferreira et al., 2016). Similarly, airlines' business models have been researched extensively. Scholars have laid the focus in this domain on the emergence of low-cost business models that continue to challenge traditional network carriers (Bieger & Agosti, 2005; Doganis, 2010), the convergence of these models (Daft & Albers, 2013, 2015), and performance effects of emerging hybrids between these business models such as the already dissolved airberlin (Corbo, 2017).

In contrast, the business model of maintenance-, repair, and overhaul firms has attracted considerably less interest. This is despite its relevance for explaining competitive advantage and network formation in the context of servitization, as well as its high potential for technological and scientific optimization (Uhlmann et al., 2013). Instead, different authors have outlined single elements of the MRO business models (e.g. organizational requirements, Hinsch, 2012), operational efficiency gains through lean methods (Thomas et al., 2008), and digitization (Sahay, 2012; Kashyap, 2012), or maintenance management (Tsang, 1998, 2002). As this fundamental underlying basis is missing, business model innovation of MRO providers, competitive advantage against manufacturers, and the formation of service networks cannot be explained by academia. Besides, practitioners cannot rely on a solid academic basis to drive their business model innovation efforts.

1.2 Purpose and Contribution

As the main objective of this study is to delineate the MRO firms' strategic BMI options to ensure sustainable competitiveness in these circumstances, I formulate the overall research question of:

"How can Maintenance, Repair and Overhaul service firms retain firm performance through business model innovation, when faced with servitization practices of aerospace manufacturers?"

This initial research question has been broken down into the following three sub questions:

1. *What are the elements and characteristics of the business model of Maintenance, Repair, and Overhaul service firms in the Aerospace Industry prior to servitization?*

2. *What are adequate strategic options for MRO service firms to cope with servitization?*

    a) *How can competitive advantage between MROs and manufacturers be explained based on their respective business models?*

    b) *What are adequate configurations of their business model that MROs can develop to cope with servitization?*

    c) *Which contingency factors influence the decision which configuration should be implemented?*

3. *How can MRO service firms reconfigure their business model to implement the identified configurations?*

    a) *What are the specific business model elements that MROs need to develop to implement these configurations?*

    b) *What are the specific dynamic capabilities and their microfoundations that MROs require to successfully reconfigure their business model?*

By answering these questions, I make three main contributions to servitization research that has mostly overlooked pure service firms so far.

Strategic Options for Pure Service Firms to Cope With Servitization My first contribution is to determine viable strategic options for pure service firms to cope with servitization through business model innovation. By employing a multiple case study, I build a two-dimensional framework containing five different archetypes of MRO business models. The first dimension encompasses the choice of delivering traditional service or solution offers. The second dimension involves the choice of whether to compete or collaborate with a manufacturer. Following the identification of the five archetypes, I outline their adequacy and implementation. This is performed by first discussing how the generic competitive strategies of differentiation, cost leadership, and focus can be applied in the MRO market for different types of service offers. Then, I examine how manufacturers and MRO service firms may leverage their business models to gain a positional advantage. Based on these findings, I explore the contingency factors that influence the alliance decision of MROs and hence the adequacy of the different archetypes. In the last step, I outline the business model reconfigurations involved in implementing these archetypes and the dynamic capabilities required to do so.

This study is motivated by two prior studies that have considerably advanced our understanding of competition between pure service firms and servitizing manufacturers in general and particularly in the aerospace industry. The first study by Ulaga & Reinartz (2011) examines how manufacturers can leverage the unique resources from their manufacturing background to build distinct capabilities that can be applied to generate a positional advantage against pure service firms. The reason why this contribution is seminal in the context of hybrid offerings is that Ulaga & Reinartz (2011) are the first and very few authors that examine competition between manufacturers and pure service firms in hybrid offers. In contrast, prior studies have examined servitization as a strategy to achieve competitive advantage against other manufacturers (Lightfoot et al., 2013) and have — possibly involuntarily — overlooked competition with pure service firms almost entirely. Ulaga & Reinartz' main argument underlining competitive advantage of manufacturers is their ability to link the product and service business. According to this argument, manufacturers are in a position to leverage their unique manufacturing-specific resources to build distinct capabilities that pure service firms do not possess. By applying these capabilities on different types of industrial product-service offerings, manufacturers can achieve differentiation or cost advantages versus service firms that do not possess these unique resources and capabilities.

The main limitation of Ulaga & Reinartz'study is that the authors base their sample only on manufacturers. Hence, sources of competitive advantage of manufacturers may underlie a certain bias by interviewees and, more importantly, sources of competitive advantage of pure service firms cannot be identified. Ulaga & Reinartz (2011, p. 22) explicitly acknowledge this limitation by stating: *"Scholars could also investigate how pure services firms venture into hybrid offerings and compare their resources and capabilities with our results."*. However, pure service firms possess unique resources, capabilities, or other sources of competitive advantage based on their service-oriented business model that are difficult to imitate for manufacturers. One example are cost advantages through economies of scale, learning curves, and pooling effects that service firms can realize by servicing equipment of various manufacturers (Mathieu, 2001b; Cohen et al., 2006).

In this context, the commercial aerospace industry represents an excellent empirical field for making a contribution, since traditional MRO service firms continue competing successfully against manufacturers in this industry.

However, competition is not always the best choice, as the numbers of alliances between MROs and manufacturers in recent years shows (Spafford & Rose, 2014). In this context, the second influential article provided by Schneider et al. (2013) comes into play. These authors provide further insights regarding the development of hybrid offerings and forming alliances by MRO providers in the aerospace industry, employing Business Model Innovation as the underlying conceptual lens. Schneider and her colleagues develop a rudimentary MRO business model and propose developing solutions and forming alliances as appropriate business model innovation paths for MROs to deal with changes in the aerospace industry.

Even though Schneider's study forms a solid base to start from, the study has noteworthy limitations. First, the MRO business model remains generic, being based on two dimensions only and is therefore very limited in explaining the core logic of MRO service firms. Second, the study proposes the two generic BMI paths of developing solutions and alliancing, however, remains unspecific in which cases which BMI path should be pursued and what configurations emerge, when these paths are executed simultaneously. Third and most importantly, the study states that alliances with manufacturers are a necessary but not sustainable approach until the manufacturers have gained sufficient service capabilities to provide solutions on their own. This statement poses an intriguing point of departure for my research, as the question arises, whether options for MROs exist to make this bitter side of servitization sweeter? Could MROs, for example, forego the creation of unsustainable alliances in some cases or establish certain types of partnerships that create more value and are more sustainable than others?

In conclusion, it remains unclear under which circumstances and how to perform which type of BMI. Additionally, we have a limited understanding of whether the different BMI paths are pursued in isolation or simultaneously and of the types of business models that evolve in each case. To give helpful guidance to MRO service firms, we need a much more detailed understanding of these parameters.

My study not only allows us to understand better how pure service firms can create solutions but also improves our understanding of the alliance decision of these firms in solution networks. While academia portrays the decision of manufacturers as a strategic choice that these firms make to either make or buy service capabilities (Paiola et al., 2013; Salonen & Jaakkola, 2015), our understanding of the respective choice of pure service firms has remained superficial. However, service firms should take a strategic approach towards the alliance decision, since it may compromise its established position in the service market and eradicate competitive advantage. My research shows that the alliance decision has more severe antecedents and effects than previously expected, directly tying into the competitive positioning between both parties. The quote *"if you can't compete, you better collaborate"* of one of the interviewees serves as vivid proof of that. Hence, unlike previously assumed, solution networks contain not only cooperative but also competitive aspects. This study outlines the complicated coopetitive nature of solution networks and the specific dynamic capabilities required by pure service firms to establish and manage these relationships with manufacturers.

However, the results indicate that not all alliances are created equal; instead, they involve different benefits and trade-offs for the service firm. Through a multiple case study, I identify three different types of alliances that pure service firms can pursue and the trade-offs involved in this choice. In contrast to earlier studies, I find that some configurations are a sustainable approach for MROs to develop their business model, while others are not. These findings contrast previous studies that have portray alliances with manufacturers as a time-limited and hence not sustainable approach (Schneider et al., 2013). Additionally, the developed contingency approach enriches our understanding of how pure service firms cope with servitization through alliances.

In the last part of this study, I outline the business model reconfigurations and specific dynamic capabilities required to implement each of the archetypes. Implementing these configurations by the means of the particular capabilities allows MRO service firms to successfully develop and implement viable strategic options to survive and thrive when faced with servitization. Overall, the main contribution of this study is developing a viable approach to business model innovation that MROs can employ to thrive and survive when faced with servitization. This involves identifying the contingency factors that determine the appropriate configuration and outlining how to implement it.

Unveiling the "Dark Side" of Servitization The competitive survival of pure service firms is not only an end in itself but has important implications for functioning service markets. Current research portrays servitization to be associated with positive effects, such as competitive differentiation, reduced risk, increased customer value, and the customer being locked-on, not locked-in (Wise & Baumgartner, 1999; Vandermerwe, 2000; Shankar et al., 2007; Ng et al., 2009). However, the manufacturers' downstream movement can have severe effects on customers that are left with reduced or no service choices for the lifecycle of their equipment. This is especially severe in industries such as aerospace that use complex product systems. These industries are characterized by long product lifecycles, where services such as maintenance constitute a significant proportion of the total cost of ownership for the customer (Davies & Hobday, 2005). By identifying the manufacturers' strategies to erect insurmountable barriers for service firms or bind them into their service networks, I shed light on the "dark side" of servitization. Explicitly, I identify the specific mechanisms that manufacturers employ to erect barriers to keep pure service firms from servicing their equipment. These mechanisms differ considerably from previous assumptions of how manufacturers can gain a positional advantage versus service firms (i.e., by leveraging distinctive capabilities based on their unique resources from their manufacturing background).

MRO Business Model Innovation Third, I make a contribution to business model literature in the commercial aviation industry. So far, research in this area has been limited to explaining innovative approaches to compete based on business model innovation of aerospace manufacturers (e.g., Ng et al., 2013; Batista et al., 2015; Ferreira et al., 2016) and airlines (e.g., Bieger & Agosti, 2005; Doganis, 2010; Daft & Albers, 2013). In this study, I develop an empirically grounded business model of MRO service firms, closing the missing link in the business model literature about the aerospace supply chain. MROs need to understand and adapt the core logic of how they conduct business, as business models of both their suppliers and customers change dramatically. When doing so, they can leverage unique elements of their business model to create a positional advantage by achieving strategic fit in times of increased environmental dynamism. One example is using the well-developed service-related engineering capabilities to create new digitally-enhanced service offers, which will be decisive for gaining a competitive edge in the commercial aerospace industry within the next years.

Managerial Implications This study also lays claim to make a threefold of managerial implications: first, managers of maintenance, repair, and overhaul firms within and outside of aerospace can make use of this study to successfully innovate their business model to survive and thrive when faced with servitization. While alliancing is a promising option, it is not the only choice and managers should carefully select the type of alliance arrangement depending on the presented contingency factors. When competing, coopeting, or alliancing with manufacturers, MROs should rely on the unique business model elements identified in this study. These elements can be used for both, formulating valuable contributions for manufacturers and building a competitive edge against them.

Second, the findings have implications for airline managers who are responsible for the development of the technical operations function, the MRO make-or-buy decision, and procurement of MRO services. Servitization is a severe environmental shift that presents these managers with opportunities and threats. On one hand, airlines can improve costs and reduce risks by relying on solution offers; on the other hand, they need to actively manage increasing long-term dependencies arising in the aerospace supply chain.

Third, this study has implications for aerospace manufacturers. Managers of these firms can benefit from the insights developed in this work to design alliances that allow MROs to make better value contributions to the partnership and ultimately the customer. Focusing on the core manufacturing business and outsourcing most services to a capable partner is another promising option to benefit from aftermarket revenues while limiting the risk associated with servitization.

1.3 Structure

The study is structured according to a design that consists of seven chapters, which aim to answer the research questions in a concise and structured manner. Following the introduction, the *conceptual background* is explained in Chapter 2. First, business models and their innovation are introduced as suitable underlying concepts to guide and structure this thesis; then servitization is introduced as the main academic research field to which I plan to contribute.

Section 2.1 outlines the concept of business models and the Business Model Canvas as an analytical tool to describe these models. Then, I introduce business model innovation and dynamic capabilities as the suitable underlying theoretical lenses that are used to explain the MROs' quest for sustainable firm performance. By studying this section, the reader can gain an understanding of what business models are and how they can be captured, analyzed, and innovated. In addition, the reader will be informed about the underlying strategic management constructs that aim to explain competitive advantage of the firm.

Section 2.3 is dedicated to *servitization*, the academic research field to which this research aims to make its main contributions. In this chapter, readers are provided with the required background terms, definitions, and the underlying rationale of servitization, to understand the context into which research is embedded. Existing servitization literature is synthesized into a business model framework, which allows us to comprehend solutions and their elements by the terms and logic of the business model lens. Another primary focus of this chapter is understanding the role of pure service firms in servitization literature, which is accomplished via a systematic literature review.

The *methodology* Chapter 3 explains the epistemological positioning and the research approach of the study. Systematic combining is introduced as the underlying methodology that systematically links established theory or concepts with qualitative case studies in an iterative process to create meaningful findings. Also, the data collection method, the course of the investigation, including the pilot and the multiple case study are introduced. Chapter 3 concludes the data coding and analysis process to explicate how the findings are derived from the data.

Chapter 4 outlines the *aerospace industry* as the empiric research field, providing the reader with a profound understanding of this exciting industry that builds the empirical context of this study. The description incorporates a characterization of the commercial aviation value chain from aircraft manufacturing over MRO to airlines as central actors of the value chain, including rules and regulations, as well as trends that are shaping the industry today.

One focus is the creation of the traditional MRO business model that is outlined in the Business Model Canvas. The traditional MRO business model allows us to understand the core logic of how MROs conduct business and compete as well as what is being innovated to fit with the new market realities induced by servitization. Besides, the traditional MRO business model forms the basis for understanding sources of competitive advantage of manufacturers and MROs, as both parties possess unique business model elements rooted in their traditional manufacturing and service background. A second focus lies on exploring the business model innovation practices of airlines and manufacturers that, being suppliers and customers, have the most substantial influence on MRO service firms. In conclusion, this chapter contains the traditional MRO business model and characterizes dynamic environment to which MRO firms have to adapt to achieve competitive survival and ensure sustainable firm performance.

Chapter 5 is dedicated to the empirical investigation, describing and interpreting the *Engine, Component, and Aircraft Case*, which represent the empirical foundation of this study. For each case, the developments of the respective market segment are analyzed, including the manufacturers' incursion into the aftermarket, as well as the focal firm's BMI activities to react to this environmental change. In Chapter 6, I outline a *strategic approach for MRO business model innovation* to cope with servitization practices of manufacturers. To achieve this target, I first define a portfolio of different strategic options for MROs to develop their business model. This portfolio contains different configurations of the MROs business model and is based on the two generic BMI paths of developing solutions and alliancing with manufacturers that have been identified by earlier studies (e.g., Schneider et al., 2013). In this context, a conceptual approach towards Porter's (1980) generic competitive strategies underlines the importance of solution development to escape cost-based competition in the MRO market.

Subsequently, competitive advantage of MROs and manufacturing companies is explained based on the unique elements of the respective business models. Together with an empirically developed contingency approach, the question of in which cases MROs should develop stand-alone solutions and in which situations they should ally with manufacturers is answered. The two core streams of the empirical investigation build around the questions of how pure service firms can create different types of alliances with manufacturers and develop integrated solutions. Following this approach, the chapter concludes with the exploration of the respective business model innovation paths to reach the different configurations and an analysis of the required dynamic capabilities and their microfoundations.

In the final chapter, Chapter 7, the findings of the study are discussed, which involves the *implications for academia and practice*. Here, I reflect upon how the results of this study inform and contribute to servitization research, MRO business models and competitive advantage between manufacturers and service firms in hybrid offerings. Besides, I reflect upon the partly paradoxical implications of the findings for managers of pure service firms, manufacturers, and airlines. In a last and final section, interesting alleys for *future research* and *limitations* of the study are outlined.

2
Conceptual Background

Contents

2.1 Business Models

2.1.1 Introduction

The concept of business models (e.g., Magretta, 2002; Osterwalder & Pigneur, 2013; Wirtz, 2011) is chosen as the conceptual framework to structure my research into distinct questions and guide the generation of findings. Business model frameworks are especially suitable for this task: they allow abstracting the complex reality of firms into comprehensible models that enable the description and understanding of the firm's core logic of value creation (Rentmeister & Klein, 2003; Zott & Amit, 2010).

According to Morris et al. (2005), the business model concept is based on various strategic management constructs, such as the value chain (Porter, 1985b), strategic positioning (Porter, 1996), the resource-based view (Barney, 1991), strategic network theory (Jarillo, 1988), cooperative strategies (Dyer & Singh, 1998), boundary decisions, and transaction cost economics (Williamson, 1981; Barney, 1999). Firms are analyzed on strategic (corporate core logic), structural (value chain activities), and resource level, following a systemic, multi-level approach (Daft & Albers, 2013). These properties allow the researcher to emphasize certain areas of interest without jeopardizing the comprehensiveness of the model.

Besides their strong link to strategic management approaches, business models are nowadays amongst the most widely used concept in strategic planning as stated by Baden-Fuller & Morgan (2010, p. 156) *"when people are asked 'what is strategy'? most give an answer that includes the words business model"*. Originating from e-business, business models have extended their application to other areas, such as low-cost and networks (Daft & Albers, 2015), McDonald's franchising system (Baden-Fuller & Morgan, 2010), and Apple's iPod (Johnson et al., 2008).

However, the business model concept has not remained free from critique, especially in its early days, when contributions criticized it of being unclearly defined. For example, Porter (2001, p. 13), notes that *"the definition of a business model is murky at best"*. Other authors such as Magretta (2002) disapprove of the sloppy definition of the term and the overlap with the concept of strategy. Contemporary business model literature has, however, overcome these initial hurdles and provides a more harmonized understanding and definition of the business model concept (Zott et al., 2011; Daft, 2015).

Servitization literature has broadly embraced the business model concept since the beginning, however with little rigor especially in earlier papers that refer mostly to the Value Proposition and types of services provided (Baines et al., 2017). In contrast, only few servitization studies that employ the business model concept offer a holistic approach to implementing hybrid business models. Instead, studies are mostly concerned with either establishing business model typologies or with the business model innovation process required for successful service infusion (Kowalkowski et al., 2017). However, the concept is well-suited to investigate servitization, as firms need to focus on innovating all areas of their business models in a holistic fashion, and not just change isolated elements to successfully convert to a service-based business model (Kindström, 2010; Kindström & Kowalkowski, 2014; Adrodegari et al., 2015; Forkmann et al., 2017a). As this shift is a dynamic process affecting many business model elements simultaneously (Ferreira et al., 2013), business model frameworks are of high utility for companies that aspire to master this change successfully (Barquet et al., 2013; Weeks & Benade, 2015).

In the Aerospace industry, the business model concept has been widely accepted to explain how firms compete with each other through different business logics. Especially business models of airlines have been extensively researched, as traditional network carriers were challenged by low-cost carriers such as Southwest or Ryanair (Doganis, 2010; Gillen & Morrison, 2003; Bieger & Agosti, 2005; Daft & Albers, 2013). Also, the aircraft manufacturers' innovation of their business models from the traditional build-to-print setup, via risk-and-revenue partnerships in the 1990s towards solution provisioning since the 2000s has received considerable research (Esposito, 2004; Pritchard, 2002; Baines et al., 2007; Esposito & Raffa, 2007; MacPherson & Pritchard, 2007).

As manufacturers compete with new, service-infused business models against maintenance, repair, and overhaul firms, business model innovation is a well-suited concept for MROs to react to this competitive threat. The reason is that business model innovation goes beyond pure differentiation and cost leadership strategies. Instead, it reconfigures the core logic of the enterprise, aiming to mitigate threats, seize opportunities, and ensure competitiveness (Teece et al., 1997). Schneider et al. (2013, p. 288) explicitly support this approach by stating that *"[t]o ensure survival, firms such as the MRO providers are not only required to consider and drive the commercialization of isolated product or service innovations but also to question their underlying core business logic"*.

In conclusion, the business model concept offers a strong foundation on which the MROs need for offering solutions and alliancing with manufacturers can be conceptualized from a single, holistic perspective.

2.1.2 Business Models, Business Model Innovation, and Sustainable Competitive Advantage

A firm's business model determines how the elements of the business fit together in a unique combination that results in superior value creation and thus can partly explain how competitive advantage is created (Morris et al., 2005). Thus, the general assumption is that business models can create competitive advantage by two mechanisms: first, unique, valuable elements can be leveraged into a positional advantage, or second, the unique combination of business model elements that is difficult to imitate can create a positional advantage (Teece, 2010). Business model literature draws on various strategic management constructs to explain competitive advantage based on single elements of the business model (Morris et al., 2005). Amongst the most popular theory are the resource-based view (RBV) (Barney, 1991) and its extension the resource advantage (RA) theory (Hunt & Morgan, 1995). Both concepts view the firm as a bundle of resources and capabilities that have the potential to create competitive advantage over competitors. While the RBV posits that the sheer possession of valuable, rare, inimitable, and not substitutable resources and capabilities explain performance differences (Barney, 1991), RA theory accounts for the market position of the firm (Hunt & Morgan, 1995).[1] According to RA theory, resources do not lead to a competitive advantage per se; rather they have the potential for rent generation (Morgan, 2012). I.e., Superior performance is achieved, as superior resource endowments allow firms to achieve a better relative cost position or superior value creation for certain customer segments (see Figure 2.1). As resources and capabilities form part of the internal value creation logic of business models (Wirtz, 2011), these theoretical concepts are commonly used to explain competitive advantage based on elements inherent in the business model.

		Relative Resource-produced Value		
		Lower	Parity	Superior
Relative Resource Costs	Lower	?	Competitive Advantage	Competitive Advantage
	Parity	Competitive Disadvantage	Parity	Competitive Advantage
	Higher	Competitive Disadvantage	Competitive Disadvantage	?

Figure 2.1: Competitive Position Matrix (adapted from Hunt & Morgan, 1995, p. 7)

Strategic networks are *"stable interorganizational ties which are strategically important to participating firms. They may take the form of strategic alliances, joint ventures, long-term buyer-supplier partnerships, and other ties"* (Zaheer et al., 2000, p. 203). As business model frameworks explicitly take value creation with partners into account, strategic network theory can be used to answer some of the main questions associated with joint value creation, such as *"how is value created in strategic networks?"* and *"how do firms positions*

[1]For simplification purposes, resources, and capabilities that fulfill the criteria of being rare, inimitable, and non-substitutable are referred to as being unique.

and relationships in networks affect their performance?" (Zott et al., 2011). In the context of alliances, also the relational view is a relevant theory, as it seeks to explain competitive advantage through inter-organizational arrangements such as (a) relation-specific assets, (b) knowledge-sharing routines, (c) complementary resources and capabilities, and (d) effective governance mechanisms (Dyer & Singh, 1998).

The second mechanism by which business models can create a positional advantage is by creating a unique combination of a business model's elements that is difficult to imitate.[2] As such, competitive advantage can emerge from the superior coordination of the firm's activities, its internal value chain or the excellent management of the interfaces with others in the value network (Morris et al., 2005).

However, firms do not only compete in the present but also need to be concerned about a favorable competitive position in the future, a concept known as ambidexterity of the firm (O'Reilly 3rd & Tushman, 2004). In other words, firms need to formulate ways in which they can achieve sustainable competitive advantage through current and future business logics, which has traditionally been at the field of strategy research (Porter, 1996). Business model innovation is a way for firms to sustainably create and appropriate value, especially in times of economic change (Zott & Amit, 2010). This is achieved by creating new business logics which are well adapted to a changing environment. Hence, strategy and business model innovation are two concepts that are inevitably tied to one another. For example, Teece (2007, p. 1325) notes: *"the essence of strategy involves selecting and developing technologies and business models that build competitive advantage through assembling and orchestrating difficult-to-replicate assets, thereby shaping competition itself."*. However, the relationship between strategy and BMI remain ambiguous, and business model innovation has not been anchored in any particular strategic management field (Foss & Saebi, 2017). To avoid ambiguity and inconsistencies, I rely on the business model innovation terminology throughout this study.

Casadesus-Masanell & Zhu (2013, p. 464) provide a definition of business model innovation that is particularly well suited in the context of this study: *"At root, business model innovation refers to the search for new logics of the firm and new ways to create and capture value for its stakeholders; it focuses primarily on finding new ways to generate revenues and define value propositions for customers, suppliers, and partners."*. Maintenance, Repair, and Overhaul firms face changing market logics, existing stakeholder with evolving roles, and customers that require more encompassing types of Value Propositions. Hence, BMI is a suitable concept to examine the different strategic options in which MROs can aim for sustainable performance.

In conclusion, the business model concept provides a large variety of possibilities to explain competitive advantage especially in a dynamic environment based on well-established strategic management concepts. It has even been argued that in certain markets no single strate-

[2]Matzen (2009) and (Storbacka et al., 2013) refer to the proprietary level of the business model.

gic management construct can fully explain competitive advantage by itself, while the business model concept provides the required integration of the distinct perspectives (Amit & Zott, 2001). Hence, scholars should draw on a variety of concepts that are most relevant for the idiosyncratic case to explain competitive advantage better. The dynamic environment in the aerospace industry forces MRO firms to find new core logics of how to compete, which makes business model innovation a well-suited concept for examination.

2.1.3 The Business Model Canvas

Academia has generated an abundance of business model frameworks (e.g., Osterwalder et al., 2005; Wirtz, 2011; Gassmann et al., 2013; Daft, 2015) from which a researcher can choose to structure their research. To choose an appropriate framework, considerations regarding the content and logic of each attempt as well as practical considerations need to be made.

Considerations regarding content and logic require business model frameworks to *"be reasonably simple, logical, measurable, comprehensive, and operationally meaningful"* (Morris et al., 2005, p. 729). Also, the framework needs to define how the contained elements relate to and influence each other (Baden-Fuller & Morgan, 2010). The Value Proposition should be defined as the central component around which activities are designed to deliver value to the customer (Osterwalder & Pigneur, 2013; Gassmann et al., 2013; Schallmo, 2013). The framework should consider financial aspects such as cost structure and the generation of revenues, as these allow making considerations regarding profitability (Schallmo, 2013). Zott & Amit (2010) suggest the support of an activity system, which can be designed or modified to generate value from internal or external resources and capabilities. Finally, business model frameworks should visualize information to facilitate the understanding of complex information by its users (Osterwalder et al., 2005).

Additional requirements for the business model framework arise from practical considerations. In the aerospace industry in general and in solution provisioning in particular, service networks are used to co-create value for the customer (Gebauer et al., 2013; Paiola et al., 2013). Therefore, value creation through alliances or in networks should be included as one of the framework's elements. Furthermore, the business model framework should facilitate communication in designing, innovating or refining business models. Hence, selecting a business model framework that is well-established in practice is advantageous, as practitioners do not have to familiarize themselves with the peculiarities of the concept.

The Business Model Canvas (BMC) is a business model ontology that has been initially developed by Alexander Osterwalder in his doctoral thesis (Osterwalder, 2004) based on structured review of current business model literature at that time. Since its creation, it has quickly disseminated in research and practice (Günzel & Holm, 2013), i.a. in the focal company, and was refined in various publications (e.g., Osterwalder et al., 2005; Osterwalder & Pigneur, 2013). Due to its conceptual maturity and acceptance in research and practice, the Business Model Canvas is selected as the analytical framework for this publication.

Its nine elements structured around the Value Proposition allow for clear visualization and are structured clearly in a value creation part on the left and customer-oriented part on the right side. Financial aspects are included through the two elements Cost Structure and Revenue Streams. Also, Key Partners are explicitly considered as an element of the value creation part.[3]

Value Proposition The Value Proposition describes the *"bundle of products and services that create value for a specific Customer Segment"* (Osterwalder & Pigneur, 2013, p. 22). It can be decomposed into a set of offerings that can be managed individually, allowing for differentiation from competition, thus achieving a competitive position. Value is created for each Customer Segment through a mix of distinctive elements, such as newness, increased performance, "getting the job done", price-, cost-, or risk reduction. A Value Proposition should be evaluated over its entire life cycle from value creation, over the purchase, in use, renewal, and transfer at the end of the life cycle (Anderson & Narus, 1998). This aspect is especially relevant in the context of servitization, as manufacturers extend their responsibilities for value creation from manufacturing downstream towards the full life cycle (Mont, 2002).

Customer Segments Customer Segments are the *"different groups of people or organizations an enterprise aims to reach and serve"* (Osterwalder & Pigneur, 2013, p. 21). Customers can be segmented according to distinctive offers required, distribution Channels used, desired Relationships, their profitability, or according to their willingness to pay for certain aspects of the offer. Segmentation allows the firm to identify and focus on attractive customer groups, as well as formulating the right ways on how to address them, such as Channels and desired Relationship (Osterwalder, 2004; Grant, 2010; Scheuffelen, 2017).

Channels This element describes *"how a company communicates with and reaches its Customer Segments to deliver a Value Proposition"* (Osterwalder & Pigneur, 2013, p. 26). The Channel element can be decomposed into different links with the customer that can

[3]To avoid ambiguity, reference is made to each of the elements throughout this thesis by capitalizing the first letter of each word, e.g., Value Proposition.

[4]Source: https://strategyzer.com/canvas/business-model-canvas.

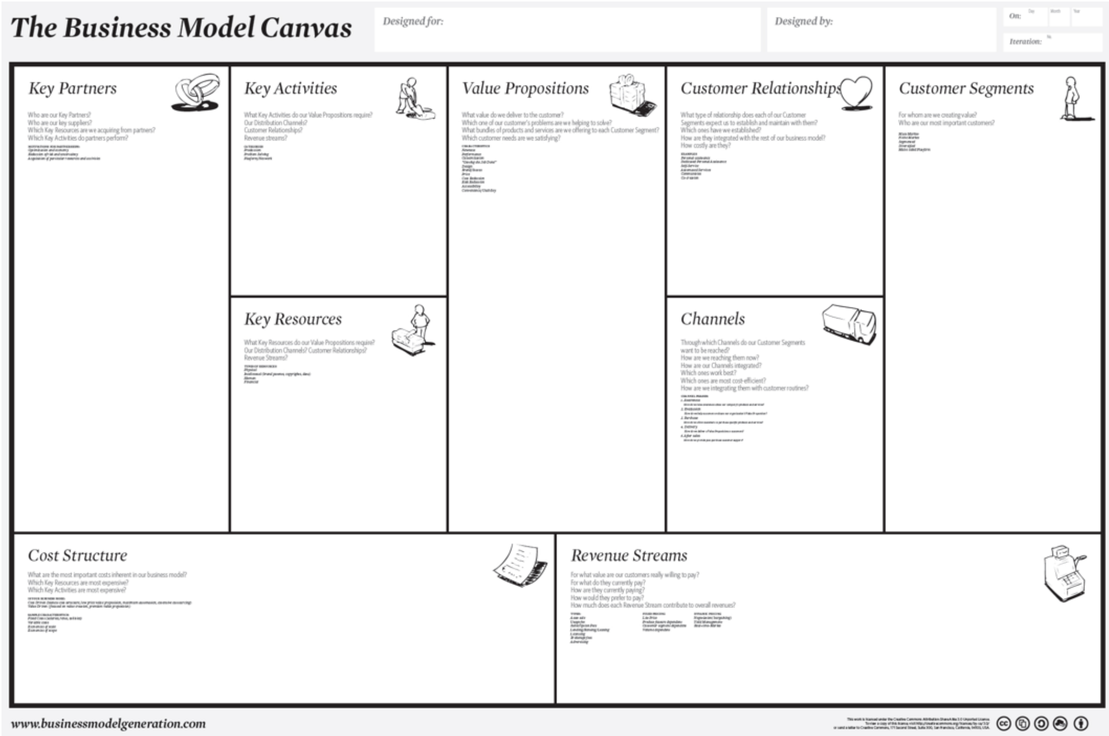


Figure 2.2: The Business Model Canvas[4]

be employed simultaneously, such as the company's website and retail stores. A company's interface with the customer comprises three types of Channels: communication, distribution and sales channels. The choice of Channels is crucial for delivering the Value Proposition and influences the Relationship with the customer: firms have the choice to either use their own channels such as the firm's sales force, web sales or owned stores or partner channels such as wholesale stores or online platforms to advertise, sell and deliver the firm's offerings. While owned channels provide a firm with higher opportunities for margins and closer customer contact, they may be costly to establish and operate. Partner channels, on the other hand, offer the benefit of a wider reach and utilization of the partner's strengths, may however lead to lower margins (Osterwalder & Pigneur, 2013).

Customer Relationships The element Customer Relationships describes *"the types of relationships a company establishes with specific Customer Segments"* (Osterwalder & Pigneur, 2013, p. 28). Osterwalder describes various relationships from automated processes that recognize particular customers, over personal assistance (e.g., a customer representative) up to user-communities or value co-creation between customer and supplier.

One of the most crucial factors determining buyer-supplier relationships is interdependence and power (Wilson, 1995), discussed in the Resource-Dependence Theory (Pfeffer & Salancik, 1978; Anderson & Narus, 1984, 1990; Dwyer et al., 1987; Heide & John, 1988).[5] The power of a firm A over a firm B comes from control of resources[6] that are valuable for B and not available elsewhere. Thus, power and dependence are inverted: B is dependent on A to the extent that A has power over B. Furthermore, power is not a zero-sum game: mutual interdependence occurs, when A and B have power over each other (Davis & Cobb, 2010). The dependence on a trade partner depends on the extent to which he provides critical resources for which there are few alternative sources of supply (Buchanan, 1992). A lock-in is a type of pronounced dependence in which the dependent firm is confined to an exchange relationship. Causes of this confinement can be i.a., the lack of alternative options, high switching costs, or even of cognitive nature (Harrison et al., 2012).

Key Activities The element Key Activities includes *"the most important things a company must do to make its business model work."* (Osterwalder & Pigneur, 2013, p. 37). Key Activities involve the firm's operating routines, as these secure the operational functioning of the company. Operating routines involve the routines along a company's value chain by which a company usually earns profits (e.g., purchasing of raw materials, research and development, production, and selling of goods, Wilhelm et al., 2015).

Porter (1996) highlights the importance of Key Activities for competitive advantage, by claiming that firms must either deliberately choose a specific set of activities that differentiate them from their competitors or perform them differently. Hence, Key Activities must be tailored to the individual business model to make it work and enable effective strategic positioning of the firm.

Key Resources The element Key Resources includes *"the most important assets required to make a business model work."* (Osterwalder & Pigneur, 2013, p. 34), including both material and immaterial resources. This element is rooted in the resource-based view of the firm (Wernerfelt, 1984; Barney, 1991; Peteraf, 1993), arguing that (a) companies need resources to create value and (b) may achieve a sustainable competitive advantage through the deployment of unique resources and capabilities. In line with the relational view (Dyer & Singh, 1998), the Business Model Canvas argues that resources and capabilities do not have to be developed internally but can also be provided by other firms through Key Partnerships.

[5] For a list of theoretically and empirically supported variables describing buyer-supplier-relationships, refer to (Teece et al., 1997, p. 4)

[6] Besides control of resources, other sources of dependence exist. For example, idiosyncratic investments made for a relationship that have little value outside of the relationship can be antecedents to dependence (Bensaou, 1999).

Resources per se do not enable a competitive advantage but need to be transformed through capabilities to do so (Helfat & Lieberman, 2002). A capability is *"a firm's capacity to deploy Resources [...] to a desired end"* (Amit & Schoemaker, 1993, p. 35) through the Key Activities of the firm.[7] Capabilities are information-based, firm-specific and are developed over time through complex interactions among the firm's resources (Amit & Schoemaker, 1993). Hence, Key Capabilities are both, created by the interaction or usage of resources, and required for transferring resources into Value Propositions. In the Business Model Canvas, Key Capabilities are included in the Key Resources element (Osterwalder, 2004).

Dynamic capabilities can be discerned from operational capabilities as being higher-order versus zero level capabilities. Sydney Winter illustrates the difference, by defining DCs as *"capabilities that would change the product, the production process, the scale, or the customers (markets) served"* (Winter, 2003, p. 992), while operational capabilities are *"how we earn a living now capabilities"*. As dynamic capabilities are required for innovating and not sustaining the business model (Fowler & Reisenwitz, 2013), I have chosen to place them in a separate section.

Key Partners The element Key Partners describes *"the network of cooperative agreements with other companies necessary to efficiently offer and commercialize value."* (Osterwalder et al., 2005, p. 10). Multiple theories offer various motivations for firms to enter alliances:[8] Transaction Cost Economics (Williamson, 1985) take an efficiency perspective, arguing that alliances can provide cost advantages compared to the internalization of production processes or purchasing of goods on the market (Dussauge & Garrette, 1999). According to the resource-based and the complementary relational view (Dyer & Singh, 1998; Gulati & Gargiulo, 1999; Lavie, 2006) firms can create value from resources, capabilities, and knowledge that are not fully owned by a single organization but a network of partners. In this view, alliances can create a competitive advantage based on complementary capabilities, relationship-specific assets, effective governance, and interfirm knowledge-sharing routines (Dyer & Singh, 1998). The institutional view (DiMaggio, 1988) argues that organizations are motivated to seek legitimacy or approval through social constituents such as shareholders, customers, and suppliers. Another benefit of alliance formation is the reduction of risks and uncertainties, which can be reduced by partnering even with competitors (Brandenburger & Nalebuff, 1996).

Cost Structure The element Cost Structure contains the most important costs of a business model (Osterwalder & Pigneur, 2013). Companies choosing a cost leadership

[7] Amit & Schoemaker (1993) refer to processes instead of Key Activities.

[8] Typically, an alliance is formed with the Key Partners, an alliance being defined as "Institutionalized, voluntary cooperation between two or more firms toward a common goal" (Albers, 2010, p. 205). For an extensive review of antecedents to alliances, see Beuren et al. (2013).

strategy (Porter, 1985a) need to put a higher emphasis on this element than companies choosing a differentiation strategy. To reduce a business model's Costs Structure, leveraging economies of scale or scope can be viable tactics (Grant, 2010). The Cost Structure is determined by analyzing all elements of the business model that may incur substantial costs, such as Key Resources, Key Activities, Channels, Customer Relationships, or Key Partnerships.

Revenue Streams The element Revenue Streams describes the incoming cash flows from each Customer Segment. Furthermore, it delineates the mechanisms, which are used to determine the pricing of the value proposition (Osterwalder, 2004; Osterwalder & Pigneur, 2013). In the context of solutions, pricing is an essential element, as it changes from an input- towards an output-based logic (Tukker, 2004). By jointly analyzing a firm's Revenue Streams and Cost Structure, the financial viability of a business model can be described.

2.2 Business Model Innovation

The difficulty of continuing with traditional business logic has become a common phenomenon for firms operating in various industries. Previously successful business models come increasingly under pressure from shifting competitors, technologies and blurring industry boundaries (Helfat et al., 2007; Teece, 2007). The airline and retail industry are two examples in which new competitors have revolutionized the way to do business and put enormous competitive pressure on market incumbents that needed to innovate their deteriorating business models (Johnson et al., 2008).

In consequence, business model innovation, taking the whole business model instead of products, services, or management processes as the locus of change has received increasing managerial and scientific attention (Baden-Fuller & Morgan, 2010; Chesbrough, 2010; Zott & Amit, 2010). Zott & Amit (2010, p. 217) provide a popular definition, defining business model innovation as: *"the bundle of specific activities that are conducted to satisfy the perceived needs of the market, including the specification of the parties that conduct these activities (i.e., the focal firm and/or its partners), and how these activities are linked to each other."* This definition is suitable for this thesis, as it deliberately recognizes the fact that partners play a significant role in value creation, and that BMI involves value creation for all involved parties (i.e., customers, partners, and the firm), not merely value attribution.

BMI can be applied both to companies that aim to make small but meaningful changes in their business model and to entrepreneurs or companies that aim at designing entirely new business models (Zott & Amit, 2010). In markets that are characterized by low levels of dynamism, scaling and stretching of the business model to better exploit given business opportunities may be the most viable option for BMI (Winter & Szulanski, 2001). In cases in which firms are confronted with significant levels of environmental dynamism, a mere fine-tuning of business models is not sufficient. Instead, firms will require more substantial reconfigurations to remain competitive (Helfat et al., 2007; Teece, 2007).

2.2.1 A Portfolio Approach for Business Model Innovation

Portfolio Approaches in Strategic Management

Portfolio approaches to develop the business model or to improve the strategic positioning of the firm's offering are common practice. One example is Hertz & Alfredsson (2003), who examine third-party logistics providers' strategic options and the underlying capabilities for providing advanced services and logistics solution offers for their customers. Another well-known example from corporate strategy is BCG's growth-share matrix that uses industry attractiveness and competitive position to compare the strategic positioning of different businesses and steer their development (Grant, 2010).

The popularity of portfolio approaches for strategic management can be partly explained by strategic uncertainty that firms face when committing to a specific plan and the tradeoffs involved in that decision. In this context, firms must transform their business model to fit this plan (Zott & Amit, 2008) and make sustainable long-term commitments to preempt imitation and ensure sustainable performance (Raynor, 2007). Simultaneously, strategic uncertainty and environmental dynamism lead to situations in which firms make in hindsight wrong long-term strategic decisions and subsequent resource commitments (the development of Sony's Minidisc Player is an example of this feat, where a chosen strategy was meticulously planned and executed, however the development of MP3 technology rendered the Minidisc player uncompetitive). In these situations, a portfolio approach that entails various strategic options, helps firms to better cope with the tension that arises between adaptability and commitment caused by environmental dynamism and strategic uncertainty (Raynor, 2007).

On the other hand, committing to a specific configuration of a business model entails certain tradeoffs. The underlying reason for these tradeoffs are the distinct Key Activities, Resources, and Capabilities that firms must excel at to make unique Value Propositions to their customers and achieve competitive advantage. For example, Hertz & Alfredsson (2003) show how logistic service providers need to balance between general problem-solving capabilities and specific customer-adaption capabilities when providing different types of logistics solutions to their customers. Also, business models employ distinct value creation logics, including creating value by transferring standardized inputs into products or services or finding solutions to unique customer problems.

A third option is to create value by integrating resources, capabilities, and linking actors in a networked approach (Stabell & Fjeldstad, 1998).[9] Firms need to deliberately choose a configuration and execute the associated Key Activities based on unique Key Resources and Capabilities, as trying to be everything at once involves tradeoffs, dilutes the business model, and erodes competitive advantage (Stabell & Fjeldstad, 1998; Porter, 1996).

Finally, firms need to build specific dynamic capabilities that enable them to reconfigure their business model into the desired configuration (Teece, 2007; Ludwig & Pemberton, 2011). As these are costly to develop and maintain (Zollo & Winter, 2002), firms should focus on building the dynamic capabilities that are required to reach the desired configuration, not all types of possible configurations. Providing solutions, for example, requires more advanced service-related customer need sensing capabilities than traditional product offers (Kindström et al., 2013). The specificity of dynamic capabilities is the reason why manufacturers that wish to add services to their business model need to concentrate more on building these capabilities than manufacturers that follow a pure product differentiation strategy.

Pure service firms face the dilemma of increased environmental dynamism and strategic uncertainty caused by servitization efforts of manufacturers with the simultaneous need to commit to a particular configuration of their business model on which they plan to compete. Besides, they face tradeoffs when developing their business model along different dimensions. For example, it is difficult to simultaneously build the required dynamic capabilities to understand the manufacturer and adapt the business model to cater to the manufacturer's needs, while simultaneously undertaking all needed efforts to develop solutions for end customers. Hence, the portfolio is a useful strategic approach to guide pure service firms in general and MROs in particular in creating their business model innovation plans. Therefore, the portfolio approach allows service firms to reach an ideal fit with changes in the external environment caused by servitization.

Configurations

I use a configurational approach (Miller & Friesen, 1984) paired with the Business Model Canvas as the underlying framework that describes the individual configurations of MRO business models. The described configurations are an abstraction of real MRO business models into ideal types or archetypes (Miller & Friesen, 1984), in which complex situations are parametrized by a limited set of mutually supportive parameters (i.e., the business model elements) that form a cohesive system (Miller, 1986).

[9] These three business model configurations have been labeled by Stabell & Fjeldstad (1998) as Value Chain, Value Shop, and Value Network.

This abstraction is useful, as *"Configurations allow people to order and make sense out of their worlds by sorting things into discrete and relatively homogeneous groups."* (Meyer et al., 1993, p. 1197), which can be better analyzed and understood than the complex reality of single instances. The configurations that are presented here are in line with the common assumption of having a close fit between external situational factors and the internal design parameters (Mintzberg, 1979). Working with configurations allows me to identify the contingency factors that determine which ideal type firms should choose from the portfolio.

However, I depart from the equifinality assumption, which states that the configurations are equally effective as they are a harmonic combination of context and structure (Meyer et al., 1993). The reason is that some of the identified business model types have the potential for a higher firm performance of the MRO service firm than others. Even though I was not able to collect figures to support this claim, interviewees clearly stated which configuration is preferential for which reasons.

According to configurational theory, a firm must seek to align strategy, organizational arrangements, and conditions of the external environment. In order to do so, the firm will choose different organizational arrangements depending on internal (i.e. firm- and offering-specific) and external (i.e. market-specific) contingency factors (Mintzberg, 1979; Gresov, 1989; Donaldson, 2001). This logic is reflected in business model literature which highlights that a fit between the business model itself, the environment, and the firm's strategy needs to be achieved (Osterwalder, 2004; Zott & Amit, 2008; Demil & Lecocq, 2010). Hence, there is no single, best way to organize a firm; instead business model innovation should seek to develop a business model that is best suited to the particular circumstances (Davies & Brady, 2000).

Contingency Factors can take a variety of forms and can be present externally of the firm (e.g., as market-specific factors) or reside internally (e.g., a change of strategy may trigger adaptions in the business model, Kowalkowski et al., 2011b). A well-known market-specific factor is the level of environmental dynamism, as the type of dynamic capabilities required for business model innovation and the effectiveness of dynamic capabilities on firm performance is contingent on the level of environmental dynamism (Zollo & Winter, 2002; Winter, 2003; Schilke, 2014). At the same time, the presence of dynamic capabilities represents an internal contingency factor for BMI (Foss & Saebi, 2017). The reason is that dynamic capabilities are required to perform specific BMI paths (Teece, 2007) but are not readily present. Instead, they need to be built and sustained, which requires time and effort (Zollo & Winter, 2002).

A firm's dependence on resources controlled by external actors is another contingency factor for organizational arrangements, which has been broadly explored by scholars employing the Resource Dependence Theory (RDT, Pfeffer & Salancik, 1978). RDT characterizes the firm as an open system that is dependent on the contingencies of the external environment (Pfeffer & Salancik, 1978). Central to the RDT is the concept of power, which is derived from the control of critical resources (Ulrich & Barney, 1984).

According to RDT, firms attempt to limit the power others have over them, while often trying to increase their control over others (Hillman et al., 2009). These actions may lead to power imbalance and mutual interdependence between firms (Casciaro & Piskorski, 2005). Firms can develop their business model in various ways to limit dependence, e.g., by adding partners in the form of strategic alliances or joint ventures and adding activities such as political actions to their business model (Hillman et al., 2009).

Resource dependence and the enactment of power over other actors are of particular relevance in the context of servitization. The reasonx is that interdependence is present in service networks that manufacturers employ to provide their hybrid offerings. While on one hand manufacturers try to gain a central network position that can be used to obtain power and exert it over the suppliers in the network (Corsaro et al., 2012; Salonen & Jaakkola, 2015), they also depend on their partners due to relationship-specific investments and adverse image effects of their partners' unsuccessful service offerings, which leads to mutual interdependence (Kindström, 2010; Salonen & Jaakkola, 2015). As dependence on the manufacturer has emerged as a pivotal theme in the pilot study, RDT is expected to have high explanatory power for MRO competitiveness and alliance formation in the aerospace industry.

2.2.2 Dynamic Capabilities: Enablers of Business Model Innovation

The Nature of Dynamic Capabilities

The Dynamic Capability View (DCV) of the firm arose approximately two decades ago, aiming to identify *"the sources of enterprise-level competitive advantage over time"* (Teece, 2007, p. 1320). The DCV attempts to explain why some firms thrive and survive in turbulent environments and aims to identify the underlying drivers of long-term firm survival and success (Wilden et al., 2016). The DCV resulted out of the critique on the resource-based view, being too static and not taking the possibly disruptive effects of changing environments into account (Helfat et al., 2007). Over the last decade, the DCV has emerged as one of the most influential lenses of strategic management, with a steady and strong incline in research activity (Di Stefano et al., 2014; Schilke, 2014). Helfat et al. (2007, p.4) provide a widely-accepted understanding of a dynamic capability being: *"the capacity of an organization to purposefully create, extend, or modify the tangible, intangible, and human assets/resources as well as capabilities, which the company owns, controls, or has access to on a preferential basis"*. As such, dynamic capabilities are the internal enablers of business model innovation (Foss & Saebi, 2017). Dynamic capabilities can be distinguished from operational capabilities by the fact that they are required to innovate not operate the business model (Helfat & Peteraf, 2003).

Microfoundations of Dynamic Capabilities

Dynamic capabilities are often disaggregated into the three categories of sensing, seizing, and reconfiguring according to the framework developed by Teece (2007). Sensing refers principally to the perception of opportunities and threats by gathering and assessing business intelligence. This category may include the sensing of customer preferences, the emergence of new technologies, developments of local and global markets but also new competitors (Helfat et al., 2007; Teece, 2007).

Once firms perceive opportunities, they need to seize them to leverage them into competitive advantage. Seizing almost always requires an investment, for example into an R&D project. Also, structures must be in place to decide which of the multiple, often competing, opportunities to pursue. During this process, the firm may create or select a particular business model that supports the commercialization strategy and investment priorities (Teece, 2007). However, a pure investment in technological competency and complementary assets is not sufficient. Instead, the firm must run a business model that is flexible enough to sustain and exploit new opportunities as they present themselves (Chesbrough, 2010; Teece, 2010).

A key to successful and sustainable growth is the capability to reconfigure the business model of the firm, adapting it for example to changing markets or technologies (Teece, 2007, 2012). Successful firms often become complacent and rigid over time, frequently rather fine-tuning their business model and focusing on exploitation instead of exploration. This fine-tuning may be sufficient in cases of minor environmental dynamism; however, firms will require more substantial reconfigurations when faced with higher environmental dynamism or even disruptive change (Helfat et al., 2007; Teece, 2007).

The three categories of sensing, seizing, and reconfiguring can be further disaggregated in their microfoundations, which are the *"organizational and managerial processes, procedures, systems, and structures that undergird each class of capability"* (Teece, 2007, p. 1321).

In conclusion, dynamic capabilities enable organizations to purposefully innovate or reconfigure all elements of their business model, be it their own or partners' resources and capabilities, their Key Activities, Customer Relationships or the very core logic of how value is created.

The Context-specificity of Dynamic Capabilities

Dynamic capabilities are not universal but depend on the specific industry and context (Ludwig & Pemberton, 2011). While early studies exhibit a bias towards products and technological innovation (Kindström et al., 2013), only little progress in the service domain have been made. For example, scholars have undertaken conceptual and empirical studies of the dynamic capabilities required for service innovation in general (den Hertog et al., 2010; Wilden et al., 2018), in service networks (Agarwal & Selen, 2009) and specifically in the context of servitization (Kindström et al., 2013).

Dynamic Capabilities and Environmental Dynamism The nature of dynamic capabilities and the effect that DCs have on performance varies with the level of environmental dynamism that is present in a market. While markets with low dynamism are characterized by infrequent changes that can be mostly anticipated (Schilke, 2014), highly dynamic environments are *"ones in which market boundaries are blurred, successful business models are unclear, and market players (i.e., buyers, suppliers, competitors, complementers) are ambiguous and shifting."* (Eisenhardt et al., 2010, p. 1111). For low levels of environmental dynamism, dynamic capabilities only have a limited effect on performance, since dynamic capabilities are both costly to build and sustain (Zollo & Winter, 2002; Winter, 2003) while these type of markets do not provide ample opportunities for resource reconfiguration. Instead, markets with low levels of environmental dynamism rather foster exploitation of the existing resource base (Leonard-Barton, 1992; Teece, 2007). Hence, service firms need to develop specific dynamic capabilities, depending on whether they aim to drive market change, or quickly react to a changed environment in dynamic markets (Wilden et al., 2018).

In highly dynamic market environments, routine-based dynamic capabilities are not an adequate means for change, due to their path dependency and organizational inertia (Eisenhardt & Martin, 2000; Schreyögg & Kliesch-Eberl, 2007). Here, competitive advantage is quickly eroded, which leads to the necessity of establishing simpler, more experimental, and iterative routines. Consequently, DCs *"consist mostly of simple rules and real-time knowledge creation, [however] they may have detailed routines to deal with aspects of the process where prior knowledge and/or codification are particularly useful"* (Eisenhardt & Martin, 2000, p. 1113).

Thus, dynamic capabilities have the strongest effect in intermediate levels of environmental dynamism, where on the one side opportunities for reconfiguration are present, while on the other side routine-based dynamic capabilities are suited to seize them (Schilke, 2014). In these markets, DCs are *"complicated, predictable, analytic processes that rely extensively on existing knowledge, linear execution and slow evolution over time"* (Eisenhardt & Martin, 2000, p. 1113). In contrast, they are not "simple rules" (Eisenhardt et al., 2010) and ad-hoc problem solving activities, some type of innate talent, or one-time idiosyncratic resource-reconfigurations or best practices (Winter, 2003; Helfat et al., 2007).

Environmental Dynamism in the Aerospace Industry The aerospace industry traditionally displays low environmental dynamism and is characterized by long product lifecycles, few market entries or exits, and high safety regulations, slowing down technological innovation (Fan & Zhang, 2010). The principal aircraft manufacturers Airbus and Boeing are stable competitors whose duopoly has been strengthened even further by the integration of Bombardier and Embraer, respectively. Meanwhile, new competition from Asia is only slowly emerging through COMAC and Mitsubishi, while Russian aircraft manufacturing does not represent any credible threat to the Western supremacy in this industry. Also, MROs have been competing for decades in a relatively stable environment with other third party and independent MRO providers.

Servitization represents a considerable increase of environmental dynamism for MRO firms, as they are forced to compete with manufacturers that go downstream (Wise & Baumgartner, 1999) and compete with different resources and capabilities based on their manufacturing-led business model (Ulaga & Reinartz, 2011). The simultaneous trends of an increasing amount of airlines that focus on their core business and demand of solution offerings (Ward & Graves, 2005; Schneider et al., 2013) further adds to these dynamics and creates the need to develop the MROs' business model to fit with the new market realities. Hence, dynamic capabilities are crucial for MROs to innovate their business model, which allows them to mitigate risks and benefit from opportunities that servitization provides.

Dynamic Capabilities for Solution Provisioning Servitization is a research field that is increasingly linked to the Dynamic Capabilities View (Kindström & Kowalkowski, 2014). There appears to be consensus on that manufacturers require dynamic capabilities to guide them towards a successful service-oriented business model earning the expected revenues and profits (Fischer et al., 2010; Kohtamäki & Helo, 2015). This service innovation process is based on a deliberate, evolutionary process of sensing, seizing, and reconfiguring routines, which are facilitated through the management innovation (Gebauer, 2011).

As these are context-specific to the servitization phenomenon and thus represent a good indication of dynamic capabilities that may be required by MROs aiming to develop Solutions, I analyze articles that explicitly specify the dynamic capabilities that manufacturers need to provide hybrid offerings in Chapter 2.3.

2.3 Servitization

2.3.1 Introduction

Innovative manufacturing firms increasingly compete strategically through service provisioning (Spring & Araujo, 2009). Particularly in manufacturing sectors with a high installed product base, integrated product-service offerings can be used to defend a competitive advantage versus lower cost economies (Wise & Baumgartner, 1999). Consequently, there is a growing amount of research concerned with the phenomenon known as servitization of manufacturing (Vandermerwe & Rada, 1988). A commonly cited example is Xerox that instead of selling printers are selling document management solutions. In this offering, the customer does not acquire the printer but pays a fee for each page printed, while Xerox is responsible for installation and all maintenance tasks (Baines et al., 2007).

While the origins of servitization in strategic management literature are commonly traced back to the early 1990s, Davies et al. (2007) point out that the industrial marketing literature suggests origins in the 1960s with the introduction of 'systems selling' strategies. Since then, many manufacturing companies have moved dramatically into services blurred the boundaries between product and service industries. Servitization is a common and rising practice in many industries, predominantly of investment goods such as medical equipment, automotive or train manufacturing, where manufacturers are achieving an increasing portion of their revenue with services. As depicted in Figure 2.3, about 80% of the European manufacturers were offering services while earning 10-15% with service revenues in 2014.

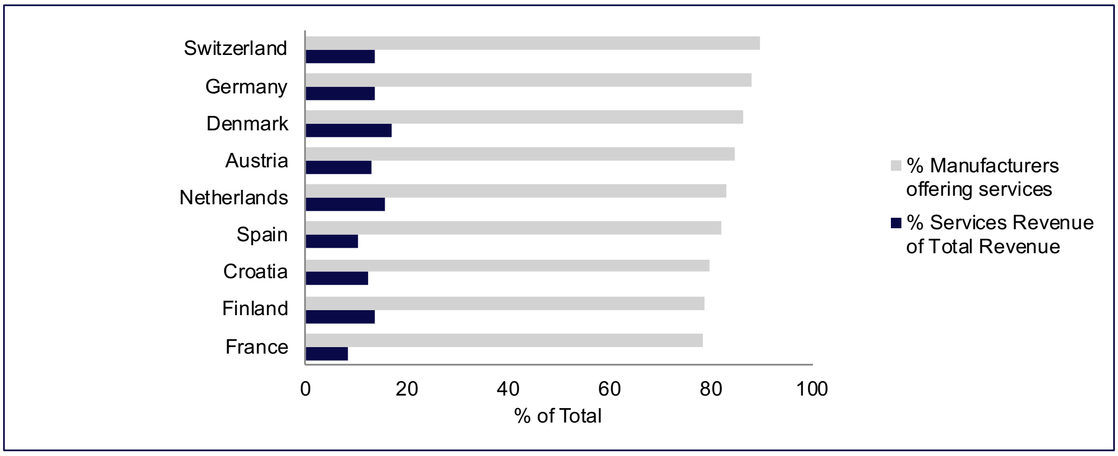


Figure 2.3: Relevance of Product-related Services in Manufacturing (Dachs et al., 2014)

Due to the rising importance of servitization in practice, many research communities have adopted the concept for their work (Müller & Sakao, 2010), leading to an increasing number of publications (see Figure 2.4) and importance of servitization as a research topic (Kowalkowski et al., 2015).

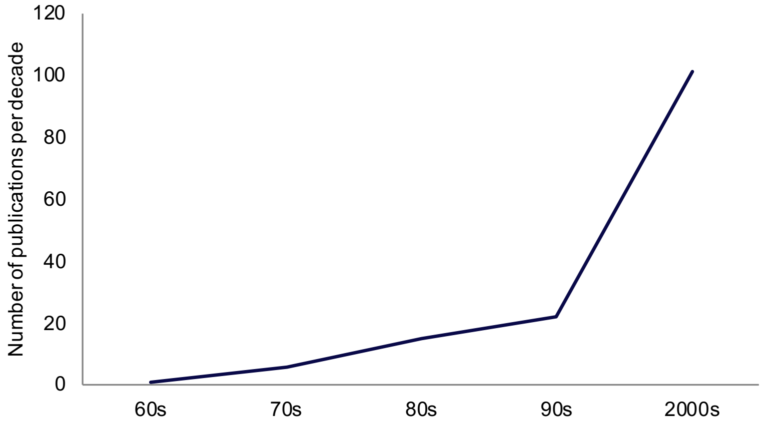


Figure 2.4: Number of Publications in Servitization research (adapted from Lightfoot et al., 2013)

2.3.2 Related Terms and Concepts

According to Baines et al. (2009), the term "servitization" was coined by Vandermerwe & Rada (1988, p. 314), who stated that servitization is: *"the increased offering of fuller market packages or 'bundles' of customer-focused combinations of goods, services, support, self-service and knowledge in order to add value to core product offerings"*. Subsequently, research has been launched under different terminologies and headlines (Wang et al., 2011). Moreover, a clear ontology is missing (Vasantha et al., 2012; Sakao et al., 2009; Müller & Sakao, 2010). Some terms are used synonymously although they are not the same (Beuren et al., 2013) and different terms have been used to describe the same phenomena (Pawar et al., 2009). Some authors have even come to the conclusion that a *"jungle of terms"* (Park & Lee, 2009, p.1) exists. These terms include e.g. *"servicisation"* (Quinn et al., 1989), *"service infusion"* (e.g., Eloranta & Turunen, 2015), *"development of product-service systems"* (Baines et al., 2009), *"through-life management"* (Ward & Graves, 2005), *"going downstream"* (Wise & Baumgartner, 1999), *"integrated solutions"* (Davies, 2004), and *"new manufacturing"* (Marceau et al., 2002). Not until very recently, has this *"jungle of terms"* received a major step in clarification, although earlier attempts[10] have helped to systematize the research field. However, the servitization research community still lacks a common lexicon to structure the scientific and practical debate but

[10] The systemization of the research field has been an effort of various authors: Baines and his colleagues conducted two literature reviews regarding servitization (Baines et al., 2009) and PSS (Baines et al., 2007) clarifying both concepts. Reim et al. (2015) identify and define further concepts related with PSS, whereas Park & Lee (2009) provide a literature review to create a common terminology and unify the different terms under the umbrella term "Integrated Product-Services" (IPS). Velamuri et al. (2011) provide a literature review including German publications with the aim to concise a set of current definitions and categorize the work on hybrid value creation.

Authors	Definition of Servitization
Kindström (2010), p. 481	Companies need to adopt a more holistic, business model-like, approach in order to be successful in developing new services and moving to [a] service-based business model.
Adrodegari et al. (2016), p. 519	In order to successfully move "from products to solutions", companies need to redesign their business model.
Forkmann et al. (2017), p. 151	This study conceptualizes service infusion as a business model reconfiguration by using a process perspective. Service infusion is therefore understoodas a process affecting the business model dimensions of transaction content, structure, and governance.

Table 2.1: Selected Definitions of Servitization

continues relying on various terms and concepts (Kowalkowski et al., 2017). However, the research field is becoming more structured with literature reviews that aim to integrate and cluster the different research streams (Brax & Visintin, 2017; Raddats et al., 2019). In the following sections the related concepts are introduced, delimited, and a leading ontology for this thesis is defined.

Servitization

Literature related to servitization refers with different terms to either the process of a manufacturer transitioning towards services, the product-service offerings, or practices undertaken in the process. Servitization is a term that commonly refers to the process of leading a service-led growth strategy (Kowalkowski et al., 2017). It has received synonyms such as *"service infusion"* (Brax, 2005; Kowalkowski et al., 2012), and *"service transition"* (Oliva & Kallenberg, 2003; Fang et al., 2008), which are interchangeably used in literature. The different synonyms employed are due to the different geographical and research interest of the several research communities[11] which investigate the phenomenon (Lightfoot et al., 2013). Servitization literature has recently employed the business model concept in the definition of servitization. The common denominator is that servitization is interpreted as a change from a pure product-centric towards a service-centric business model (see Table 2.1).

As business model innovation is one of the central concepts of this study, I define servitization in line with Kowalkowski et al. (2017, p. 8) as *"the transformational process whereby a company shifts from a product-centric to a service-centric business model and logic"*.

Tukker (2004) and Clayton et al. (2012) conceptualize a continuum between products

[11] According to Lightfoot et al. (2013), the following distinct research communities are concerned with the phenomenon of servitization from a range of different perspectives: Marketing, Service Management, Operations Management, Service Science. For an overview of each community and their main research concerns, please refer to Lightfoot et al. (2013, p. 1428).

and services on which firms can position themselves defining their product-service mix (see Figure 2.5). Manufacturers that venture from the product-side of the continuum towards an increasing focus on services are engaged in servitization.

Recently, literature has identified the *deservitization* as the reverse process to servitization, in which manufacturers return to a focus on their core competence manufacturing, either outsourcing services to specialized service firms or spinning-off their service divisions (Kowalkowski et al., 2017; Valtakoski, 2017). Deservitization can be explained by different factors such a lack of profitability and shareholder value generated by the service offering (Gebauer et al., 2005; Johnstone et al., 2009) or the fact that the customer or specialized service provider is better able to provide services than the manufacturer due to tacit knowledge required for the operation of the equipment (Valtakoski, 2017). Hence, cases may exist in which it is more advantageous for the manufacturer to offer less rather than more services and focus on the core business.

Above, we have clarified the terms used to describe how manufacturers reconfigure their business model to include more services or focus on products. However, what about pure service firms that compete with manufacturers either with pure services offers or integrated bundles of services and products? While extensive guidance has been given for firms undertaking servitization, both advice and empirical evidence for productization remains scarce. In contrary, servitization literature has not yet established a clear terminology regarding this type of business model innovation.

The few empirical studies concerned with the business model innovation of pure service firms towards providing a combination of products and services refer to this change of business model as *"moving upstream"* (Davies, 2004, p. 728), or *"becoming [...] integrated solution providers"* (Brady et al., 2005, p.364). Baines et al. (2007) and Clayton et al. (2012) propose *"productization"* as a term for pure service firms that start to add products to their service offerings, to enter the product-service continuum from the right (service) side. However, productization has already been established as a term referring to a process aiming at *"making services more tangible, product-like and repeatable"* (Harkonen et al., 2015, p. 70). Practitioners have developed a similar understanding of

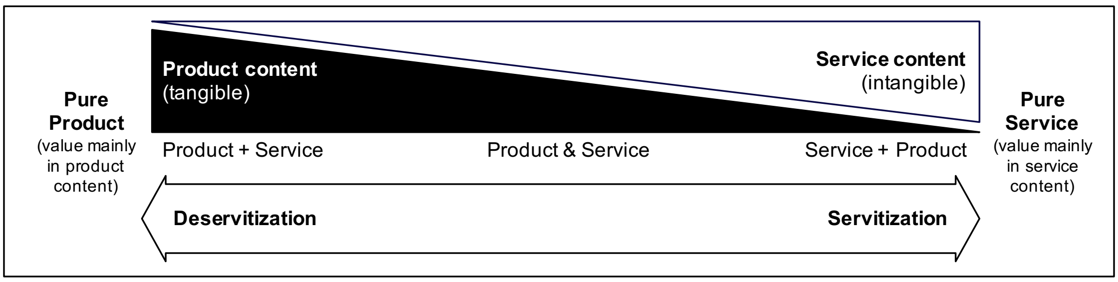


Figure 2.5: Product-Service Continuum (adapted from Tukker, 2004; Clayton et al., 2012)

productization as being a practice involving (a) specifying and standardizing the service offering, (b) concretizing the service offering and making it more tangible, and (c) systemizing and standardizing processes and methods (Jaakkola, 2011). Hence, productization is not a suitable term for the innovation of a service firm's business model towards providing hybrid product-service offerings.

Very recently, literature has coined the term *"reverse servitization"* referring to *"a strategy in which a service firm builds technology innovation competencies and delivers advanced services"* (Baines et al., 2017, p. 269). As reverse servitization includes building manufacturing capabilities, I do not regard it as a suitable term in the context of this study, since service providers may also compete with pure service solutions or solutions based on the equipment of various manufacturers (Hobday et al., 2005). In conclusion, the business model innovation process of pure service firms competing with bundles of services and products against manufacturers is labeled in congruence with Brady et al. (2005) as *"becoming a solution provider"*.

Types of Product-Service Systems

A Product-Service System (PSS) is commonly defined *"an integrated product and service offering that delivers value in use"* (Baines et al., 2007, p. 3). Multiple other terms describe the combination of products and services, such as *"industrial product-service systems"* (IPS2, Meier et al., 2010), *"functional product"* (Markeset & Kumar, 2005), and the marketing-led concept of *"hybrid offerings"* (Beuren et al., 2013; Kowalkowski et al., 2017). PSS has evolved beyond its original usage in the context of engineering, operations management, and ecology (Lightfoot et al., 2013), as it has been widely adopted by a stream of literature that interprets servitization as an innovation of a firm's business model (e.g., Reim et al., 2015; Adrodegari et al., 2016).

In the attempt to classify different types of PSS, servitization literature has produced a massive number of typologies[12], aiming at both classifying types of PSS business models and describing the degree of servitization of a manufacturer on the product-service continuum. Interestingly, however, the papers do not employ any of the established business model frameworks to describe the different types. Instead, the description is mostly limited to either the payment model or the Value Proposition. The probably most cited classification is provided by Tukker (2004), who categorizes PSS into product-oriented, use-oriented and result-oriented offerings (see Figure 2.6). Each of these categories is composed of further subcategories, comprising a total of eight PSS offerings. As pointed out earlier, also Tukker refers to these types of offerings as business models, although the description is limited to the offering and revenue structure while omitting changes in all other dimensions of a business model.

[12]For a review please refer to Oinonen & Jalkala (2013) or to Wallin (2013a).

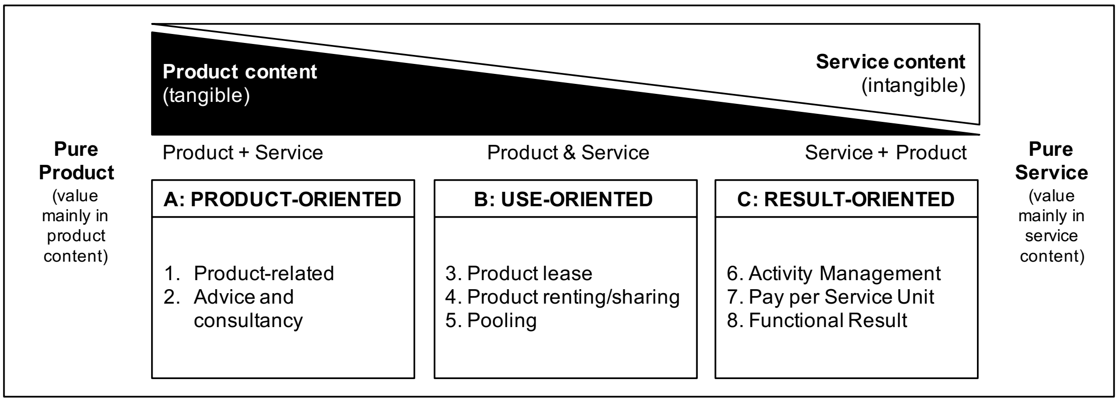


Figure 2.6: Product-, Use-, and Result-oriented PSS Offerings (adapted from Tukker, 2004)

In product-oriented offerings, the product is sold in a traditional manner together with services that ensure the utility such as after-sales services, repair, and maintenance. Since the value lies mainly in the product content, customers perceive services often as mandatory and compulsory, which goes along with a low willingness to pay. Accordingly, manufacturers may be obliged to either offer them for free or include them free of charge in comprehensive packages (Lele, 1997). In use-oriented Value Propositions, the customer pays based on the usage of the product, such as in car-sharing models. In result-oriented offerings, the customer pays for the achievement of the agreed results. This may be achieved through process outsourcing such as office cleaning, pay per service unit or the agreement on a functional result (Tukker, 2004). An illustrative example for pay per service unit are Xerox document management solutions, in which the customer does not pay for printers or their maintenance but each page printed (Xerox, 2015).

While this typology is useful for the classification of the revenue streams that underly the solution offer, it does not reflect the change of perspective required by manufacturers, who traditionally focus on product instead of service aspects and is therefore of limited value for the the required business model innovation (Lightfoot et al., 2013). In her early work, Mathieu (2001a) problematizes this change, clustering services according to their recipient: services supporting the product (e.g., maintenance services) and services supporting the client (e.g., consulting services). She finds that manufacturers need to overcome barriers to successfully offer services supporting the client, which are characterized as a closer customer relationship, a higher degree of customization, innovation potential and opportunities for differentiation (Mathieu, 2001a).

Ulaga & Reinartz (2011) define a typology of PPS offers building on Mathieu (2001a), who clusters service offers according to their recipient (services supporting the product and services supporting the client) and Tukker (2004), who distinguishes between input- and output- (i.e., availability and performance-based) based offerings. Combining these two approaches, the authors define a theoretically and empirically-founded service typology (Figure 2.7) that clusters services along the two dimensions "Nature of the Value Proposition" (i.e., input- or output-based) and "Service Recipient" (i.e., product or customer's process).

Nature of Value Proposition	Product Life Cycle Services (PLS)	Process Consulting Services (PCS)
Suppliers promise to perform a deed (input-based)	Definition: "Services that facilitate the access to the supplier's good and ensure its proper functioning during all stages of the life cycle." Examples: • Installation of satellite antenna • Component Maintenance Services	Definition: "Services to assist customers in improving their own business processes" Examples: • Engineering consulting services • Optimization of maintenance schedule
	Asset Efficiency Services (AES)	**Solutions (SOL)**
Suppliers promise to achieve performance (output-based)	Definition: "Services to produce productivity gains from assets invested by customers" Examples: • Engine health monitoring • Assessment and installation of Service Bulletins	Definition: "Services to perform processes on behalf of customers" Examples: • Engine Solutions • Component Solutions
Service Recipient	Oriented towards OEM's good	Oriented towards Customer's process

Figure 2.7: Typology of Industrial Services for Hybrid Offerings (adapted from Ulaga & Reinartz, 2011)

This framework is especially valuable for a strategic portfolio-based analysis since the Key Capabilities and Resources required for each type of service, and the underlying logic for competitive differentiation differ fundamentally in each of the quadrants (Ulaga & Reinartz, 2011). Thus, the framework is suitable for analyzing competitive advantage between pure service providers and manufacturers in different types of PSS offers.

Product Life Cycle Services Product life cycle services (PLS) refer to *"the range of services that facilitate the customer's access to the manufacturer's good and ensure its proper functioning during all stages of its life cycle, whether before, during, or after its sale"*, such as installation and maintenance (Ulaga & Reinartz, 2011, p. 15). PLS are promises to perform a deed, directed towards the manufacturer's good (e.g., exchange of a toner cartridge when empty). Since PLS are core services required for the functioning, such as maintenance services, manufacturers may be faced with the necessity to provide these services to sell their goods. Since these kinds of services are considered a "must-have" by the customer, a minimal opportunity for competitive differentiation and low willingness to pay may be present. Consequently, a cost leadership strategy may be the most appropriate, which requires vendors to provide these services in a cost-efficient way.

Asset Efficiency Services Asset efficiency services (AES) are *"the range of services suppliers provide to achieve productivity gains from assets invested by customers"* (Ulaga & Reinartz, 2011, p. 17), such as condition monitoring or reliability management. Just like product lifecycle services, AES are geared towards the manufacturer's good, however, aim at improving performance (e.g., the guaranteed 98% availability of inflight entertainment screen). Customers do not consider AES as part of the core offering, and therefore AES provide a basis for competitive differentiation and profit potential.

Process Consulting Services Process consulting services[13] (PCS) are *"the range of services a manufacturer provides to assist customers in improving their own business processes"* (Ulaga & Reinartz, 2011, p. 18), such as audits and consulting services. These services promise to perform a deed (e.g., a consulting project with the aim to define a maintenance schedule for the customer), without assuming responsibility for performance outcomes and are geared towards the customer's processes (e.g., the usage of the product). This type of service is based on the competence regarding the operation of an asset and can be provided independently of the sale of the asset, or even for the assets of a competitor. Since these services are tailored to the individual customer needs and are based on intimate knowledge in the operation of the asset, the customers' willingness to pay tends to be high. Consequently, these types of services are often priced like professional services according to the time and resources needed (Ulaga & Reinartz, 2011).

Solutions Finally, solutions[14] (SOL) are *"comprehensive bundle of products and services tailored to the individual customer's need that involve assuming the responsibility for the operation and performance of customer's processes"* (Hakanen & Jaakkola, 2012, p. 594), such as tire management for a fleet of a trucking company. The customer typically outsources parts of the operation of the asset to the service supplier, who assumes responsibility for the performance of the customer's process. Solutions are typically a complex, integrated bundle of products and services, customized to the individual customer's needs that require some form of customer involvement and risk-transfer to the supplier (Hax & Wilde II, 2001; Stremersch et al., 2001; Galbraith, 2002).[15] Solution offers are positioned on the right (service) side of the product-service continuum, due to their focus on services and their outcome-based nature of the Value Proposition.

[13]Ulaga & Reinartz (2011) name this service category Process Support Services (PSS). Since the acronym of this term is easily confounded with Product-Service-Systems (PSS), I have decided to rename this service category.

[14]Ulaga & Reinartz (2011) name this service category Process Delegation Services (PDS). Since the services described in this category are commonly referred to as solutions, this more common term is used.

[15]For an extensive review about the characteristics of solutions, please refer to Oinonen & Jalkala (2013).

2.3.3 Servitization as a Competitive Strategy

Literature commonly identifies three drivers of servitization: financial, marketing, and strategic (i.e., aiming to achieve a competitive advantage) (Baines et al., 2009): Financial drivers include a higher profit margin and stability of income, especially in the capital goods industries, where manufacturers possess an installed base of products (Wise & Baumgartner, 1999). In these industries, the ratio between units in operation and annual sales varies in between 13:1 for the U.S. automotive industry, 22:1 for train manufacturers and 15:1 for the civil aerospace industry (Wise & Baumgartner, 1999). Revenues created with services on the installed base can be one or two magnitudes larger than revenues from the initial product sales, especially in industries with complex products of long life-cycles in which the potential for revenue generation shifts downstream to the after-sales service period (Wise & Baumgartner, 1999; Ward & Graves, 2005).

Services are known to influence the purchasing decision and create marketing opportunities, resulting in increased product sales. This is especially true for B2B markets where higher technical complexity and pressures to outsource as well as increased customer contact through service provisioning lead to more differentiated products and higher customer loyalty (Baines et al., 2009). In solution provisioning, services occur before, during, and after a product is delivered to the customer (Davies, 2004) resulting in lengthened customer relationships, and future sales opportunities (Malleret, 2006). During these lengthened relationships, social capital is developed between manufacturer and customer by relational processes providing further options for differentiation (Tuli et al., 2007) against competing manufacturers.[16] The result is an added customer value which may offer more profit potential than pure product innovation (Pawar et al., 2009; Gebauer et al., 2005).

Servitization is also commonly observed as a strategy aiming to increase competitive differentiation as a reaction to the commoditization of product markets in mature industries (Lightfoot et al., 2013). Authors have used different strategic management approaches such as Porter's market power and competition paradigm (Porter, 1998), the resource-based view (Wernerfelt, 1984; Barney, 1991), and the relational view (Dyer & Singh, 1998) to explain a competitive advantage gained by manufacturers adding services (Eloranta & Turunen, 2015). Most studies explicitly or implicitly focus on explaining competitive advantage against other (e.g. low-cost) manufacturers (e.g., Wise & Baumgartner, 1999; Oliva & Kallenberg, 2003; Gao et al., 2011), however not against incumbent service firms. More recently, an increasing number of studies employ the dynamic capabilities view (Teece et al., 1997; Winter, 2003) to understand how manufacturers can add services to their business model to achieve competitive advantage over time.

Studies following the *market forces paradigm* argue that servitization is not only a re-

[16]Competition between manufacturers and service firms is reviewed in Section 2.3.7.

action to changing customer demands but also commonly seen as an optimal way to address Porter's market forces, actively shaping the market (Neely, 2008; Gebauer et al., 2011). According to this view, firms need to consider the strategic fit between the external environment and the organization to achieve their desired competitive market position with their servitization strategy, based on either differentiation or cost leadership (Gebauer, 2008). Often, servitization is seen as a way to escape price-based competition by building competition barriers and achieving a differentiation advantage (Gebauer et al., 2010a; Nordin & Kowalkowski, 2010). However, the popularity of the market forces approach has diminished nowadays and is used mostly in combination with more modern strategic management theories such as the dynamic capabilities view (Eloranta & Turunen, 2015).

Because resources needed for production and service provision differ (Bharadwaj et al., 1993), the *RBV* is the most popular perspective on servitization (Eloranta & Turunen, 2015). Studies taking the RBV argue that manufacturers can build a sustainable competitive advantage by building valuable, rare, and inimitable service-specific resources (Barney, 1991). Manufacturers possess unique resources, including an installed base (Wise & Baumgartner, 1999; Oliva & Kallenberg, 2003; Ulaga & Reinartz, 2011), unique and complex offerings, (Gremyr et al., 2010; Ulaga & Reinartz, 2011) and service-enhanced relationships (Davies et al., 2007; Nordin & Kowalkowski, 2010). However, servitization is a challenging task, as manufacturers need first to develop a bundle of service-specific operational resources and capabilities to successfully transition towards PSS business models (Matthyssens et al., 2009) such as a service culture (Gebauer et al., 2010a) and integration capabilities (Davies & Hobday, 2005). To develop these operational capabilities and reconfigure their business model from a product- to a service-focus, manufacturers require solution-specific dynamic capabilities (Gebauer et al., 2012; Kindström et al., 2013).

Servitization studies that follow the *relational view* argue that relationships in solution networks are sources of competitive advantage. Both suppliers and customers form an ecosystem in which value is created. Specific capabilities are required to initiate, maintain and profit from relationships and value constellations in the ecosystem that supports the PSS offering (Eloranta & Turunen, 2015).

Servitization literature has broadly embraced the *business model concept* since the beginning; however, only few of these studies are concerned with the competitive advantage of manufacturers. Instead, papers either (a) establish different typologies of PSS business models (e.g., Benedetti et al., 2015; Ferreira et al., 2016), or (b) target the business model reconfiguration process from goods to hybrid value provisioning (e.g., Kindström, 2010; Kindström & Kowalkowski, 2014; Adrodegari et al., 2015; Forkmann et al., 2017b).

Studies that take the business model lens to explain differences in firm performance highlight that adding services to the manufacturer's business model is an important method to employ a differentiation strategy against low-cost producers (Gao et al., 2011). To generate significant financial value, manufacturers need to undergo a comprehensive business model transformation. In contrast, merely adding services to the product portfolio can lead to negative financial performance (Parida et al., 2014a,b). Negative financial performance may also result since a critical percentage of service revenues needs to be achieved to overcompensate initial investments required for pursuing a servitization strategy (Kastalli et al., 2013).

In conclusion, most studies focus on single aspects of competitive advantage in hybrid value provisioning (e.g., either resources and capabilities or the network) and do not make use of the holistic perspective that the business model concept has to offer to explain competitive advantage. In turn, studies that employ the business model concept mostly limit themselves to exploring typologies and business model transformation paths instead of using the opportunities this holistic concept provides for explaining competitive advantage through servitization. In addition, the usage of established business model frameworks that allow us to understand the many facets of solution provisioning remains scarce. Hence, we need to understand better how competitive advantage between manufacturers and pure service firms in solutions can be explained through the business model approach.

2.3.4 Servitization Challenges

Although financial, marketing and strategic drivers offer opportunities for improving firm performance, servitization poses many challenges for manufacturers that have received broad academic attention (Zhang & Banerji, 2017). Empirical studies show that in practice servitization is not always successful, but shows rather mixed results: In the growth phase, firms may experience the service paradox, a situation in which manufacturers are not able to reap the expected benefits from their initial investments to move towards services (Gebauer et al., 2005; Brax, 2005). After an initial profitability increase with simple add-on services, manufacturers often face a decline in profitability. Only after their investments are translated into economies of scale, manufacturers then can regain profitable growth (Kastalli et al., 2013). Typically, positive effects on firm value only become pronounced when a critical mass of 20-30% of services in total firms sales is reached (Fang et al., 2008).

In a 2004 study, the consulting firm Bain & Co found that only 21% of companies succeed with their service strategies and only some firms outperform their goods-offering competitors in terms of revenue growth, margins or return on equity (Baveja et al., 2004). According to Hancock et al. (2005) half of all solution providers realize only modest benefits, while 25% realize losses. Also, Neely et al. (2011) report that there is no statistically significant correlation between service maneuvers and profitability of manufacturing firms. However, newer research by Eggert et al. (2015) points out that hybrid innovations, referring to the simultaneous development of new products and services, improve firm performance above pure product innovations. This effect is especially prominent in competitive markets with a highly concentrated customer base.

While both above and below average performance may be caused by a properly or poorly executed servitization strategy, some firms turn away from in-house service provisioning altogether, effectively deservitizing (Finne & Holmström, 2013; Kowalkowski et al., 2017). This underpins the importance of the question of which are the specific challenges that need to be overcome by manufacturers to add service to their product portfolio successfully.

Zhang & Banerji (2017) divide the challenges that manufacturers face into five types: (a) the organizational structure, (b) the business model, (c) the development process, (d) customer management, and (e) risk management. The *organizational challenge* arises from the need to change internal product-based structures and culture to support service provisioning (Fang et al., 2008; Kindström et al., 2015). This is because value creation involves services, which are fuzzier, intangible, (Grönroos, 2007) and bundled with the products. Hence, manufacturers cannot merely add services on top of their transaction-based product business but need to employ a radical approach (Brax, 2005). Organizational arrangements may include the formation of a separate service division or establishing a network of service providers to support service provisioning (Salonen, 2011; Gebauer et al., 2013; Paiola et al., 2013).

The changes that manufacturers have to make to their *business model* have received much academic attention, especially in the last years (Zhang & Banerji, 2017). The holistic business model concept is especially suitable to investigate challenges that manufacturers face for successful servitization, as they can be disaggregated into the different dimensions of business model frameworks. This sheds light on the many facets of change that servitization requires and the interdependencies between business model elements. Hence, I develop a PSS Business Model Canvas in the next section in which the differences in each dimension of the business model are discussed in more detail.

As service development differs considerably from product development, manufacturers cannot rely on their established product development process but need to make the establishment of a *service development process* a top priority (Baines et al., 2009; Kindström et al., 2015). To do so, manufacturers need to develop new tools and techniques (Baines et al., 2007) and build relational processes with the customer (Tuli et al., 2007). One reason is that services are intangible which makes it more challenging to receive instant feedback in the development process and requires testing at the customer (Demeter & Szász, 2013).

In contrast to pure product offerings, value is co-created in-use with the customer when providing PSS (Vargo & Lusch, 2004; Hakanen & Jaakkola, 2012). This causes challenges regarding *customer management*, as the value intended by the supplier is not always the value perceived by the customer (Hakanen & Jaakkola, 2012). For example, some customers may not be motivated by the concept of ownerless consumption (Baines et al., 2007), or share their operational data with the supplier (Matthyssens & Vandenbempt, 2008). In cases in which solution providers operate their customers' equipment, increased attention may be required for the management of third-party customer relationships. As the manufacturer operates the customer's equipment, the customer's competitors may perceive the manufacturer now as a competitor, not anymore as a mere supplier of hardware or systems (Helander & Möller, 2007). This, in turn, may have implications for future business prospects with these potential customers, or may even damage existing buyer-supplier relationships with these firms.

Servitization entails a variety of *risks*, e.g., increased financial requirements (Neely, 2008), the risk for the customers' operations in result-based offerings (Ulaga & Reinartz, 2011), or even an increased risk of bankruptcy (Benedetti et al., 2015). In solution offerings in which manufacturers take over the responsibility for maintenance of the complete system, often components or software of competitors or third parties can be present that increase the difficulty and risk of ensuring the performance of the system (Helander & Möller, 2007). Hence, manufacturers need to build the capabilities to recognize and mitigate these risks if they want to introduce services to their business model (Benedetti et al., 2015) successfully.

In conclusion, servitization is no easy endeavor for manufacturers. Instead, it should be seen as a strategic move with the potential to increase revenues and profits that comes at the risk of performance or even bankruptcy, if challenges are not adequately tackled and associated risks mitigated. Besides, successful servitization requires the reconfiguration of large areas of the business model as well as the management of interdependencies of these areas.

2.3.5 Literature Review: a Canvas for PSS Business Models

Since the Business Model Canvas is used throughout this study as an analytical instrument to describe business models and their innovation in the aerospace industry, I have decided to perform a systematic literature review[17] that outlines the core logic of solution-based business models with the Business Model Canvas. The literature review contained 72 papers that were analyzed regarding the conceptualization of servitization as business model innovation and the distinct elements. It shows that servitization has been conceptualized as the innovation of manufacturers' business models from products towards a greater service content (Forkmann et al., 2017a). However, the terminology is used rather loosely, and especially early papers use the term business model but refer mostly to the Value Proposition, revenue model, or the different types of services provided (Baines et al., 2017).

[17] The method is explained in Section 3.4 in the Methodology section.

Furthermore, studies that take the business model lens on servitization were not able to give a complete picture of the different dimensions of PSS business models. Instead, servitization literature that employs the business model concept can be discerned in two sets of studies (Kowalkowski et al., 2017): The first set is concerned with establishing generic (e.g., Tukker, 2004) or industry-specific typologies of PSS business models, for example in energy services or aerospace (Benedettini et al., 2015; Ferreira et al., 2016). Other studies in this set employ a configurational approach, highlighting that different equifinal (i.e., equally effective) configurations of business models can be used for successful hybrid value provisioning (Forkmann et al., 2017a). The configurational approach argues that success of the hybrid offering does not depend on the chosen configuration per se, but on the strategic fit between the organizational-, and PSS configuration, as well as the selected service strategy (Aurich et al., 2009; Gebauer et al., 2010b).

The second set of studies interprets servitization as the reconfiguration or innovation process of the manufacturer's business model. The authors that adhere to this set stress that manufacturers need to focus on all areas of their business model in a holistic fashion and not just change isolated elements, to successfully convert to a service-based business model (Kindström, 2010; Kindström & Kowalkowski, 2014; Adrodegari et al., 2015; Forkmann et al., 2017b). As this shift is a dynamic process affecting many business model elements simultaneously (Ferreira et al., 2013), the business model concept shows a high utility for companies that aspire to master this change successfully (Barquet et al., 2013; Weeks & Benade, 2015). However, the use of established business model frameworks to delineate the different configurations remains very limited, with Barquet et al. (2013) being one of the few exceptions.

The fact that only few servitization studies take the holistic business model perspective, although servitization requires reconfiguring multiple elements and their interdependencies of the established business model (Forkmann et al., 2017b), underpins the need to develop a holistic PSS business model. This PSS business model would then allow abstracting the complex reality of providing solutions into a comprehensive system, thus enabling us to understand the changing core logic of firms that transition from their legacy business focus towards solution provisioning (Rentmeister & Klein, 2003). Furthermore, understanding the manufacturers' business model innovation process from products to service provisioning provides only limited guidance for pure service firms that wish to provide solutions. As a consequence, we must first establish an understanding of solution business models as a general end state of business model innovation, to then understand how pure service firms can transition towards this end state from a base in services.

The Solution Business Model Canvas proposed here (Figure 2.8) represents a synthesis of the papers identified in the literature review, focusing on the elements relevant in the context of solution provisioning in the aerospace industry and pure service providers. It builds on earlier work by Barquet et al. (2013) that was enriched with newer literature as well as previous relevant papers that contribute to the understanding of hybrid business models. While the Solution Business Model Canvas of Barquet et al. (2013, p. 698) was a valuable basis that provides an overview on solution-based business models, it suffers from some limitations that the present literature review intents to overcome. One limitation was the lack of transparency, as Barquet and colleagues did neither disclose search terms, time frame, databases or inclusion criteria that were used to conduct the literature review, which significantly hampered the reproducibility of their findings. A second limitation was the fact that the paper was published in 2013, which is especially relevant considering the novelty and increasing importance of the business model concept in general and in servitization research in particular in recent years.

Key Partners	Key Activities	Value Proposition	Customer Relationship	Customer Segments
• Network of service partners to complement internal capabilities • Types: Banks, consulting firms, specialized service firms (e.g. maintenance, logistics, IT) • Extent of network usage explained by various theories (RV, TCE, …)	• Design & manufacturing, intertwined with services • Integration (incl. customization, standardization, modularization) • Operational services & problem-solving • Final service provision	• Provide asset and ensure proper functioning during its lifecycle through basic and advanced services • Reduction of operating costs • Asset performance improvement • Getting-the-job-done: Asset performance, availability and reliability • Risk transfer • Enable customer to focus on core competencies • Financing of asset • Customization	• Close, long-term relationship consisting of relational processes • Increased interdependency but also incentive alignment	• Segmentation according to preferences about ownership, responsibilities, availability and costs. • Customer portfolio management balancing different customer groups
Key Resources	**Key Capabilities**		**Channels**	
• Installed base (data) • R&D, manuf. assets • Service sales force and distribution network • Field service organization • Service Culture	• Operational Capabilities • Relational Capabilities • Integration and Multi-vendor Capability • Risk Management • Data Processing and Interpretation Capability • Design To Service Capability		• Channel control required • Customer-facing unit and/or KAM to manage customer Channel • Dedicated personal assistance predominant • Diverse direct and indirect channel configurations in solution networks	

Cost Structure	Revenue Streams
• Increased employee, working capital and net asset base costs Initiatives to positively influence cost structure: • Modularization of product/service units • Productization of services • Outsourcing of services to specialized service providers • Risk-sharing and mitigation through formalized contracts with customers and service providers	• One-off, deed-based payment for product/services • Use-based payment for product/service • Performance-based payment for product/service • Option: bundling/unbundling of revenue streams

Figure 2.8: PSS Business Model Canvas

Value Proposition

PSS business models entail a wide range of Value Propositions that range from the product plus simple add-on services such as installation and maintenance up to providing integrated turnkey solutions (Stremersch et al., 2001). Depending on a firm's position on the product-service continuum, the customer value can be created mainly through the product or the service components of the PSS offering (Tukker, 2004). In Section 2.3.2, I have introduced a service typology for PSS business models, ranging from product-lifecycle services, via process consulting services, asset efficiency services up to solutions. Here, we explore the underlying Value Propositions that can be made in these different types of PSS.

In *product-lifecycle services*, the product is sold in a traditional manner together with services that ensure the utility such as after-sales services, repair, and maintenance (Tukker, 2004; Ulaga & Reinartz, 2011). Basic services (e.g., documentation, repair, spare parts, basic training) and advanced services (e.g., advanced training, remote monitoring and remote product diagnosis, product upgrade/retrofit, warranty extension, and maintenance contracts) fall into this category (Adrodegari et al., 2015). The central Value Proposition of these type of industrial services is to ensure proper functioning of the good during all stages of its lifecycle, e.g., pilot and crew training enables airlines to train sufficient staff to operate the aircrafts (Ulaga & Reinartz, 2011). Hence, the main focus of the Value Proposition of the manufacturer's PSS is inherent in the product and its proper functioning and to a lesser extent in the services provided. Nonetheless, outsourcing basic and advanced services can also result in lower asset operating costs for the client, if the manufacturer can provide these services more cost-efficiently than the customer or a specialized service firm.

Asset efficiency services include services such as condition monitoring or preventive maintenance that aim at increasing the performance of the asset. Hence, the central Value Proposition of these services is not to perform a deed but to achieve an output that can be summarized as "asset performance improvement". Process consulting services aim at using the manufacturer's knowledge of the asset to improve the customer's processes related to its operation (Ulaga & Reinartz, 2011). This indirectly supports both of the previous Value Propositions, as better operations enable the customer to reap more benefits of the asset or lower its costs. For example, manufacturers can suggest maintenance schedules that optimize the energy efficiency of machinery.

Finally, *"Getting the job done"* (Osterwalder & Pigneur, 2013, p. 25), is one of the main Value Proposition of *solutions* (Davies et al., 2003; Oliva & Kallenberg, 2003; Brady et al., 2005; Johnson et al., 2008). As Davies and his colleagues put it: *"customers are not paying for an integrated package of products and service. They are buying guaranteed solutions for trouble-free operations. The onus is on the providers of integrated solutions to identify and solve each customer's business problem by providing services to design, integrate, operate and finance a product or system during its life cycle."* (Davies et al., 2006, p. 40). Thus, solutions incorporate result-oriented Value Propositions, in which the customer pays for the achievement of the agreed results. In this type of agreements, the supplier assumes the *responsibility for the risk* associated with performance outcomes previously carried by the customer. The risk transfer is one of the main motivations for customers to enter into this type of complex agreement; however, this typically requires the payment of a risk premium to the supplier (Tukker, 2004; Ulaga & Reinartz, 2011).

Another motive of customers to enter into solution agreements is to *focus on their core competencies* (Hamel & Prahalad, 1990), which is an aspect that has been reported for many industries, i.a., defense, passenger transport, and automotive (Cousins & Crone, 2003; Johnstone et al., 2008; Nair et al., 2013; Schneider et al., 2013; Smith, 2013). While result-oriented performance indicators can take a variety of forms, the system's availability over a certain period (e.g., 95% availability) and reliability are the predominant indicators (Ng et al., 2009; Lightfoot et al., 2013). Servitization literature argues along the service-dominant-logic that value is co-created between supplier and customer in-use (Vargo & Lusch, 2004; Baines et al., 2007; Toossi et al., 2013). As solutions are often complex and need to be *tailored to the individual customer needs,* (Davies & Hobday, 2005), customization of the solution represents another Value Proposition (Tukker & Tischner, 2006; Toossi et al., 2013). PSS can also incorporate use-oriented Value Propositions, in which the customer pays based on the usage of the product in either a lease-, rental/sharing, or pooling agreement (Tukker, 2004). Here, the customer benefits from ownerless consumption (Mont, 2002), which effectively represents *financing the PSS* during its lifecycle (Davies et al., 2006).

Key Resources and Capabilities

The further manufacturers venture towards services, providing solutions and other advanced or customized services, the higher is the value potential but also the risk, complexity and amount of resources and capabilities that must be developed and coordinated (Kindström & Kowalkowski, 2014).

Key Resources Manufacturers that wish to deliver solutions successfully need to develop new Key Resources and reconfigure the existing resource base (den Hertog et al., 2010). The "installed base" represents the number of assets currently in use in a given capital goods industry, such as machines, cars, or airplanes. It is a Key Resource since capital goods require services throughout their lifecycle and present manufacturers with service- or solution-provisioning opportunities (Oliva & Kallenberg, 2003). Furthermore, tThe installed base generates product and usage data that can be used for the development of services directly tied to the product (Ulaga & Reinartz, 2011). Besides, increasing data-availability of the installed base has the potential to lower maintenance costs, enabling a cost leadership strategy (Baines et al., 2007).

Product development and manufacturing assets comprise both tangible and intangible resources such as R&D and production facilities, tools, intellectual property, patents, and licenses. These assets are required for the development and production of the physical goods and provide spill-over effects that can be used in service provisioning (Ulaga & Reinartz, 2011). The extent to which a solution provider possesses these assets depends on its in/outsourcing configuration for production: the "system seller" refers to a configuration that relies on internal production, requiring proprietary, in-house technology, while the "system integrator" relies on systems and technologies of multiple external vendors (Davies et al., 2007). However, the system integrator can acquire access to intellectual property even if for example a complete subsystem has been outsourced (Baines et al., 2011). Thus, product development and manufacturing assets are a Key Resource, which is either present internally or attained through partners.

The *product sales force* and *distribution network* provide the manufacturer with close ties and privileged access to the customer which can be used to sell services to the customer (Ulaga & Reinartz, 2011). However, the product sales force is not effective in selling services per se. Instead, it needs to acquire additional knowledge, capabilities or even require reorganization. The reason is that sales managers have to transform from a passive recipient of a predefined offer into more active participants in a value-creating relationship typical for services (Kowalkowski et al., 2015). It has even been argued that firms need to create a separate service organization with a dedicated sales force and build a *service culture* to successfully provide solutions (Gebauer & Friedli, 2005).

While manufacturers can add some level of services to their business model based on their internal resource-base, they need to build additional resources and capabilities for advanced service offers and solutions (Matthyssens et al., 2009). One valuable resource is a *field service organization* that performs services on the asset, especially if the asset cannot be moved easily to the manufacturer's premises. Manufacturers are faced with the challenge to recruit highly qualified staff that possesses the required capabilities (Ulaga & Reinartz, 2011; Kindström & Kowalkowski, 2014), or rely on a network of third-party service providers, who have a greater experience providing these types of service (Cohen et al., 2006; Helander & Möller, 2007; Beuren et al., 2013).

Last but not least, the typical manufacturing culture often focuses on efficiency, economies of scale, and the idea that variety and flexibility are costly. In contrast, service-orientation centers on innovation, customization, and flexibility. Manufacturers that are becoming solution providers hence need to build a service culture and balance both product and service culture to achieve a symbiotic relationship (Gebauer et al., 2005).

Key Capabilities Service infusion creates a need to develop new capabilities to manage a service-oriented business, including *operational capabilities* such as maintaining, operating, or renovating a product throughout its operational life cycle (Brady et al., 2005; Kowalkowski et al., 2013). However, such product- and service-based operational capabilities cannot achieve the expected level of service profits and revenues alone but need to be accompanied by a set of PSS-specific capabilities (Kindström & Kowalkowski, 2014). Since Servitization literature has identified an enormous variety of capabilities[18], a not comprehensive selection of Key Capabilities is provided. I have based the decision

[18] Kindström & Kowalkowski (2014) alone name 24.

of whether or not to include a Key Capability on whether it has been named repeatedly throughout literature and whether it is applicable beyond the particular context.

Solution providers require a set of *relational capabilities* to interact with customers and the Key Partner network (Windahl & Lakemond, 2006; Kindström & Kowalkowski, 2009; Forkmann et al., 2017b), because the development of new services often involves mutual investments and co-specialization among suppliers, the customers, and other actors in the business network (Möller & Törrönen, 2003).

The *integration capability* refers to the organization's capacity to integrate both internal and external activities, skills and knowledge from other organizations to produce more complex products and services (Hobday et al., 2005). Due to the ever-increasing complexity of high-technological products such as aircraft and the reliance on network partners in solution provisioning (Gebauer et al., 2013), solution providers require the integration capability as one of their Key Capabilities. Companies aiming to provide solutions for equipment of competing manufacturers require a *multi-vendor capability* (Raddats & Easingwood, 2010), which is an advanced form of the integration capability. Supporting the competitors' products if it is in the customer's best interest has been described as the "acid-test" (Foote et al., 2001; Davies et al., 2006) since it competes with the own product business and requires a credible consultancy approach (Raddats & Easingwood, 2010).

As advanced consulting services, performance-based contracts, and especially solution offers involve assuming the performance risk of the customers' operations, developing the capability to *assume, manage and mitigate risks* thus becomes a central issue for solution providers (Tukker, 2004; Ulaga & Reinartz, 2011; Zhang & Banerji, 2017). PSS that incorporate asset efficiency services require special *data processing and interpretation capabilities* to improve the asset's performance during operation (Ulaga & Reinartz, 2011). These capabilities include the capacity to capture, adequately exploit, and convert this data into actionable knowledge (Kamp et al., 2017). The importance of this type of capabilities may well increase due to the increasing availability of big data as industry 4.0 gains a foothold in industry and also in literature under the label of smart servitization (Kamp et al., 2017).

Finally, a specific capability that manufacturers can develop when providing PSS is the *design-to-service capability*. This capability enables manufacturers to build and offer PSS so that *"its tangible and intangible elements interact synergistically to tap its full differentiation and/or cost reduction potential"* (Ulaga & Reinartz, 2011, p. 13). The authors highlight the importance of manufacturers to *"think service from the beginning"* already in the production design process as, for example, including hardware and software that enable remote monitoring and first level support of the asset may improve both cost-efficiency and asset performance.

Key Partners

While the great majority of early servitization literature has focused on the internal development of capabilities in single organizations, servitization research has moved towards the analysis of solutions provisioning in networks (Eloranta & Turunen, 2015). In this stream of literature, most studies analyze the manufacturer as the focal point of the network and provider of the solution to the customer, while pure service providers become network partners providing certain services to or on behalf of the manufacturer.

As stated earlier, manufacturers often outsource non-core services to third-party service providers with service-specific resources and service experience (Cohen et al., 2006; Helander & Möller, 2007; Beuren et al., 2013). As a result, a network with these third-party service providers is formed by the solution provider, which is usually referred to as service or solution network (Windahl & Lakemond, 2006; Beuren et al., 2013; Gebauer et al., 2013; Eloranta & Turunen, 2016). In the service networks, each actor contributes to the offering (Vargo, 2011), focusing on their core competence and cooperation with other network actors (Basole & Rouse, 2008). Relationships differ in the networks from equity alliances, as Joint Ventures, via strategic partnerships, down to cooperative relationships that are formalized by contractual agreements (Lockett et al., 2011; Turunen & Toivonen, 2011; Forkmann et al., 2017b).

Outsourcing in PSS Business Models A central theme of servitization research is the outsourcing decision, i.e., the decision about whether resources and capabilities should be developed internally, externally, or in a hybrid manner.[19] Researchers have developed various strategic outsourcing approaches (see Table 2.2) to explain the configuration that manufacturers that wish to provide solutions choose.[20]

Cohen et al. (2006) noted early that some cases exist, in which the outsourcing decision is not a choice, but that contextual factors exist that make outsourcing a necessity. Pure service providers may be equipped with opportunities for generating synergies, reduced pooling risks, and economies of scale that enable them to gain a competitive advantage, for which reasons manufacturers may be obliged to outsource. Later works do not pick up these findings but portray outsourcing as a deliberate decision taken by the manufacturer according to different sets of contingency factors.

[19] Different terms have been established for this decision, such as make or buy decision (Paiola et al., 2013), internalization/externalization (Kowalkowski et al., 2011b), servitization strategy (Bustinza et al., 2015), or firm boundary decision (Salonen & Jaakkola, 2015).

[20] Many studies explicitly or implicitly assume that the solution provider is a manufacturer that develops solutions. Studies as (Davies et al., 2007) that expressly acknowledge that service providers can become solution providers are an exception.

Approach	Description	Authors
Business Model	• System Seller: primarily internal service provisioning • System Integrator: primarily external service provisioning	Davies et al. (2007)
Configurational Approach	• Internal, external, or hybrid configurations • Contingency factors: market strategy, customer relationships, product-service linkages, internal competences and market channel characteristics	Kowalkowski et al. (2011)
Competitive Strategy	• Outsourcing of non-core activities enables cost- and differentiation leadership	Gao et al. (2011)
Competitive Strategy	• Outsourcing decision contingent on differentiation versus customer satisfaction strategy	Bustinza et al. (2015)
Strategic outsourcing approach	• The strategic approach for delivering solutions determines the outsourcing decision: • Seller of after-sales services: mostly internal • Integrator of after-sales solutions: mostly external • Seller of life-cycle solutions: mostly internal • Orchestrator of total solutions: mostly external	Paiola et al (2013)
Firm boundary conceptions	• Identity: manufacturer versus service provider • Competence: close versus distant knowledge fields • Efficiency: minimize transaction / governance costs • Power: strategic control of network	Salonen & Jaakkola (2015)

Table 2.2: Solution Providers' Outsourcing Approaches (own illustration)

The system seller versus system integrator approach of Davies et al. (2007) represents an early study of two possible configurations for building service capabilities. While the system seller aspires to develop most resources and capabilities required for service provisioning internally, the system integrator relies on external partners to provide services and concentrates on the core competence of integration. Newer empirical studies (Kowalkowski et al., 2011b; Paiola et al., 2013) find that firms choose between three different configurations of value creation: internal, external, and hybrid. While the internal and external setups are very similar to the abovementioned system seller and integrator approaches, Kowalkowski et al. (2011b) find however that the most common setup is, in fact, the hybrid arrangement, in which the solution provider outsources a varying extent of services to external service providers.

Firms that choose their desired configuration, rely on a set of firm-, offering-, and market-specific contingency factors such as risk aversion, service orientation, strategic priorities (Kowalkowski et al., 2011b). As these factors can contrast each other, a company needs to balance opposing forces when planning their configuration. In broad lines, Kowalkowski and colleagues argue that services that are core to the manufacturer and its customer or provide additional value are to be retained in-house, while services that are either regionally distant, non-core or demand an entirely different resource base, should be performed by external service providers.

Gao et al. (2011) and Bustinza et al. (2015) interpret the firm's competitive strategy as the dominant contingency factor for the outsourcing decision. According to Gao et al. (2011) firms should outsource all non-core activities to the service network, as this allows each actor to concentrate on its core business and add value to the system. Gao and colleagues argue that this way cost leadership and differentiation leadership could be achieved at the same time through the network of actors. On a similar note, Bustinza et al. (2015) find that the outsourcing decision is contingent on the competitive advantage the firm pursues either through differentiation or customer satisfaction. Firms aiming at achieving a differentiation advantage should make use of an external partner or a separated internal unit. Firms aiming for competitive advantage through customer satisfaction, should, in turn, rely on developing the required capabilities in-house.

Paiola et al. (2013) identify four strategic approaches for delivering solutions that determine the outsourcing decision: (a) seller of after-sales services, (b) integrator of after-sales solutions, (c) seller of life-cycle solutions, and (d) orchestrator of total solutions. While the first two mostly rely on internal capability development to develop solutions, the latter two base their competitive advantage on the integration of external service providers. The authors base the outsourcing decision on the theoretical lenses of transaction cost economics, the resource-based view of the firm, and the core competence approach.

Salonen & Jaakkola (2015) investigate the outsourcing decision using the four firm boundary conceptions identity, competence, efficiency, and power.[21] According to the identity view, firms try to maintain coherence between their identity as a manufacturer and the transfer to solutions. Accordingly, firms that aim to preserve their manufacturing identity choose external partners for service provisioning, while firms that intend to change their identity develop service capabilities internally. According to the competence view, companies seek to maximize the value of resources required for solution provisioning. Resources closely related to current fields of knowledge should be developed internally, while distant fields of expertise are to be integrated from external partners. The efficiency view argues that governance and transaction costs for the management of interdependencies of solutions elements should be minimized. This means that only systems that can be modularized should be integrated externally, others need to be integrated internally. Last but not least, the power lens is concerned with reaching strategic control and a central network position. According to this lens, solution providers should select partners that accept them as an attractive customer channel.

Conclusion: The outsourcing decision of manufacturers has evolved from anecdotal evidence to strategic, theoretically founded approaches that manufacturers can use to make their outsourcing decision deliberately. These approaches result in configurations of solution networks on which manufacturers base their competitive advantage. However, outsourcing requires two partners: one company that outsources and one that delivers. In comparison, the delivery side has received surprisingly little research. As traditional service providers need to take an informed decision of

[21] The boundary conceptions of the firm are based on the seminal article by Santos & Eisenhardt (2005) that draw on established management theories such as i.a. the resource-based view of the firm, transaction cost economics, managerial cognition, and resource-dependence theory.

whether to ally with a manufacturer, the literature review has uncovered the need for research regarding this type of business model innovation.

Revenue Streams

The transformation of Revenue Streams from deed-, and thus often cost-based, (Adrodegari et al., 2016) towards use- or performance-based payments is one of the major shifts discussed in solution business model literature. In use-based contracts, revenue streams are generated through the usage of the product in either a lease, rental/sharing, or pooling agreement (Tukker, 2004). The automotive industry is an industry that has widely embraced this business model through car leasing, rental or sharing concepts (Vezzoli & Ceschin, 2008). Through this type of contract, companies have the opportunity to secure long-term revenue streams, which may come however at the cost of the initial one-off sale of the asset (Mont, 2002).

In performance-based contracts, different mechanisms such as KPIs that measure the asset's performance as well as pain/gain-sharing models need to be established (Ulaga & Reinartz, 2011). Depending on the individual contract, revenue streams can be determined to a significant proportion on the performance achieved by the provider, as hefty penalties for asset outage may occur.

A common misconception of both use- and result-oriented Value Propositions lies in the issue of ownership of the asset: while most literature states that the manufacturer retains the ownership of the asset, in most cases it is transferred to the customer or a financial third party (Baines & Lightfoot, 2014). For example, a farming company will still own or lease the farming equipment that they operate. However, unklike in traditional product sales, they can rely on a 24h trouble-shooting and maintenance support (Claas, 2019).

Manufacturers have the choice to either bundle or unbundle their product-service systems: in bundled offerings, the asset and subsequent services are sold together, while in unbundled offerings, the asset is sold and billed separately from the services. Similar, service offers can be sold bundled or unbundled as well: In a bundled offering, the solution provider offers an "all-inclusive" service package, while in an unbundled offering, services such as maintenance, training, and consulting are priced individually. Finally, a mixed bundling strategy can be employed in which products and services are offered in a both bundled and unbundled manner (Stremersch et al., 2001). For example, certain services such as installation and maintenance may be bundled and priced together, while others, such as consulting services, are priced separately (Forkmann et al., 2017a). Steiner et al. (2016) find that customers have on average a 5% lower willingness to pay for bundled offers, and hence unbundling has the potential to enhance firm profitability considerably.

In summary, the PSS provider can incur one-off, use-based, and performance-based revenue streams for both asset and services and has the opportunity to employ different bundling strategies. Against a common misconception, the ownership of the asset is often transferred to the user or a financial third party and does not remain with the provider.

Cost Structure

On average, servitizing firms incur additional costs compared to their pure manufacturing counterparts in the areas of employee costs, working capital, and net asset base (Neely, 2008). Staff cost increase can be explained by the fact that staff that is able to offer consultancy services and design complex systems and solutions are likely to be more expensive than staff with a narrower skill set working in a manufacturing plant. Besides, additional assets, stocks and hence working capital is likely to be required for the offering of additional services which leads to a cost increase in these fields (Neely, 2008; Baines et al., 2011). Finally, when performance rather than ownership is sold, cost structures should be adapted to support the increased demand for cash-flow (Adrodegari et al., 2016). Thus, cost structure management is one of the main challenges for successful PSS provisioning (Sundin et al., 2009).

Companies employ a variety of tactics to lower their cost structure and increase profitability. Modularization of product and service units has been proposed as a way to achieve cost savings and improve reliability. In this approach, solution providers and their partners jointly develop modular units that are consistent, easy to understand and assemble into a customized solution package (Davies et al., 2006, 2007). A second approach is the productization of service components, which aims at standardizing solutions to achieve lower costs by reaping economies of scale and in-house knowledge and resources (Kowalkowski et al., 2015). In this approach, companies aim at improving their replication capabilities through formalizing, specifying and standardizing services to take advantage of what Davies & Brady (2000) call economies of repetition. These activities include concretizing professional expertise and systemizing processes and methods (Jaakkola, 2011). Since this strategy requires long-term service experience, profound knowledge of customers, product and process data, feedback loops and modularization capabilities, few manufacturers are successful in its implementation (Kowalkowski et al., 2015).

A third approach is to outsource services to specialized service providers that enjoy cost advantages against manufacturers entering the service domain through economies of scale and learning (Mathieu, 2001b). Economies of scale result from servicing the equipment of multiple manufacturers, while the manufacturer usually does not start with multi-vendor service offers. Learning advantages result on the service provider's focus on services (such as maintenance), while the manufacturer needs to build and maintain competencies in both the service and manufacturing domain (Mathieu, 2001b). Thus, choosing to outsource service provisioning to specialized service firms may lower the manufacturers cost structure for service provisioning if these firms can realize synergies, pooling risks, or economies of scale (Cohen et al., 2006).

Providers of usage-based agreements are exposed to the risk of higher maintenance costs, as the effort required for maintenance may considerably exceed previous expectations. One tactic to limit risks and resulting costs is to establish risk-sharing agreements with the service partners, making them less pronounced for the manufacturer (Lockett et al., 2011; Reim et al., 2015). However, customers may also show adverse behavior resulting in exceeding costs for the PSS provider, as they do not carry the risk. Companies have the option to mitigate these risks by establishing contractual terms that include a limitation or loss of warranty in cases in which the customer displays these types of adverse behavior (Azarenko et al., 2009).

Customer Segments

Different Customer Segments may display distinct preferences about product ownership, which are caused by factors such as consumer habits, behaviors, and values (Manzini & Vezzoli, 2003; Barquet et al., 2013). Manufacturers often segment their customer base according to different types of user behavior, since PSS involves changes in ownership, responsibilities, availability and costs (Matzen, 2009; Barquet et al., 2013). For example, some customers groups may not be enthusiastic about ownerless consumption, while others may even prefer this type of PSS (Baines et al., 2007).

To define specific Value Propositions for each segment, the PSS provider has to establish an excellent understanding of customers, as well as their operations and business, as PSS are often more customized that pure product offers (Kindström, 2010; Reim et al., 2015). Kindström & Kowalkowski (2014) highlight the importance of customer portfolio management, aiming at assessing the profitability of the accounts and understanding the overall return of relationships. In this regard, companies should maintain close ties with established customers but not at the expense of building relationships with new ones. Also, a dynamic portfolio of large customers with a more significant buying power and smaller customers with a lower buying power should be established, to balance the varying profitability of product and service contracts between those segments.

Customer Relationship

Customer Relationships play an important role in the context of PSS in general and in particular in solution provisioning because suppliers become part of customer's on-going operation (Windahl & Lakemond, 2006). Designing effective solutions requires strong customer interaction since they rely on understanding both the customer and its needs, business goals, practice, and culture. Thus, knowing the customers' business contexts and operational conditions is fundamental (Oliva & Kallenberg, 2003; Windahl et al., 2004; Brax, 2005; Windahl & Lakemond, 2006). Accordingly, the general assumption in servitization is the notion that firms should increase their relational orientation and develop long-term and close relationships with customers (Oliva & Kallenberg, 2003; Penttinen & Palmer, 2007).

In PSS, services are delivered before, during and after product delivery to the customer (Davies, 2004) resulting in lengthened customer relationships and future sales opportunities compared to traditional product sales (Malleret, 2006). The intensivied set of ties consists of relational processes, which are established for effective PSS provisioning, resulting in social capital and opportunities for competitive differentiation (Gao et al., 2011). These processes include (1) definition of customer requirements, (2) customization and integration of goods and services and (3) solution deployment, (4) post-deployment customer support (Tuli et al., 2007).

Vandermerwe (2000) argues that through solution provisioning, customers can become *"locked-on"* (p. 29), a situation in which they freely decide to continue business with the solution provider, due to the superiority of the product-service bundle and not due to a lack of alternatives or change barriers.[22] However, switching barriers for customers increase due to co-specialization with the provider's processes, which result in an adaption of the internal processes and are possibly supported by relation-specific assets such as IT-systems (Bharadwaj et al., 1993). Consequently, the joint interdependence between customer and supplier increases from pure product-over use-based up to performance-based agreements (Windahl & Lakemond, 2010). By outsourcing (core) processes to the supplier, the customer becomes more dependent on the supplier and its performance, especially when core processes are affected. At the same time, the customer loses internal process knowledge and thus depends more strongly on the supplier's expertise. Giving up ownership of the equipment increases supplier dependency even further, since insourcing operations or shifting it to a different supplier is further complicated (Windahl & Lakemond, 2010). Hence, it is highly questionable, whether customers indeed become locked-on instead of locked-in, when they rely on comprehensive solutions.

On the other hand, the supplier also becomes more dependent on the customer and its performance through the sales of integrated solutions. While the sales of equipment represents a one-off sale, customer revenues depend on the usage of the solution (Windahl & Lakemond, 2010). Successful customers will generate a higher output than

[22] A lock-on then is an especially pronounced type of differentiation advantage, which is not to be confounded with a lock-in, which is a buyer-supplier relationship in which one party is heavily dependent on the other (Narasimhan et al., 2009).

unsuccessful ones and hence generate more stable revenues for the manufacturer. To balance the increased reciprocal interdependencies, firms typically align interests between buyer and supplier through performance guarantees, long-term contracts, and pain/gain-sharing models (Penttinen & Palmer, 2007; Windahl & Lakemond, 2010; Kowalkowski et al., 2015).

In conclusion, providing solutions leads to customer relationships characterized by longer durations and increased reciprocal interdependency, especially if core processes are outsourced to the solution provider. The customer's dependence on the supplier is typically balanced by employing pain/gain-sharing mechanisms. However, it is questionable if these can offset the increased supplier-dependence due to the loss of the customer's internal capabilities required for insourcing the respective services or changing the supplier.

Channels

Manufacturers that wish to penetrate the service market can use their established customer Channels to promote their service or solution offers (Ulaga & Reinartz, 2011). In some cases, however, distributors or traditional service firms may occupy the service sales channel to the customer, which presents a barrier that first needs to be overcome. One often-cited example is the simulator manufacturer Thales, whose early attempts to provide pilot training solutions have been thwarted by established flight training schools (Davies et al., 2006).

Once solutions enter into the operational phase, a close relationship with customers can be achieved by establishing a set of Channels including operational links, information exchange, legal ties, and cooperative rules (Matthyssens & Vandenbempt, 2010). These channels are then used by manufacturers to decrease their reliance on distributors and strengthen their direct customer relationships (Schmenner, 2009). Manufacturers require some organizational adaptions to build adequate channels for solution provisioning. One element is the establishment of a central customer-facing unit responsible for the management of Customer Channels, strategic engagements, the definition of the Value Proposition, system integration and the provisioning of operational services (Davies et al., 2006). The maintenance of the system is predominantly conducted by dedicated personnel, representing the main operational channel to the customer (Hakanen & Jaakkola, 2012; Jaakkola & Hakanen, 2013; Hakanen, 2014). In this context, the installation of a dedicated Key Account Manager (KAM) as knowledge integrator has been proposed as a critical Channel element (Hakanen, 2014).

If service provisioning is outsourced to a third-party (e.g., a maintenance specialist), a triad evolves, whose channel configurations depend on the type of solution offering and can change over time (Ferreira et al., 2016; Forkmann et al., 2017a). One option is to establish a direct channel link to the customer (e.g., via IT or representatives), while another approach is to let the service provider handle everyday interactions with the customer (Forkmann et al., 2017a). However, for the solution provider, the latter option runs the risk of the establishment of a profitable intermediary that controls the daily customer interface (Kowalkowski et al., 2011b).

Key Activities

The Key Activities element encompasses the most important activities required to operate the PSS, linking the other business model elements together (Osterwalder & Pigneur, 2013). In general, providers of PSS must extend their focus of activities from pure manufacturing towards services. This extension establishes a higher level of interdependency between the seller's activities and the buyer's operations (Barquet et al., 2013). PSS providers perform Key Activities before, during and after the product's usage phase (Cook et al., 2006) that can be clustered into four phases from manufacturing to final service provisioning (see Figure 2.9).

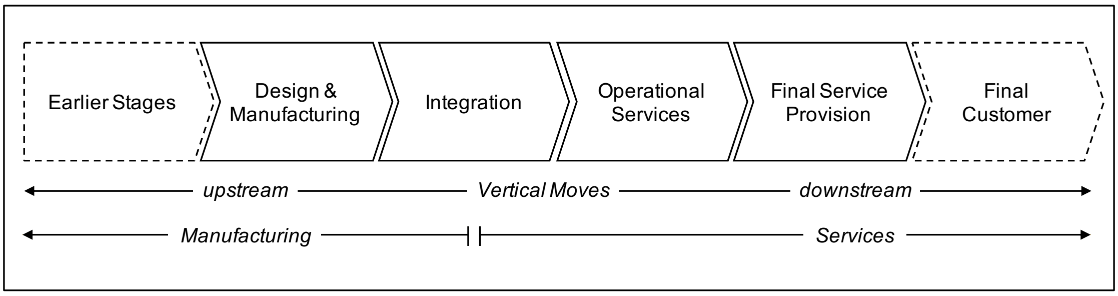


Figure 2.9: Value Stream (adapted from Hobday et al., 2005, p. 1134)

In *design and manufacturing*, solution providers should expand and modify the new-product-development (NPD) process to create a new-service-development (NSD) process to develop the service concept and ensure its rollout (Kindström & Kowalkowski, 2009). In the NPD process, particular emphasis needs to be placed on designing physical product characteristics synergistically with service components to enable cost savings and enable new revenue potential (Ulaga & Reinartz, 2011). Also, superior product properties such as the ability to be maintained, upgraded, and reused easily, should be identified and implemented to increase the value creation of the new business model (Adrodegari et al., 2016). To improve future generations of equipment, the manufacturer should implement dynamic feedback loops with the final user or maintainer of the system (Davies, 2004; Kindström et al., 2013; Schuh et al., 2015).

In the final manufacturing activity of this phase, the solution provider transfers raw materials and sub-assemblies or -systems into the asset. The extent to which the production of subsystems is outsourced depends on the solution providers' upstream integration (Hobday et al., 2005). *Integration* is at the heart of solution provisioning, since solutions involve the integration of horizontal or vertical products and services (Galbraith, 2002; Davies, 2004). System integration is defined by Hobday et al. (2005) as an activity adding value through the design and combination of physical components, subsystems, software, and services. Integration involves, however, a broader scope: organizational units and activities inside the firm, Key Partners, and customers need to be deliberately integrated as well. Inside the firm, the integration of operations and actions must be managed intentionally on tactical and strategic levels, since business processes require a new orientation to support PSS (Meier & Massberg, 2004). Examples of this decision are whether or not to integrate product and service sales organizations (Gebauer et al., 2005) or NPD and NSD organizations (Isaksson et al., 2009).

Customization is a commonly named element of solution provisioning, as solutions are co-developed with the customer and customized according to his needs (Stremersch et al., 2001; Galbraith, 2002). Customization serves as an antecedent to a closer buyer-supplier relationship which is a prerequisite for providing high-value services and thus allows for competitive differentiation and increased profitability (Mathieu, 2001a). However, customization is a two-sided medal, since it also decreases standardization at the expense of increased costs (Kowalkowski et al., 2015). Thus, customization needs to be balanced with standardization and modularization to be able to deliver customized solutions cost-efficiently (Davies et al., 2006; Kowalkowski et al., 2015).

Delivering *operational services* includes the support and maintenance of the system required to provide services (e.g., the flight simulator, Hobday et al., 2005). The delivery of operational services needs to be planned to take place at a specific location and time to provide value to the customer. To provide services efficiently, the service provider needs to assign resources such as service technicians, tools and spare parts efficiently to service tasks and deliver the services as planned (Meier et al., 2013). Another option to improve maintenance efficiency is the use of monitoring and preventive maintenance activities (Azarenko et al., 2009). Also, the adaption of the problem-solving attitude and activities are crucial, since its characteristics change severely from manufacturing to solution provisioning (Adrodegari et al., 2016). Unlike in production, the solution provider has to provide quick responses at minimum costs to repair failures of the equipment (such as a train failure) to avoid penalties (Baines et al., 2011).

Final service provision includes activities such as providing the final consumer with the service (e.g., telecom or air transport), as well as engaging in brand, marketing, sales, distribution, and customer care activities (Hobday et al., 2005). Only in a few cases, solution providers take over customer's operation, providing the final customer directly with the service. Instead, customers such as train companies typically continue to operate their fleet of trains.[23] The efforts required in changing the sales approach and

[23]The predominant alternative approach is to entirely integrate downstream to become the competitor of the customer. One example are car manufacturers that offer mobility services which compete directly with the traditional customer segments of Taxi firms and rental companies.

activities to lower the cost structure are included in this phase, have however already been discussed extensively in the respective sections.

In conclusion, manufacturers add activities beyond production to their business model, when undertaking servitization. These activities start already in the design and manufacturing phase (e.g., the NSD process) and extend to the final customer beyond the point of sale of the asset (e.g., by providing maintenance services in operation). Hence, providing solutions requires an extension of the scope and number of Key Activities in the manufacturer's business model.

2.3.6 Dynamic Capabilities for Developing Solutions

bThere appears to be a consensus about that manufacturers require dynamic capabilities to guide them towards the development of successful service-oriented business models that successfully generate revenues and profits (Cohen et al., 2006; den Hertog et al., 2010; Fischer et al., 2010; Kohtamäki & Helo, 2015). This service innovation process is based on a deliberate, evolutionary process of sensing, seizing, and reconfiguring routines, which are facilitated by management innovation (Gebauer et al., 2011). To synthesize relevant servitization literature on dynamic capabilities, I identify and analyze articles that explicitly specify the dynamic capabilities and their microfoundations that manufacturers require to provide hybrid offerings. The insights of this systematic review are presented in the table below.

The findings suggest that several studies have ventured independently from each other to identify the dynamic capabilities required by manufacturers to pursue servitization successfully and hence show considerable overlaps. Even though the studies position themselves in applying the DCV to the phenomenon of servitization, they sometimes remain blurry regarding their definitions. Especially distinguishing dynamic from operational capabilities and dynamic capabilities from their microfoundations are the main issues. One example are Kindström et al. (2013, p. 1078), who define the microfoundation of reconfiguring *"Orchestrating the service system: Managing and transforming the service system, especially managing external actors central to performance of the service."*. While the transformation of the service network to co-create solutions is undoubtedly dynamic, the management of the service system is operational. In consequence, I have re-named some of the identified microfoundations to highlight the dynamic aspect and improve conceptual clarity.

Sensing Manufacturers develop capabilities to sense market and user needs, technological developments, and opportunities within the firm and their service network. Since the value of new services and underlying customer needs may differ between product and service provisioning (Ulaga & Eggert, 2006), and service-oriented values are more difficult to measure (Grönroos, 2007), manufacturers need to develop new

Dynamic Capability	Microfoundations	Illustrative Quote
Sensing	Customer need sensing	• Identification of service opportunities through observation of customer needs, their perceived risks, and competitors (Fischer et al. 2010)
	Technology sensing	• Signaling technological options: capability to see promising technological options for new service configuration (den Hertog et al. 2010)
	Service System Sensing	• Building up an understanding of the entire service system, including links to partners and suppliers, and creating network skills (Kindström et al. 2013)
	Internal Service Sensing	• Building up internal sensing: e.g. opportunities related to the integration of products and services and the detection of decentralized initiatives (Kindström et al. 2013)
Seizing	Conceptualization and co-creating	• Conceptualizing, designing, prototyping or testing more fuzzy types of service innovations (den Hertog et al. 2010)
	Structuring the service development process	• Routines of quick and timely decisions to create a dominant design of the total offering. • Formulate "planned strategies" for service business development including rigid scenario planning. (Fischer et al. 2010)
	Restructuring the service delivery process	• Having the ability to restructure internal and external resources swiftly, for the delivery of new or improved services, including roles dedicated to services at both operational and strategic levels (Kindström et al. 2013)
	Bundling and unbundling	• Creating smart service combinations with a customized "one stop shopping" character • Unbundling services and stripping these down to their bare essentials creates highly specialized services that are very similar and can therefore be standardized to a certain extent (den Hertog et al. 2010)
Reconfiguring	Orchestrating the transformation of the service network	• Managing the transformation of the service system, especially integrating external actors central to performance of the service. Extend the resource base into new markets and services and incorporate complementary resources and co-specialization. (den Hertog et al. 2010)
	Scaling and Stretching	• Scaling and stretching of service innovation so that services can be provided in a uniform way on a large scale (den Hertog et al. 2010)
	Learning and adapting a service-oriented mental model	• Creating service-oriented mental model: Often referred to as a service logic; implies a learning dimension (Kindström et al. 2013)
	Balancing product and service-innovation related assets	• Capacity to overcome internal resistance and conflicts • Capacity and resources to set up a separate strategic business unit for services with own profit-and-loss (Fischer et al. 2010)
	Protection of spare parts business	• Routines to reconfigure assets and resources to protect the spare parts business from imitation (Fischer et al. 2010)

Table 2.3: Dynamic Capabilities of Manufacturers Required for Solution Development

customer-linked sensing capabilities (Kindström et al., 2013). In doing so, they should use empathetic capabilities to sense unmet user needs and intensely interact with lead users and potential clients (den Hertog et al., 2010). These sensing activities can also include competitors and their competitive moves (Fischer et al., 2010).

Manufacturers need to sense the latest technological innovations that are directly related to the services business, to identify promising options for new service configurations (den Hertog et al., 2010). *Technology sensing* for service innovation differs from traditional product research in that it aims at tapping into possibilities that technological innovation offers not for product development but for service innovation (Kindström et al., 2013).

Internal service sensing relates to the capability of the manufacturer to identify the opportunities associated with the integration of products and services to differentiate the total offering (Fischer et al., 2010). Internal service sensing is especially challenging for firms, since service innovation may be little structured and transparent (Gebauer & Friedli, 2005) compared to product innovation but nonetheless critical as it may have a direct influence on turnover, profitability, and sales (Kindström et al., 2013).

Service network sensing refers to sensing service innovation opportunities, not from the customer, but other actors in the service network. This sensing capability is especially relevant in solution provisioning since it commonly involves other actors, such as third-party service providers or system partners that are organized in such a network (Kindström et al., 2013).

Seizing To seize opportunities from service innovation, the more intangible and fuzzy combinations of existing ideas compared to product innovation need to be conceptualized. Conceptualizing includes designing, prototyping or testing these fuzzy innovations types as a service-innovation-specific capability that is expected to be less tangible and codified (den Hertog et al., 2010). Firms that co-create advanced services through repeated cycles of interactive co-creation with their customers can create and seize opportunities for innovation and competitive advantage (Kindström et al., 2013). This *service design* process needs to be structured: since service development involves more disciplines than product development, firms need to organize senior management support (den Hertog et al., 2010; Kindström et al., 2013). These authors highlight that firms should separate service from product development to mitigate unplanned and ad-hoc service development due to lower prioritization. The separation ensures quick and timely decisions to create a dominant design of the total offering (Fischer et al., 2010).

Firms that add advanced services to their portfolio require the capacity to restructure internal and external resources swiftly, for the delivery of new or improved services, which is a capability that I call *"restructuring the service delivery process"* (Kindström et al., 2013).[24] This capability includes striking a balance between service quality and cost efficiency (Grönroos & Ojasalo, 2004) and a continuous balancing of the comparative strengths and weaknesses of their internal service functions and their external service partners. This balancing act includes determining where in-house service units are located (typically at headquarters versus locally) and which services should be outsourced to external parties (Kowalkowski et al., 2011b).

Bundling also known as *integration capabilities* enable manufacturers to create seamless but customizable combinations of products and services with a "one-stop-shop" character. *De-bundling* capabilities, on the other hand, allow for standardization of services by stripping them down to their bare essentials (den Hertog et al., 2010). The latter capacity enables the manufacturer to achieve minimum operational costs and achieve

[24]Kindström et al. (2013, p. 1068) call this capability "managing the service delivery process". Since this name resembles somewhat an operational capability, I have decided for to re-label it.

service profits (Fischer et al., 2010).[25] De-bundling, closely resembles the operational concept of optimizing service productivity (Grönroos & Ojasalo, 2004). As both the integration capability and product optimization rather represent operational capabilities, they are treated as such and not conceptualized as a dynamic capability of pure service providers.

Manufacturers that aim at providing output-based Value Propositions often struggle with developing the appropriate revenue mechanisms (Kindström et al., 2013). When the value is determined in-use by the customer (Vargo & Lusch, 2004), revenue streams are defined through gain-sharing mechanisms and service outcomes, such as availability and performance. Thus, the capacity to *develop and adopt new revenue mechanisms* needs to be developed by the manufacturers. This also includes charging the customer for services that were formerly offered for free or were incorporated in the product price (Fischer et al., 2010).

Reconfiguring Short-term competitive advantage can often be reached by focusing on sensing and seizing of opportunities. Efforts to reconfigure the resource base are required, however, to convert this short-term advantage into a sustainable one (Zahra et al., 2006; Helfat et al., 2007).

Cooperating across firm boundaries and managing and engaging in networks is a crucial dynamic capability for being able to provide solutions (den Hertog et al., 2010; Gebauer et al., 2013). The reason is that many value propositions are combinations of product and service elements of different providers that fulfill a service need together (Ramirez, 1999). Solution providers need to *orchestrate the service system*, actively managing the external actors that are central to the performance of the service system. To effectively do so, solution providers have to develop a common language with suppliers and customers (Gebauer et al., 2013). This reconfiguration capability also included the extension of the resource base into new markets and shifting roles, resources and the locus of control in the service system (Kindström et al., 2013).

The capacity to *protect the spare parts business* is vital for manufacturers using the exploitation servitization strategy. Spare parts are an essential foundation for the development of the service business because they remain relatively free from imitation and hamper independent service providers that wish to provide services for the installed base. Tactics for protecting spare parts include maximizing the ratio between manufactured and purchased parts, controlling the parts supply chains, optimizing parts

[25] Bundling and de-bundling of product and service elements has been discussed as both a dynamic and operational capability, the latter mostly under the term integration capability (den Hertog et al., 2010; Wilson, 1995) as a dynamic capability. In my conceptualization, the dynamic capability of bundling aims at the reconfiguration from previously separated to jointly sold and priced offerings. The operational integration capability refers to the actual practices that firms perform to integrate product and service components during daily operations, e.g., through a Key Account Manager.

logistics and the use of condition monitoring to detect non-authorized service activities or the use of alternative parts (Fischer et al., 2010).

Scaling and stretching service innovation is a critical dynamic capability to provide services in a uniform way on a large scale (den Hertog et al., 2010). The authors base the dynamic capability on the replication strategy, which is sometimes called the "McDonalds approach" and was first described extensively by Winter & Szulanski (2001). Scaling and stretching is especially important in service markets since communication and branding are essential for creating a recognizable service offering (Krishnan & Hartline, 2001). As such, building a valuable service brand requires serious investment and a consistent strategy (den Hertog et al., 2010).

Learning and adapting is defined as "capability to deliberately learn from the way service innovation is managed currently and subsequently adapt the overall service innovation process" (den Hertog et al., 2010, p. 504). This involves creating a service-oriented mental model, which is one of the most time-consuming and challenging elements of reconfiguration for manufacturers. Learning and adapting also implies unlearning and objecting obsolete routines, which should then lead to the adoption of more effective behaviors (Sinkula, 2002; Matthyssens et al., 2006). Deliberate learning and adapting is vital for long-term success and continuous service innovation (Gebauer & Friedli, 2005; den Hertog et al., 2010).

Firms coming from a base in manufacturing need to *balance product and service-innovation* related assets. This includes overcoming the frequent tensions between product and service units and creating of roles across all organizational levels (Gebauer & Friedli, 2005; Kindström et al., 2013). Often, profit and loss accountability for services is built by establishing a separate services business unit to overcome tensions and improve the profitability of the service business (Fischer et al., 2010).

In conclusion, servitization literature has identified a well-defined set of dynamic capabilities that manufacturers require to move downstream into hybrid value provisioning. Approximately two-thirds of the identified dynamic capabilities have been described in more than one article. While this improves the empirical underpinning of manufacturers DCs to guide them to product-service business models, it also shows the isolation and overlaps of still present in the servitization research field. In contrast, the specific dynamic capabilities and their microfoundations required by pure service firms to venture into the hybrid offering space from a base into services have not been researched.

Pure service firms' dynamic capabilities differ from manufacturers' DCs, for both solution development and alliancing due to a variety of reasons: First, pure service firms come from a base in services and commonly have already established dynamic and operational routines that enable successful service provisioning. For example, routines should be set that allow sensing customer needs in the more intangible and value-oriented (Grönroos, 2007) service domain. Hence, most of the service-specific DCs that manufacturers have to develop are not new to pure service firms.

Second, pure service firms lack the internal competencies of the product-manufacturing business, as they do not possess any significant product-related production units. In effect, they are likely to require specific technology-sensing capabilities that enable them to provide services on the manufacturer's equipment. These capabilities will need to be even more pronounced if solution offers require pure service providers to assume responsibility for performance outcomes of a bundle of the manufacturer's equipment and the internal services.

Third, manufacturers develop dynamic relational capabilities to build, manage, and reconfigure their service networks from a central integrator position (Gebauer et al., 2013; Salonen & Jaakkola, 2015). The dynamic relational capabilities required by pure service are likely to differ from manufacturers for two reasons. First, they occupy a decentral network position, which requires different dynamic capabilities, which have been mostly overlooked by extant literature (Story et al., 2017).

Fourth, manufacturers are known to require dynamic relational capabilities to form and manage their solution network (Gebauer et al., 2013). These considerably differ, however, from the relational capacities required by pure service providers, as manufacturers merely search for providers to complement their resources and capabilities to provide solutions, whereas manufacturers represent an entrant competitor to established pure service providers. Hence, a specific set of relational capabilities, supporting both *cooperative and competitive* aspects of the evolving relationship will be required.

In this study, I take this service firm perspective, i.e., the perspective of service firms that use BMI to seize opportunities and mitigate threats resulting from the manufacturers' hybrid value creation efforts. Further research in this field is required due to the limited explanatory power of manufacturer-specific dynamic capabilities for explaining both, solution provisioning of pure service firms, and becoming a partner in OEM solution networks.

2.3.7 Literature Review: the Role of Pure Service Firms in Servitization Research

Due to the peripheral role that pure service firms have played in servitization research so far, I have decided to conduct a systematic literature review[26] to synthesize the dispersed knowledge stocks available regarding this topic. The literature review process entails analysis of 37 publications containing information about pure service firms in servitization research from 1990 until 2017. Considering the development of servitization research to up to 100 yearly publications (Lightfoot et al., 2013), the lack of research

[26]The method is further explained in Section 3.4 in the Methodology chapter.

on traditional service providers is notable. This finding is reinforced by recent literature suggesting that most servitization studies focus on manufacturers, while the role of service firms remains under-explored (Martín-Peña & Ziaee Bigdeli, 2016; Mountney et al., 2016).

Topics like competition with solutions (e.g., Mathieu, 2001b; Ulaga & Reinartz, 2011; Finne et al., 2015) or solution networks (e.g., Gebauer et al., 2013; Paiola et al., 2013) have been discussed mainly out of a manufacturer's perspective. In consequence, literature provides almost no guidance regarding the competitive positioning of traditional service firms and their business model innovation paths.

However, in contrast to this general finding, two studies have exceptionally advanced our understanding of competition between pure service firms and servitizing manufacturers in general and particularly in the aerospace industry. Hence, these two studies are portrayed in more detail.

The first study *"Hybrid Offerings: How Manufacturing Firms Combine Goods and Services Successfully"* has been conducted by Wolfgang Ulaga and Werner Reinartz in 2011. The authors examine how manufacturers can leverage the unique resources from their manufacturing background to build distinct capabilities that can be applied to generate a positional advantage against pure service firms. This is achieved via a theory-in-use approach (Deshpandé, 1983), gathering empirical data from two pilot studies and 22 interviews with senior executives from various manufacturing backgrounds. The reason why this contribution is seminal in the context of hybrid offerings, is that Ulaga & Reinartz (2011) are the first and very few authors that examine competition between manufacturers and pure service firms in hybrid offers. In contrast, prior studies have examined servitization as a strategy to achieve competitive advantage against other manufacturers (Lightfoot et al., 2013) and have overlooked competition with pure service firms almost entirely.

Ulaga & Reinartz' main argument underlining competitive advantage of manufacturers is their ability to link the product and service business. According to this argument, manufacturers are in a position to leverage their unique manufacturing-specific resources to build distinct capabilities that pure service firms do not possess. By applying these capabilities on different types of industrial product-service offerings, manufacturers can achieve differentiation or cost advantages (see Figure 2.10). One example is the manufacturer's sales force and distribution network that possess in-depth knowledge regarding the product and privileged access to the customer. This existing sales force can be trained to acquire the new skills required to master the more complex sales process which is required to sell hybrid offerings. Once a product-service sales force has been trained to understand specific customer problems and is able to master the mental switch from selling products to selling value while intertwining product with service features, the manufacturer possesses the unique hybrid offering sales capability that it can leverage to gain a positional advantage (Ulaga & Reinartz, 2011).

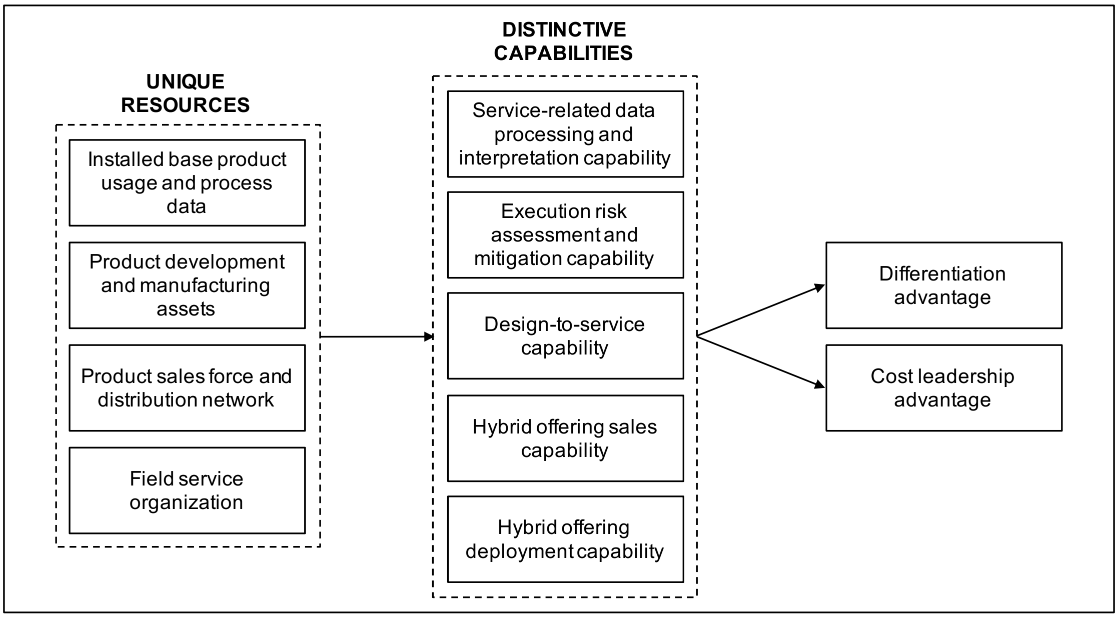


Figure 2.10: Manufacturer-specific Resources and Capabilities for Successful Hybrid Offerings (adapted from Ulaga & Reinartz, 2011, p. 10)

In spite of the seminal character, Ulaga & Reinartz' study also has its limitations: As the sample only includes manufacturers, the authors had to rely on the perception of their interviewees regarding the unique nature and value of the resources and capabilities of manufacturers. One example is the manufacturer's field service organization that many manufacturers employ to deliver services to their installed base of goods. Based on the field service organization, manufacturers can leverage the hybrid offering deployment capability, which is *"[t]he manufacturer's capacity to rely on flexible platforms that allow for standardizing production and delivery processes while safeguarding its ability to adapt to individual customers' needs."* (Ulaga & Reinartz, 2011, p. 16). This hybrid offering deployment capability in turn, supposedly allows manufacturers to achieve cost advantages against pure service firms.

These assumptions do however not hold in the aerospace industry. Here, the largest field service organizations are employed by airlines and their maintenance arms, not the manufacturers. For example, Lufthansa Technik employed in 2017 on an annual average approximately 21,000 employees (Lufthansa Technik AG, 2018), AFI KLM Engineering & Maintenance more than 14,000 (AFI KLM E&M, 2018). In contrast, the largest civil aerospace manufacturers Airbus and Boeing first needed to build their service organizations, which perform tasks like engineering, customer support, and integration of different product and service units into a service bundle. For manual maintenance work (the "dirty fingerprints") the airframers rely on a network of external MRO service partners that provide Line, Base, and Component Maintenance services to their customers (Pozzi, 2017c). Hence, these organizations are not able to leverage the internal service organizations into the proposed cost advantage.

Second, exploring manufacturers' unique sources of competitive advantage is only one side of the medal. Also service firms may use the unique resources and capabilities inherent in their service-based business model to create competitive advantage. One example are cost advantages through economies of scale, learning curves, and pooling effects that service firms are able to realize by servicing multiple equipment of various manufacturers (Mathieu, 2001b; Cohen et al., 2006). Also, pure service firms may gain a differentiation advantage through policy choices and timing: by defining service as their core business and an established service culture, pure service providers can supposedly provide more flexible, rapid, and professional services than manufacturers (Mathieu, 2001b). In addition, recent research has found that the service knowledge of pure service firms enables them to better customize services for customers than manufacturers, which may enable them to gain a competitive advantage (Story et al., 2017). This is also true in the aerospace industry, in which manufacturers typically perform poorly in customer satisfaction surveys (AeroDynamic Advisory, 2018).

In commercial aviation, service providers continue competing against manufacturers based on resources and capabilities rooted in their service business. Resources and capabilities that stem from a base in services are likely to not be available to manufacturers and hence have the potential for achieving competitive advantage. Consequentially, the aerospace industry represents a good opportunity to find a response to the unanswered call for research by Ulaga & Reinartz (2011, p. 22) who explicitly acknowledge this limitation of their study: *"Scholars could also investigate how pure services firms venture into hybrid offerings and compare their resources and capabilities with our results."*. By examining the sources of competitive advantage of pure service firms I contribute to the understanding of positional advantage in hybrid offerings from both firms based in manufacturing and service businesses.

The second seminal article is Schneider et al. (2013) who make a contribution to business model innovation literature by examining servitization in the aerospace industry as a context that makes BMI inevitable for traditional MRO service firms. Explicitly, the authors aim to shed further light on possible drivers, elements, and formats of business model innovation within a B2B context. As part of an inductive, theory-building research design, Schneider and her colleagues base their findings on 12 interviews with managers from a range of smaller private and larger commercial MROs. In context of this study, the work of Schneider et al. (2013) is seminal as their framework for business model innovation in the MRO context (Figure 2.11) contains much of the groundwork onto which this study is built.

Schneider and her colleagues identify two types of antecedents as drivers of BMI of MRO service firms. The first driver is servitization (expansion of MRO offerings through OEMs), which is caused i.a. through increasing product-lifecycles and pricing pressure at the point of aircraft sales. As a second driver Schneider et al. (2013) outline how

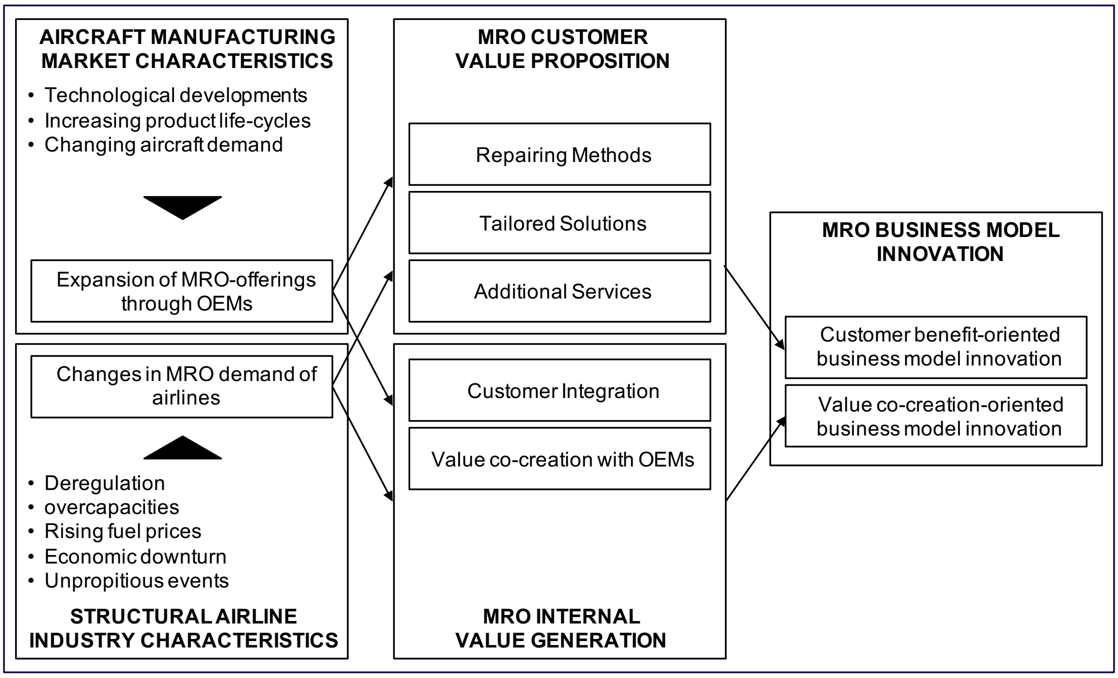


Figure 2.11: Framework of Business Model Innovation in the MRO Context (adapted from Schneider et al., 2013, p. 295)

airlines focus on their core business flight operations due to a high level of competition within the industry.

As a response to these drivers, Schneider et al. (2013, p. 288) suggest business model innovation as a possibility to realize opportunities and cope with challenges: *"[t]o ensure survival, firms such as the MRO providers are not only required to consider and drive the commercialisation of isolated product or service innovations, but also to question their underlying core business logic."*. The authors construct the MRO business model framework along two dimensions: MRO customer value proposition and MRO internal value generation. Schneider and colleagues propose that increased innovation is required along both dimensions of the business model framework: value co-creation-oriented business model innovation for the internal value generation dimension and customer benefit-oriented BMI along the MRO customer Value Proposition dimension. One option is to develop outcome-based solutions to compete with manufacturers in serving airlines that focus on their core business. This requires innovation of both the internal value generation dimension (increased collaborations with airlines) and customer value proposition (develop solutions). The second option is to form an alliance with manufacturers to become part of their solution networks. As a third option, Schneider et al. (2013) propose to form alliances with other MRO providers.

Even though Schneider's study considerably advances our understanding, the study has considerable limitations. First, the MRO business model remains generic, being based on a framework that contains only two dimensions, and is therefore very limited in explaining the core logic of MRO service firms. Second, Schneider et al. (2013) propose developing solutions and three types of alliances as a response to servitization and changing customer demand. However, it remains unclear in which case a fit with the competitive environment can be reached by pursuing these paths. For example, three major groups of manufacturers exist, namely airframe, engine, and system manufacturers. It remains unclear with which type of manufacturer, alliances should be formed. In this decision, competition for profitability across different levels of the supply chain and resulting tensions (Michaels, 2017d) need to be taken into account.

On the offering side, different types of solutions exist in the aerospace industry, with Component Solutions, Engine Solutions, and Aircraft Solutions being the most common ones. Schneider et al. (2013) do not discern between these types of solutions but generically propose solution development as a viable BMI path to cope with the emerging challenges. However, some types of solutions are already common practice, while others are more difficult to develop due to the inherent risk. In this regard, an identification of the operational and dynamic capabilities required by MROs to successfully deliver solutions would greatly improve our understanding of how and under which circumstances pure service firms can deliver this type of product-service offers.

Third, and most importantly, Schneider and her colleagues raise criticism regarding the development of OEM alliances, do however not offer any solutions to the MROs' dilemma. Critique is raised especially regarding the lack of added customer value and the fact that the alliances are perceived by 82% of their sample as a time-limited approach until the manufacturers have gained sufficient service capabilities to provide solutions on their own. This raises the question whether MROs could establish certain types of alliances that create more value and are more sustainable than others? Fourth, the study does not address, how the proposed business model paths can be pursued. As creating solutions and alliancing in solution networks requires fairly developed relational, operational and dynamic capabilities (Gebauer et al., 2013; Story et al., 2017) we however need to create a better understanding of how the proposed business models can be implemented. In conclusion, the specifics and different options of MRO business model innovation still remain unclear to academia and practice.

In conclusion servitization literature reports mostly anecdotally two distinct paths that pure service firms chose as a reaction to servitization of manufacturing: (a) developing solutions themselves and (b) alliancing with manufacturers.

The set of studies supporting the former BMI path acknowledges that also pure service firms such as WS Atkins plc, an engineering and consulting firm, or Cable & Wireless, a telecommunications provider can innovate their business model to offer integrated solutions to their customers (Brady et al., 2005; Davies et al., 2007). This BMI is not necessarily a reaction to servitization of manufacturing but can also be seen as a manner to differentiate the firm's offering by better fulfilling customer needs (Baines et al., 2009). However, developing solutions may be required to fulfill changing customer demand once they have become the norm in the market (Oliva & Kallenberg, 2003).

Alliancing with manufacturers is in fact a common theme in solutions literature that focuses on networks (e.g., Paiola et al., 2013; Gebauer et al., 2013) and business models (e.g., Storbacka et al., 2013; Adrodegari et al., 2016). In this field, many studies concentrate on the collaborative aspect of co-creating solutions. In contrast, only very few studies note that pure service firms may not have another choice but to cooperate with manufacturers to gain access to the manufacturers' resources such as repair manuals. One of the few exceptions are Schneider et al. (2013, p. 301) who underline the necessity of OEM-MRO alliances by citing a CEO of an MRO firm: *"joint ventures with OEM's are only a timely limited approach, but we need to collaborate to gain access to the technical manuals"*.

In summary, MROs need to perform BMI to cope with servitization. Developing stand-alone solution offers and forming alliances with manufacturers are deemed the two most sensible tactics. The two BMI paths either increase the competitiveness against the fuller packages of manufacturers' service bundles (Vandermerwe & Rada, 1988) or choose the collaborative option aiming to co-create solutions and gain access to the manufacturer's resources.

A Phase Model of Servitization

To understand and visualize the impact of servitization on established service industries and traditional service firms, I develop a three-phase servitization model, depicted in Figure 2.12.

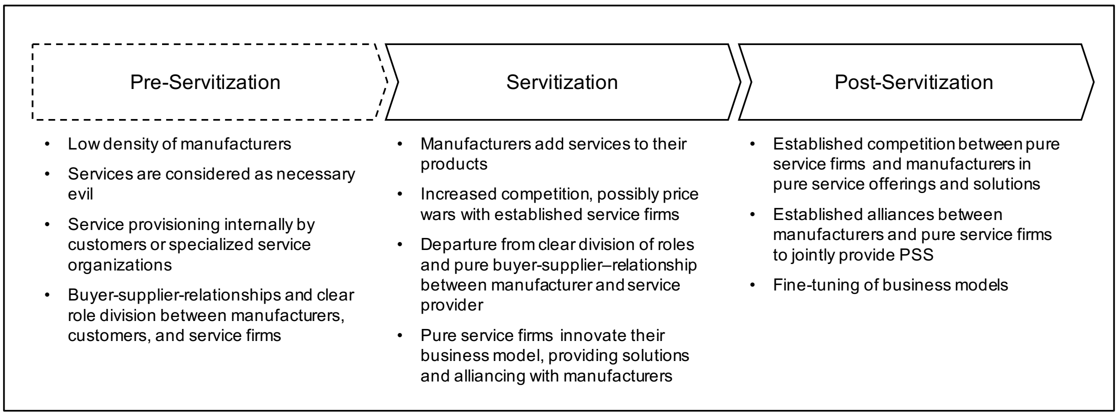


Figure 2.12: Servitization Phase Model

Pre-Servitization Phase In the pre-servitization phase, manufacturers often perceive services as "necessary evil" and are reluctant to grant them, as they are sometimes required to provide them for free as an add-on to the product, resulting in low profitability (Lele, 1997; Neely, 2008).

Consequently, auxiliary services are conducted mainly by customers themselves or specialized service organizations that offer these services to third parties. Examples from the airline industry include catering (e.g., the independents Gate Gourmet and DO & CO, as well as Lufthansa's LSG Skychefs), pilot and crew training (e.g., Emirate's Flight Training Academy and Lufthansa Aviation Training), and IT (e.g., Lufthansa Systems). The size of these service organizations varies from single mom and pop shops to national or even global players. In the automotive industry, for example, the car garage A.T.U has established more than 600 locations in Germany, Austria, and Switzerland (A.T.U Auto-Teile-Unger GmbH & Co. KG, 2017).

In this phase, manufacturers, customers and service firms create a buyer-supplier relationship with a clear division of roles between the three parties. The manufacturer is responsible for the design and production of equipment, the customer for operation and the service provider for maintenance.

Servitization Phase When transitioning from a pre-servitization phase towards servitization, the density[27] of manufacturers in an industry is still low. Consequently, the first OEMs moving downstream into services need to change the existing industry culture to reach legitimization in service provisioning (Turunen & Finne, 2014).

In cases in which the established service providers form part of a customer organization, the market entry becomes especially problematic, since manufacturers moving downstream become suppliers and competitors at the same time (Kowalkowski et al., 2011a). If they then move into their customer's domain without prior agreement or too assertively, they may encounter competition or even conflict with their customers (Davies et al., 2006). In this case, traditional service providers may make use of their established position in the service industry to hamper OEMs' entry into the service market. The probably most cited example comes from the airline industry. Here, established flight training schools have thwarted the market entry of the flight simulator manufacturer Thales, who tried to add pilot training and the management of simulator training facilities to their product portfolio (Davies et al., 2006). A common tactic to mitigate this problem and gain channel control is to merge or form an alliance with pure service firms (Davies et al., 2006; Turunen, 2011).

Traditional service firms perceive an increased level of competition compared to the

[27] Density refers in this context to the number of organizations (manufacturers) in a population (total number of firms offering services for equipment, Hannan & Freeman, 1989)

pre-servitization phase, as not only the traditional service firms but also the new entrants compete in the service market. While the resulting level of competition will depend on the specific market structure (Porter, 1998), manufacturers often employ aggressive pricing strategies to establish their service offers, resulting in price wars with traditional service firms (Schneider et al., 2013). Also, external factors such as political intervention may affect competition. One example is the the automotive industry, where antitrust acts of the European Commission have fostered the competition between manufacturers and pure service providers for car maintenance. Various interventions in between 2003 and 2011 have ensured a more level playing field by providing independent repair shops with reasonably priced access to technical information, data, tools, equipment, and training required to perform repairs (European Commission, 2007, 2010; Boston Consulting Group, 2012). On the other hand, legislation also limits competition, especially in safety-relevant industries, such as elevators and aerospace. In these industries, laws require manufacturers to ensure the safety of their equipment, however often at the expense of competition (Turunen & Finne, 2014).

Last but not least, not only manufacturers but also the limited tangible and intangible resources required for service provisioning may limit competition. Especially skilled human resources such as sufficiently skilled maintenance mechanics may be scarce (Turunen & Finne, 2014) and thus affect market entry and competitive tactics.

Post-Servitization Phase In the post-servitization phase, some manufacturers have successfully established themselves as service providers in their respective aftersales service market. Their counterparts with less success of their service-led business model may deservitize completely or outsource increasing parts of their service business to their partners (Forkmann et al., 2017b). In this phase, alliancing and competitive activity will continue between the two parties, albeit on a less dynamic level. Hence, service firms will rather need to fine-tune instead of radically change their already reconfigured business model to increase the fit with the changing environment (Teece, 2007).

Competition may also move towards the left in the product-service continuum if customers or pure service firms start backward integration towards manufacturing (Hobday et al., 2005). One example of this rather infrequent business model innovation is the Hong Kong-based MRO provider HAECO that has launched a large scale production of PMA parts especially for aircraft cabin interiors (Derber, 2014) to compete with the manufacturers' spare parts business. Manufacturers may be able to prevent these ventures by providing high-quality products at a price that makes backward integration unprofitable to the customer (Hobday et al., 2005), which would, however, come at the trade-off of sacrificing some of the profitability of the typically highly profitable spare parts business.

Competing by Developing Solutions

Most servitization literature explicitly or implicitly assumes that the shift towards integrated solutions is a downstream movement from manufacturing to services (e.g., Wise & Baumgartner, 1999; Oliva & Kallenberg, 2003), and only some limited cross-sectoral research (see Table 2.4) shows that solutions can also be provided by firms that stem from a base in services. Since solutions are complex bundles of products and services which involve assuming the responsibility of parts of the customer's processes and their performance outcomes, they require the development of specific capabilities (Hakanen & Jaakkola, 2012; Paiola et al., 2013).

Characteristics of Solution-oriented Business Model Innovation Comparing the literature available regarding pure service firms venturing into solutions, some conclusions can be drawn, as many of the analyzed cases have some common characteristics. First, the prominent and possibly only approach to provide solutions available to pure service firms is becoming a solution integrator (Hobday et al., 2005; Davies et al., 2007). In this approach, resources and capabilities that stem from inside and outside the firm are integrated into a seamless offering (Hobday et al., 2005). Due to the complex nature of solutions, companies often do so by forming partnerships with these other organizations to access their complementary resources, services or products (Foote et al., 2001; Windahl & Lakemond, 2006). In this context, the capability to integrate internal and external activities, skills and knowledge from other organizations to produce more complex products and services is required both by manufacturers and pure service firms (Hobday et al., 2005; Davies et al., 2007). To provide integrated solutions, firms need to form collaborations with customers, OEMs, and possibly competitors. Partnerships with customers enable customer-benefit orientation and value co-creation, while collaborations with OEMs allow access to the required resources such as maintenance manuals and intellectual property rights (Schneider et al., 2013).

System seller approaches, in which manufacturers develop most resources and capabilities required for solution provisioning internally (Davies et al., 2007), are not commonly pursued by pure service firms. The reasons for not choosing this approach is that pure service firms would have to integrate backward, becoming producers of goods. The system seller approach would require considerable investments in research and development as well as production assets, with very questionable results regarding the competitiveness versus the products of the established manufacturers. By selecting the system integrator approach, pure service firms can choose between equipment of leading manufacturers to provide an integrated solution, instead. This provides service firms with a flexibility advantage, as they do not possess any in-house production capabilities (Davies et al., 2006).

Firm	Traditional Service Offers	Solution Offer	Business Model Innovation	Authors
Cable & Wireless Global Markets	• Network design • Supplying telecom infrastructure and applications • Operation and management of corporate networks	• Global outsourcing solutions for corporate telecom networks including design, ownership, management, operation incl. service level agreements	• Building integration capability • Establishment of three-part organizational structure (strategic center, customer front-end, product- and service back ends) • After failure in communication crisis: channel partnership with global consulting firms	Davies (2004); Brady et al (2005); Davies & Hobday (2005); Hobday et al. (2005); Davies et al. (2006; 2007)
WS Atkins plc	• Consulting and engineering services, project management and technical services for infrastructure projects	• Integrated multi-OEM solution financed, operated and maintained for customers defense health care and other sectors (e.g. railway or baggage handling systems)	• Building integration capability • Establishment of three-part organizational structure (strategic center, customer front-end, product- and service back ends)	Davies (2004); Brady et al (2005); Davies & Hobday (2005); Hobday et al. (2005); Davies et al. (2006; 2007)
Aerospace MRO firms	• Aircraft MRO services (Line, Base, Engine, Components Maintenance)	• Tailored solutions: increasing focus on customer benefits and value co-creation, contents not further defined	• Innovation of offerings and value creation, increased customer benefit- and value co-creation orientation • Collaboration with customers, OEMs and other MROs (limited)	Schneider et al. (2013)
Machine Retailer	• Retail of machines and robots	• Integrated industrial solution comprising of machines, maintenance software and aftersales (e.g. maintenance services)	• Integration of products and services of other actors • Development of network with clear roles and stable positions	Hakanen & Jaakkola (2013)
Professional Marketing Service Firms	• Distinct service offers of each firm: Marketing, Advertising, Media Planning	• Integrated marketing, communication and consultancy service solution	• Creation of a solution network with three integrating actors, as solution cannot be provided alone • Development of complex value co-creation activities	Jaakkola & Hakanen (2013)
Distributor of automated warehouse systems (not focal company of study)	• Distribution of warehouse system	• Integrated warehouse solutions comprising of planning, installing, integrating, optimizing and servicing the system	• Taking over responsibility from manufacturer of warehouse system, development of required activities (e.g. customization) • Development of dynamic capabilities to innovate and operational capabilities to sustain business model • Intensification of relationships with manufacturer and customer	Forkmann et al. (2016)
Information technology software enterprise	• providing maintenance planning and energy consumption software as well as training and consultancy services	• Energy solution consisting of monitoring & control services, energy meters and software	• Identification of increased customer needs • Definition of solutions delivery process • Partnerships: consideration but unclear whether developed and to what aim	Benedetti et al. (2016)

Table 2.4: Examples of Solution Providers from a Base in Services

Capability Development Second, pure service firms need to develop specific capabilities to provide solutions. One example is the integration capability, which is required to integrate the manufacturers' products as well as internal and external service components. However, the capabilities needed and their development differ from manufacturers, due to the base in services (Kindström et al., 2013). Another aspect is the in-depth knowledge regarding product components that only manufacturers can leverage to build competitive solution offers (Ulaga & Reinartz, 2011). As product components form an integral part of the solution, service providers will have to develop product-specific capabilities to provide competitive solutions. Also, the development of service-specific capabilities is likely to differ, as pure service firms already possess service-infused relationships and relational processes required to provide services (Tuli et al., 2007).

Competitive Advantage The competitive positioning of pure service firms and manufacturers has, somewhat surprisingly, received only minimal attention. The main exception are Ulaga & Reinartz (2011) that explicitly examine the competitive advantage that manufacturers can gain against pure service firms in hybrid offerings.[28] All studies that touch upon the topic use mainly the resource-based view as a strategic lens, arguing that either party possesses unique, valuable resources and capabilities.

The main argument underlining the competitive advantage of manufacturers is their ability to link product and service business. Manufacturers may transfer unique product-related resources and capabilities that pure service firms do not posses onto their PSS offers (Ulaga & Reinartz, 2011). Also, they may benefit from positive spill-over effects if they transfer their product brand name on their service offers (Mathieu, 2001b), which is a common tactic with car manufacturers. Ulaga & Reinartz (2011) argue that manufacturers are in the unique position to leverage their manufacturing-specific unique resources and build distinct capabilities that pure service firms do not possess and hence achieve a positional advantage (see Figure 2.10). One example is the manufacturer's sales force and distribution network that possess in-depth knowledge regarding the product and privileged access to the customer. This existing sales force can be trained to acquire the new skills required to master the more complex sales process which is needed to sell hybrid offerings. Once a product-service sales force has been trained to understand specific customer problems and can perform the mental switch from selling products to selling value while intertwining product with service features, the manufacturer possesses the unique hybrid offering sales capability that it can leverage to gain a positional advantage (Ulaga & Reinartz, 2011).

Service providers have not received the same level of academic attention as manufacturers, may however also use the resources and capabilities inherent in their service-based business model to create competitive advantage. One example are cost advantages through economies of scale, learning curves, and pooling effects that they were able to gather by servicing multiple types of equipment of various manufacturers (Mathieu, 2001b; Cohen et al., 2006). Also, pure service firms may gain a differentiation ad-

[28] As introduced in Section 2.3.7.

vantage through policy choices and timing: by defining service as their core business and their traditional service culture, pure service providers can provide more flexible, rapid, and professional services than manufacturers (Mathieu, 2001b). Besides, recent research has found that the service knowledge of pure service firms enables them to better customize services for customers than manufacturers, which may allow them to gain a competitive advantage (Story et al., 2017).

Even though these limited advancements regarding the competitive positioning of pure service firms have been made, our understanding of competitive advantage still suffers from major limitations. First, the empirical underpinning of competitive advantage remains limited. As Ulaga & Reinartz (2011) base their empirical study only on manufacturers that were successful in hybrid value provisioning, the authors were not able to assess the availability of the identified resources and capabilities at traditional service providers. This gap is somewhat problematic, as RBV states that a firm can gain a sustained competitive advantage based on its unique resources being simultaneously valuable, rare, inimitable, and organized (Barney & Hesterley, 2012), which is however difficult to assess if the type of firms compared to are not present in the sample. The authors explicitly acknowledge this limitation of their study by stating *"Scholars could also investigate how pure services firms venture into hybrid offerings and compare their resources and capabilities with our results."* (Ulaga & Reinartz, 2011, p. 22).

Other authors remain purely conceptual and do not provide any empirical underpinnings for their arguments. Furthermore, the identified studies containing service firms in their sample did not evaluate competitive advantage but only collaborative options for solution provisioning. Consequently, empirical foundations for sources of competitive advantage of pure service firms remain close to non-existent.

Second, some of the manufacturer's sources of competitive advantage require further examination. For example, increasing data-availability of the installed base has the potential to lower maintenance costs (Baines et al., 2007) through predictive maintenance methods, which may result in a competitive advantage for whoever has access to the data and the required data processing and interpretation capabilities. This is, however, not necessarily only the manufacturer. Instead, customers argue that the data generated by their equipment is their property and that they can provide this data to whomever they prefer, including traditional service firms (Valeika, 2015).

In summary, some first steps have been undertaken to outline the competitive field between manufacturers that go downstream and established traditional service firms, with a focus on the resource-based competitive advantage that manufacturers might enjoy. To better understand competition between both parties and implications for pure service firms to cope with servitization, sources of competitive advantage of pure service firms should be identified and compared to manufacturers.

Becoming an OEM Network Partner

As discussed in the Key Partners section of the PSS Business Model Canvas, manufacturers rely on different types of partners to provide PSS, as these complement the manufacturers' resources and capabilities. While the alliance decision of manufacturers has evolved from anecdotal evidence to developing strategic, theoretically founded approaches, academia remains mostly anecdotal regarding the alliance decision of service firms (i.e., whether to become the OEM's network partner) with only recent progress (e.g., Jaakkola & Hakanen, 2013).

Service suppliers should not blindly join every service network offered by manufacturers. Instead, strategic implications need to be taken into account, as service firms may possess an established position in the service market (Turunen & Finne, 2014) or operate in a market in which they may have unique sources of competitive advantage at their disposal. In these cases, joining the manufacturer's network would strengthen the OEM's market position, eradicating the own positional advantage. In other cases, manufacturers may possess a competitive advantage that may make competing a problematic or even unfeasible option for traditional service providers. Hence, traditional service providers require strategic (e.g., contingency-based) approaches towards deciding whether to compete with their own stand-alone solutions or whether to join the manufacturer's service network.

For this reason, it is crucial from an academic standpoint to investigate the alliance decision of pure service firms to improve our understanding of the formation of solution networks. Also, alliance arrangements between manufacturers and pure service firms may significantly differ in scope, Key Activities performed by either party, Channel access to the final customer, and other properties, which has direct implications on the advantageousness of these arrangements for service firms. In consequence, understanding alliances with manufacturers, the different options, and their implications is also of paramount managerial importance.

However, as of today, servitization literature lacks such a strategic approach for service providers and remains limited to some empirical evidence regarding benefits and sacrifices experienced when joining the manufacturers' service networks. Besides, the knowledge stocks regarding changes in the business model of pure service firms required to become a service partner are still scattered as of today. Hence, I summarize these knowledge stocks in the following two sections.

Benefits and Sacrifices of Network Partners Marketing literature commonly defines value as being *"derived from the benefits and sacrifices perceived by the actor in the offering and the related exchange"* (Jaakkola & Hakanen, 2013, p. 48). While benefits for the customer concern the increased utility of the offering, benefits between firms in the service network can result from the relationships and interaction between the parties. Sacrifices, on the other hand, include monetary and non-monetary costs, such as risks or invested time and effort resulting from joining the service network (Jaakkola & Hakanen, 2013). Table 2.5 summarizes the identified benefits and sacrifices that service firms potentially perceive by joining the manufacturers' solution networks.

Benefits	Sacrifices
Growth • Increase in revenue • Access to new Customer Segments • Extension of the service offering	**Investment and Sales** • High upfront investments • Delay of profits • Limited potential to affect solution contents, sales targets and efforts • Decrease of revenues
Cost/Effort Reduction • Increased learning and economies of scale • Reduced effort for sales activities	**Access to Knowledge Resources** • Lack of information sharing by solution provider • Lack of access to intellectual property
Access to Knowledge Resources • Input in R&D from other Customer Segments • Increased product knowledge	**Culture and Governance** • Professional's reluctance to act as mere resource providers • Lack of trust in each other's competences • Lack of incentive alignment between partners
Improvement of Company Image • Credibility for being partner of a known OEM network • Access to bigger customers that can be used as reference	**Co-opetition** • Strengthening a competitor's service offering

Table 2.5: Benefits and Sacrifices of Service Firms in Solution Networks

Benefits Service firms that become network partners can benefit from potential growth of their service business by service revenues with the solution provider and access to its Customer Segments, which enables an extension of the service offering (Lockett et al., 2011; Turunen, 2011; Jaakkola & Hakanen, 2013). In turn, increasing size and stability of revenues, allows service providers to reap economies of scale or decrease service turn-around times (Lockett et al., 2011). Service firms can gain a significant learning advantage by specializing in one type of service, as e.g., the maintenance of complex technical equipment in a center of excellence concept (Gebauer et al., 2013). The resulting learning curves may improve the service provider's cost leadership advantage even over other service offers provided outside the solution network. Besides, service firms require lower customer acquisition costs, since they provide services for the solution provider's customers (Jaakkola & Hakanen, 2013).

Alliances with manufactures and access to its service network provide service firms with the possibility to access additional knowledge resources. For example, manufacturers can share valuable product know-how, which enables them to solve more advanced customer problems (Turunen, 2011). Increasing contact with possibly different customers also allows service providers to gain useful knowledge to support their service innovation activities (Jaakkola & Hakanen, 2013). Last but not least, service firms can improve their company image by becoming partners within the manufacturer's service network. An improved brand image may especially benefit smaller firms, which have not yet gained a firm market reputation, as they can refer to larger customers being served (Jaakkola & Hakanen, 2013).

Sacrifices To make an informed alliance decision, not only the abovementioned benefits but also potential sacrifices have to be taken into account. The first type of sacrifices concerns the investment that is required to enter the network and consequences for the service firm's cash flow. Lockett et al. (2011) report that service firms may need to make considerable upfront investments for building a pool of spare parts or for procuring repair equipment. Further investments may be necessary to stem other upfront R&D activities; furthermore a healthy cash flow may be required, as profits may be delayed due to the outcome-based pricing mechanisms (Jaakkola & Hakanen, 2013). To make matters worse, service firms often have limited opportunities to influence the contents of the solution, the sales targets, and sales efforts, as these activities are predominantly performed by the solution integrator (Lockett et al., 2011; Jaakkola & Hakanen, 2013). Besides lower sales volume, this may result in other sacrifices such as wasted R&D efforts or an inferior market position.

The second type of sacrifices relates to a lack of access to knowledge resources. Although manufacturers may provide service firms with valuable product know-how (Turunen, 2011), they are often reluctant to do so, as they fear the loss of intellectual property and its dissemination along the supply chain to potential competitors (Lockett et al., 2011). In cases in which solution providers assume most communication with the customer, touch points enabling service innovation of the service firm may be significantly limited. This problem is particularly severe if the solution provider is reluctant to share the customer insights or blocks the communication channel (Jaakkola & Hakanen, 2013).

The third sacrifice and possible barrier to becoming a network partner becomes apparent considering the cultural change that is required to collaborate with a manufacturer or solution integrator effectively. Jaakkola & Hakanen (2013) and Lockett et al. (2011) identify three culture- and governance-related barriers that are (a) the reluctance to act as a mere resource provider not servicing the end customer, (b) the lack of trust in each other's competencies, and (c) a lack of incentive alignment between the two partners. The latter can be especially pronounced between manufacturers and service providers due to their naturally opposing targets of a profitable spare parts business versus maximizing parts repair. Incentive alignment can be facilitated by usage and performance-based pricing models with the end customer (Baines et al., 2007) and taking decisions based on life-cycle costing (Lockett et al., 2011).

As noted earlier, alliance arrangements between manufacturers and service firms differ considerably, which is why a service firm is unlikely to experience all of the identified benefits or suffer from all of the identified sacrifices. Instead, service firms should aim at creating beneficial configurations of alliances with manufacturers that allow them to reap most of the benefits while mitigating the sacrifices to a maximum.

The Network Partner Business Model While most solution network studies focus on the manufacturer, little to no literature is available that focuses deliberately on the firms that become network partners (Story et al., 2017). Hence, the business model reconfiguration required to form solution networks remains incomplete and concentrates only on the manufacturers' perspective. This section consolidates the mostly anecdotal information on the aspired business model and its reconfiguration that pure service firms need to undertake to become an OEM network partner (see Figure 2.13). This Business Model Canvas is generic, which means that not all presented elements are present in all types of alliances and applicable to all kinds of service firms.

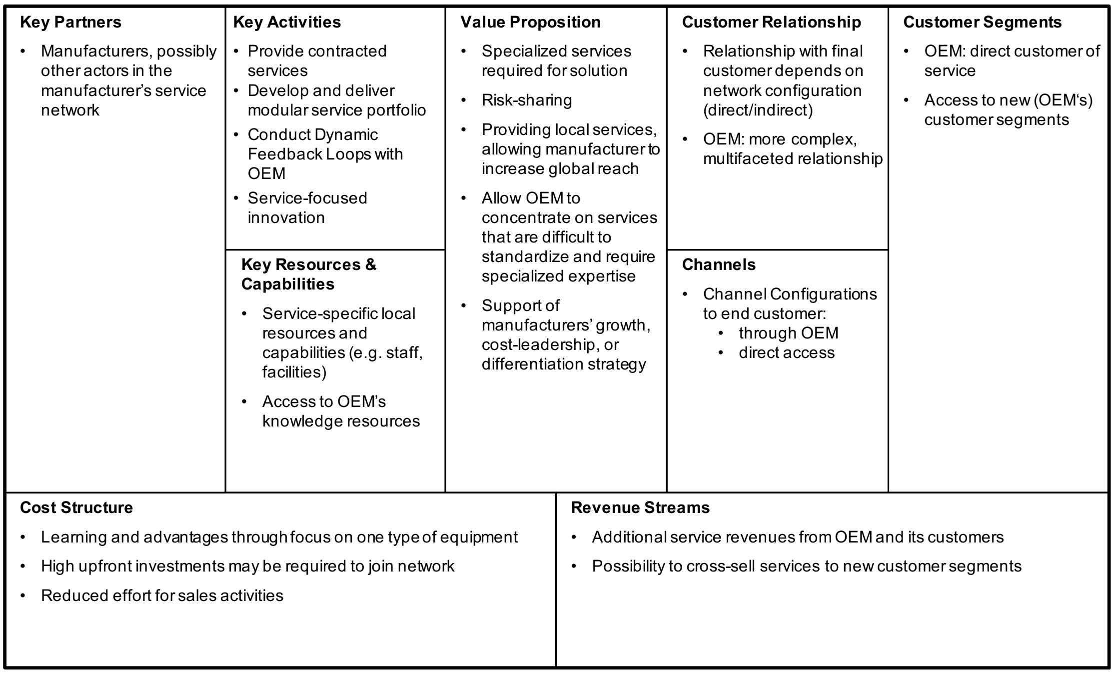


Figure 2.13: Network Partner Business Model of Pure Service Firms

Maintenance firms can make *Value Propositions* to add value to the manufacturer's solution through access to complementary resources and capabilities that are transferred through different types of services to the manufacturer's solution (Mathieu, 2001b; Helander & Möller, 2007; Jaakkola & Hakanen, 2013). These services may include but are not limited to basic or local support services, system maintenance, and labor-intensive maintenance operations. Choosing local service providers allows the manufacturer to serve global markets, building a flexible platform that meets the local demands (Helander & Möller, 2007). This platform can also serve for risk-sharing, as e.g., seasonal risks of capacity utilization can be shared among the partners (Mathieu, 2001b). If the manufacturer chooses to outsource basic services, it can concentrate on activities which are both difficult to standardize and require highly specialized expertise (e.g., consulting, Helander & Möller, 2007).

Image risks are one particular type of risk that manufacturers encounter by choosing third-party maintenance providers. These are relevant in the context of servitization as manufacturers are worried about undermining their product company image with service offerings. This risk is particularly significant at the beginning of the transition into the service business where service quality may negatively impact customer valuation in both product and service offerings (Kindström, 2010). When choosing third-party maintenance providers, manufacturers trade the image risks of internal service provisioning against image risks resulting from relying on external suppliers. These risks emerge for two reasons: first, the service provider acts directly at the customer interface, thus serving as a representative of the solution provider. Second, the customer attributes the service provider's performance direct to the solution provider and his company image, irrespective of who actually performs the service (Jaakkola & Hakanen, 2013; Nenonen et al., 2014). Hence, service providers should aim at providing consistent, high-quality services to minimize image risks. As many of these services are better provided by an external specialist than an internal unit, network partners support the manufacturer in achieving a differentiation advantage (Bustinza et al., 2015).

Service firms can also support manufacturers in reaching a cost leadership advantage by providing services more cost-efficient than an internal unit. Cost-efficiency gains are caused by significant learning advantage that service providers can gain by specializing on one specific type of service, as, e.g., the maintenance of complex technical equipment (Gebauer et al., 2013). Hence, relying on a single maintenance specialist for the sub-components of various OEMs is likely to be more cost-effective than each OEM specializing on the repair of their own equipment, as coordination costs in the service network are minimized. In summary, pure service firms aim at providing the "best" (Story et al., 2017, p. 62) service offers to the manufacturer, referring to service offers that are superior to services that either manufacturer or other service firms could provide.

The main *Key Activity* of network partners consists of delivering the above mentioned services that have been contracted by the manufacturer. In the case of maintenance firms, these consist of local and global maintenance services, operations of the system, or specialized repair services (Helander & Möller, 2007). Also, advanced maintenance management services such as data administration, calibration of equipment, inventory management, warranty tracking, and repair management (Toossi et al., 2013) can be developed and provided to manufacturers.

According to Davies et al. (2006), solution providers configure each solution individually to the customer needs, ideally from modular service components. Hence, network partners should aim at developing and delivering a portfolio of service components that are easily assembled into a seamless offering. This approach should also increase the network partner's ability to provide further advanced services to the manufacturer's portfolio or possibly increase its responsibilities in the total offer, e.g., if the manufacturer wishes to partly deservitize (Forkmann et al., 2017b).

To improve current and future generations of the PSS, the manufacturer should implement dynamic feedback loops with both the final user and maintainer of the system (Hobday et al., 2005). These feedback loops offer unique ways of gaining knowledge about the PSS in operation and benefit all parties, the feedback takers and feedback givers (Schuh et al., 2015). Hence, network partners should establish gathering, processing, sharing, and interpreting data with the manufacturer as one of their Key Activities.

Story et al. (2017) report that service firms undertake some limited innovation activities that aim towards the optimization of the joint product-service offerings. These activities focus mostly on innovating the service components of the total offering, not the product component (e.g., monitoring of tires).

The *Key Resources and Capabilities* required by pure service firms in general and maintenance firms in particular to become solution network partners have received very little attention in servitization research. However, it is evident that maintenance firms must possess the Key Resources and Capabilities required to provide local maintenance, repair and overhaul services, such as trained mechanics, engineers, and facilities and specialist skills, expertise and knowledge (Turunen & Finne, 2014; Story et al., 2017).

An important point that has been mentioned in the previous benefits and sacrifices section is that network partners regularly gain access to unique knowledge resources of the manufacturer such as maintenance manuals and product know-how which can improve their service offering (Lockett et al., 2011). At the same time, the authors highlight that manufacturers are reluctant to share these resources as they fear knowledge dissipation and future competition through the service provider.

Also, service firms may require increased financial resources to meet the considerable upfront investments that they may have to make to become part of the manufacturer's service network (Lockett et al., 2011) to finance the change from input- to output-based pricing mechanisms (Jaakkola & Hakanen, 2013).

Becoming a Network Partner affects the service firm's *Relationships and Channels* to its *Customer Segments*. By alliancing, pure service firms can benefit from gaining access to the manufacturer's customers, adding new Customer Segments, which may allow extension of their service offering, growth, and stable revenues (Lockett et al., 2011; Turunen, 2011; Jaakkola & Hakanen, 2013). Solution provisioning generally requires very close ties to the customer that can be gained both by the solution provider and its network partners (Story et al., 2017). The customer relationships that network partners can develop, depend on the configuration of the service network, as service firms may or may not enjoy direct channel access (Jaakkola & Hakanen, 2013). In case that no direct channel to the end customer is established, the manufacturer evolves as a new customer segment, as services are provided directly for him and not the final customer.

Relationships between the different actors of a solution network play a vital role as the strength of the connection between the various actors involved, the solution providers' position in the network, and the impact on the customer's core processes may both enable and obstruct the development of solutions (Windahl & Lakemond, 2006). The relationship between a service firm and the solution integrator is likely to become more complex, as it incorporates both cooperative and competitive elements and firms occupy multiple roles in the network (Lockett et al., 2011).[29] This is aggravated by the fact that incentive alignment and higher level of information-sharing are required to effectively provide solutions, which is however not always the case (Lockett et al., 2011).[30] These Relationships may, however, become less complicated over time, once they are more formalized or if the manufacturer deservitizes, handing over all service responsibilities to the service firm (Forkmann et al., 2017b).

Becoming a partner in the manufacturer's service networks represents a profound change in the business model with effects on both, *Cost and Revenue Structure*. Additional revenues may be gained by accessing the manufacturer's customer segments, either through the offerings inherent in the PSS, or the possibility to cross-sell further own service offerings to these customers. Also, the manufacturer may represent a steady source of revenues, especially if no direct access to the end customer is established, but services are conducted directly for the OEM (Lockett et al., 2011; Jaakkola & Hakanen, 2013). These positive effects may be offset however by the high upfront investment that is sometimes required to join the network, e.g., to finance the manufacturer's switch from input- to output-based offers and the associated delay of cash flows (Lockett et al., 2011).

The Cost Structure of the service provider's business model may be lowered through profiting from significant learning curves that service firms can gain from servicing complex technical equipment, which can be transferred even outside of the scope of the service network (Gebauer et al., 2013). Also, access to the manufacturer's knowledge resources is likely to decrease the Cost Structure of the service firm, as these may be used to lower the costs for the services provided. A possibly minor point is that network partners require less customer acquisition costs, as the manufacturer assumes the responsibility for this task (Jaakkola & Hakanen, 2013).[31]

[29] If manufacturer and service firm have similar service offers established targeting the same Customer Segments.

[30] As noted earlier, aims of OEMs and network partners are initially not aligned due to the contrary incentives regarding the manufacturer's spare parts business. Here, the manufacturer is inclined to maximize the profit with spare parts, whereas the maintenance firm aims at increasing the number of repaired components.

[31] This is only the case if the service provider does not simultaneously compete with the manufacturer for identical service offers, as then acquisition costs still apply.

2.4 Interim Conclusions

In this chapter, I have laid the conceptual background of this study. Business models and their innovation serve as a theoretical lens that I use to examine how MROs can cope with the manufacturers' aftermarket incursion and changing customer needs. Servitization has been introduced as both, the phenomenon that is one major antecedent to MRO business model innovation practices and the academic field to which I wish to make the main contribution.

I have introduced the concept of business models and their innovation in Sections 2.1 and 2.2. Business model frameworks abstract the complex reality into comprehensible models that allow us to understand the core logic of firms' value creation and the underlying mechanisms better. The concept of business models builds on a variety of strategic management constructs such as the resource-based and relational view. By employing these different views, we can explain sustainable competitive advantage through a variety of angles. Hence, the business model concept is especially suitable for this study as, both, suppliers and customers of MROs are in the process of changing the way in which they conduct business. This, in turn, makes reconfigurations of multiple dimensions of the business model of MRO service firms one of the most promising options to sustain firm performance.

In Section 2.3, I have introduced the manufacturers' strategy of offering hybrid bundles of products and services, which is a phenomenon commonly known as servitization. Benefits to servitization include the ability to earn revenues over the entire life cycle of the asset, increasing customer contact, and even dependency, as well as escaping price-based competition on pure product offers but instead pursuing competitive differentiation through a range of basic and advanced service offers that support the asset or the client. I have defined solutions as advanced offers in which the provider assumes the responsibility for parts of the customer's operation, which typically involve usage-based pricing components (e.g., a fee per hour of equipment usage) and performance-based pricing components (e.g., a bonus-malus clause).

However, servitization is not without challenges and manufacturers have to overcome specific barriers to add services to their business model successfully. In essence, delineating viable hybrid business models, building the required capabilities to design and deliver services, adapting organizational structures, dealing with tensions between product and service business, and assuming the risk of performance-based offers is far from straight-forward. In effect, many manufacturers suffer from the service paradox, which is a phenomenon in which additional service revenues do not result in the expected benefits. As only very few and limited knowledge stocks regarding pure service firms in the context of hybrid product-service business models exist, a systematic literature review was performed to understand this phenomenon better. The results show that pure service firms can employ the two generic BMI paths of (a) developing solution offers of their own, and (b) forming alliances with manufacturers to adjust their business model to the dramatic change in their environment caused by servitization. However, the specifics of both generic BMI paths remain elusive of today, which leaves both scholars and managers with little understanding and guidance regarding the decision and implementation of these strategic *options.*[32]

To improve our understanding the impact of servitization on pure service firms over time, a phase model was developed that explains the different phases of servitization and their effects on an industry. In the pre-servitization phase, manufacturers often perceive services as a necessary evil, which results in customers providing maintenance services themselves and the growth of professional service organizations for Maintenance, Repair, and Overhaul. In the servitization phase, customers profit from increased high-value solution offers and possibly price-based competition with traditional service firms. In this phase, Maintenance, Repair, and Overhaul firms need to innovate their business model due to (a) increasing competitive pressure by manufacturers, (b) the emergence of high-value solution offerings, and (c) the manufacturers' need for partners to provide solutions in service networks. Simultaneously, however, manufacturers may limit competition with traditional service firms by restricting access to repair manuals, equipment, and spare parts, which may lead to reduced instead of increased competition in the service market and result in increased customer prices. In the post-servitization phase, manufacturers have formed alliances with service firms. Competition outside of these alliances is expected to continue, albeit on a less dynamic level. In industries in which rivalry remains, customers will have the choice of a broader portfolio of suppliers with their individual strengths and weaknesses, while alliances between both parties may potentially provide superior joint solution offers. However, in industries where competitors have successfully been locked-out by manufacturers, customers may become locked into long-lasting solution contracts and suffer from a substantial one-sided dependency on the manufacturer once the product-service bundle has been procured.

Current literature remains anecdotal regarding competition between pure service firms and manufacturers, although a major step in understanding positional advantage from a manufacturer's perspective has been made. However, advancements on competitive advantage between both players is mostly focused on resources and capabilities and still lacks the empirical underpinnings from a service provider side almost entirely. Hence, current servitization literature has only limited explanatory power regarding the competitive advantage between manufacturers and pure service firms. Analyzing competition from both sides between these players by identifying unique resources, capabilities, and other business model elements of pure service firms was found to represent a valuable contribution to servitization research (Ulaga & Reinartz, 2011).

While previous literature has acknowledged that pure service firms can offer solutions, the business model innovation path required to do so has hardly been explored. Since these firms enter the product-service continuum from the service-, not the product-side, the needed resources and capabilities, the business model reconfigurations and the underlying dynamic capabilities are expected to differ considerably from those required by manufacturers, which makes them interesting to study (Kindström, 2010; Kindström et al., 2013). Additionally, factors that may

[32]These findings have been confirmed by a recent literature review by Raddats et al. (2019), who propose research on ramifications of servitization on service firms and on an industry level as critical research priority.

determine whether pure service firms can develop solutions or need to compete with traditional service offers, have not received any scientific attention as of today. In conclusion, servitization literate cannot explain, when and how pure service firms develop integrated solutions, although this type of business model innovation is commonly employed to ensure firm performance when faced with servitization. To increase our understanding of how pure service firms can adapt their business model to offer solutions, I have synthesized the available literature in a Business Model Canvas, which delineates the target state into which these firms need to transform the different dimensions of their business model. In addition, I have identified the specific dynamic capabilities that manufacturers require to change their business model from a product to a service focus, which builds a basis for understanding the dynamic capabilities that are necessary to venture into the space of hybrid offers from a base in services instead of products.

Studies that are concerned with solution provisioning in service networks mostly take the manufacturer's perspective, while only recent progress has been made in widening the research focus to include other actors in the service network (e.g., Jaakkola & Hakanen, 2013; Forkmann et al., 2017b). Consequently, we have little knowledge regarding the reconfigurations that pure service firms must make in the business model to become the manufacturer's network partner and the underlying (dynamic) capabilities that are required (Gebauer et al., 2013).

While a plethora of strategic approaches regarding the outsourcing decision has been developed for manufacturers, no attempts have been made that explain the alliance decision of pure service firms but is instead limited to benefits and sacrifices that service firms may experience when joining a manufacturer's network. However, alliance arrangements between manufacturers and service firms differ considerably, which is why a service firm is unlikely to experience all of the identified benefits or sacrifices. Hence, service firms need a strategic approach to the alliance decision that allows them to create beneficial configurations of alliances with manufacturers. This decision is complicated by the fact that servitization and service networks result in complex, multilateral relationships in the supply chain, as the manufacturer can simultaneously be the supplier, customer, partner and competitor of the maintenance firm and vice versa. The importance of this issue is aggravated in industries with an oligopolistic market structure, regulations, and high-technology proprietary equipment that increase the dependence of service firms on manufacturers considerably. Hence, developing the required capabilities to decide upon and implement both generic BMI paths successfully needs to be considered as critical.

In summary, servitization is becoming a more mature research field, which has however produced very few knowledge stocks regarding pure service firms. To better understand how these firms employ BMI to offer solutions of their own or form alliances with manufacturers, research that focuses primarily on these firms is paramount.

3
Methodology and Research Approach

Contents

3.1 Methodology

As only limited knowledge about business model innovation of pure service firms in the context of servitization is present, this study aims at extending our knowledge by explaining the underlying reconfigurations and contingencies of MRO business model innovation.

I chose the research methodology[1] of systematic combining (Figure 3.1), since it is particularly useful for the development of new theory and concepts (Dubois & Gadde, 2002). Systematic combining is an abductive approach in which the theoretical framework, empirical fieldwork, and case analysis evolve simultaneously. When applying systematic combining, the researcher iterates back and forth between these steps, which allows the expansion of her understanding of both theory and phenomenon, and to direct and redirect the research efforts. For example, case sampling or interview protocols can be adjusted according to the requirements of the research topic (Dubois & Gadde, 2002). Hence, systematic combining allows the researcher to conduct case studies which are better informed by and intertwined with established theoretical concepts and thus have higher explanatory power than purely inductive approaches (Dubois & Gadde, 2002).

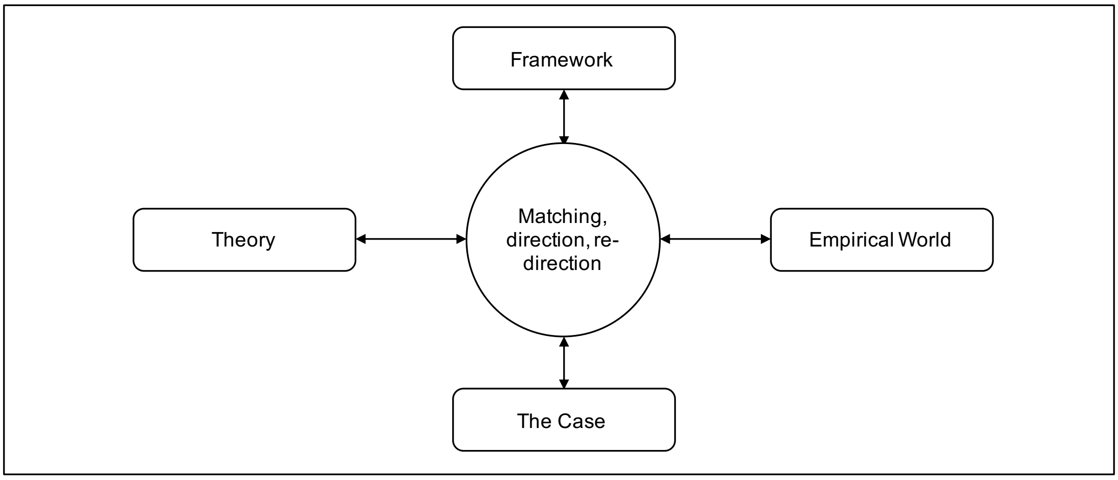


Figure 3.1: Systematic Combining Dubois & Gadde (adapted from 2002, p. 555)

[1] Research methodology is defined by Crotty (1998, p. 3) as: "The strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes."

3.2 An Industrial PhD Project

The study is placed as an industrial Ph.D. project in a single focal company, which is one of the leading aircraft maintenance, repair, and overhaul providers worldwide, providing a broad scale of MRO services and solution offers to customers on a global scale. At the time of writing, the company possesses 14 years of experience with the entry of manufacturers into the market and has innovated its business model as early as in the year 2003 by the formation of a joint venture for engine overhaul. While other ways of reconfiguring the business model exist, the focal company's path can be characterized as successful, since it is one of the few MRO service firms that have the capability to offer maintenance services for both the latest aircraft types (A350 and B787) and most of the latest engine types (GE-nx2B, LEAP-1A, and the PW1000G). The focal company is affiliated with a major European airline, which is an important prerequisite for both types of business model innovation. Overall, it is safe to assume that the company is a sensible choice for investigating business model innovation of MRO providers in the context of servitization.

The fact that the focal company is both the object under study and has been my employer during a significant time period of the study has some implications, which should be clearly indicated (Pratt, 2009). Being part of the organization allowed me to have invaluable access to key informants and rich empirical information that would be very hard, if not impossible, to access for an outside researcher. At the same time, my working background at the company for 2.5 years before starting with the Ph.D. project allowed me to gain a sound knowledge of the specific characteristics of the aerospace industry and their implications for the firms operating in this industry, at least compared to an outside researcher. This background allowed me to use the same language as the interviewees and to understand their lived experience better, and thus conduct *"get in there and get your hands dirty"* research — as called by Gioia et al. (2012, p. 5).

Studying your own organization also involves challenges and risks that need to be mitigated. The proximity to the empirical field allowed me to continuously communicate with colleagues regarding the research topic, which may lead to a biased view of the phenomena. I have tried to minimize the bias by attempting to take an outside-in perspective, searching for contrary opinions and evidence. Discussions with colleagues from university have helped me to distance myself from the particular views of the company and assume a more neutral, scientific position. Also, an extended absence from the workplace during data analysis helped me to distance myself from the company and intertwine empirical data with literature. I am very grateful that no attempts were made by the focal company or any other companies to influence the results of the study or draw preliminary conclusions, although the project was supported by some funding. Last but not least, I changed my occupation twice during the time of the PhD and started working within the airline part of the aviation group. This change helped me to mitigate much of the bias that would have resulted from being employed solely at the focal company.

Additional interviews with experts from seven other MROs and eleven airlines were conducted to triangulate the findings and limit the bias that a single company may demonstrate. Considering the size of the aerospace industry and the limited amount of MRO service firms, possessing empirical data of eight MROs and twelve airlines can be regarded as a broad empirical base.

As the focal company has not been the initiator of the project, neither its identity nor the identity of its employees is revealed. However, references to the position of the informants are made to allow the reader to judge better the background from which individual statements are made. In no instance however do those statements represent an official view of the company but they are always interpretations of individuals and are somewhat removed from the original context in which they were made.

3.3 Pilot Study and Research Model

I decided to conduct a pilot study, as research questions based on fieldwork are known to generate findings with a high relevance from a practical perspective (Yin, 2011). Specifically, the aim of this study was to gain insights into servitization practices in the aerospace industry, their significance for MRO firms, and strategic BMI options that MRO firms would employ to cope with these changes in their environment. Hence, I started the pilot study with an initial, rather open research question:

"How can Maintenance, Repair and Overhaul service firms retain firm performance through business model innovation, when faced with servitization practices of aerospace manufacturers?"

Pilot Study The pilot study consisted of a total of seven interviews with managers of the focal company and two of the affiliated airlines and allowed me to refine the initial research question, research protocol, and interview guideline (Yin, 2011). One of the emerging topics was the widespread knowledge and usage of the business model concept by managers of the MRO firm. For example, managers of both airline and MRO provider repeatedly referred to the change in the OEMs' business model, while one of the MRO's managers even used the Business Model Canvas as a tool for strategic planning and business model development. The subsequent selection of the Business Model Canvas as guiding analytical framework of analysis represents one of the strengths of systematic combining, as this approach allows to adjust the conceptual framework to improve fit with the empirical case (Dubois & Gadde, 2002).

In the pilot study, it became clear that the focal company has innovated its business model into different configurations entailing both solution offers and various types of alliances with manufacturers. These two types of business model innovation are underpinned by earlier findings by Schneider et al. (2013) that have identified them as viable generic BMI paths of Aerospace MRO firms to cope with servitization.

However, Schneider and her colleagues raise criticism regarding the lack of added customer value and the fact that the alliances are perceived as a time-limited approach until the manufacturers have gained sufficient service capabilities to provide solutions on their own. This particular statement is intriguing as the question arises, whether options for MROs exist to make this bitter side of servitization sweeter? In other words, can MROs establish specific configurations of alliances that create more value and are more sustainable than others? This question was taken into the pilot study, which confirmed that alliances with manufacturers were seen as increasingly important to gain access to intellectual property rights. Interviewees repeatedly highlighted that the dependence on the manufacturer was an increasing issue both as a driver of but also within alliances.

To make matters worse, this issue was aggravated by the fact that through servitization manufacturers have evolved from being suppliers towards becoming competitors. However, not all alliances were perceived as equally effective for achieving sustainable business success. Instead, the identified alliances could be understood as different configurations that can be more or less advantageous for the MRO service firm.

In addition, the pilot study showed that cases existed in which the focal company deliberately did not form alliances with OEMs but continued servicing the manufacturer's equipment or even develop stand-alone solutions without a manufacturing alliance partner. Consequently, forming a partnership is not necessarily the best way to innovate an MRO's business model in any given situation, especially considering the aforementioned adverse side effects. Instead, MROs should possess sources of competitive advantage inherent in their business model that allow them to sustain competition against manufacturers in some instances. Moreover, contingency factors should exist that determine whether allying is the best response for the given situation (Mintzberg, 1979). From this insight, a research model was developed to break the research down into a coherent structure.

Research Model To answer the research questions, a suitable overarching research model (Figure 3.2) was determined. This conceptual framework organizes the research questions and supports explaining the key factors, constructs, variables, and their presumed relationships (Miles & Huberman, 1984; Voss et al., 2002). In line with case study literature (Eisenhardt, 1989; McCutcheon & Meredith, 1993) and the systematic combining methodology (Dubois & Gadde, 2002), the framework was used to guide and structure but not determine data collection and analysis. The guiding nature of the framework has been considered by taking only the reaction of pure service firms to servitization as a concept into the pilot study and letting both business model innovation paths and the further research questions emerge during the systematic combining process.

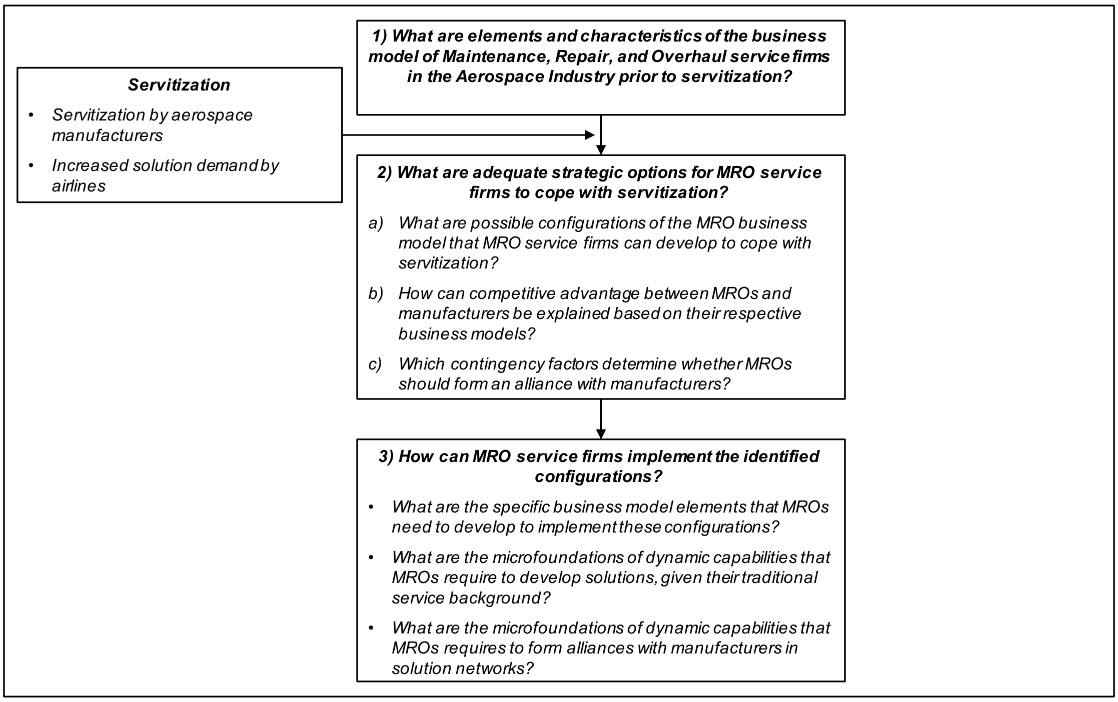


Figure 3.2: Overarching Research Model

The research model consists of three distinct parts that I perform consecutively. First, the traditional MRO business model before servitization as the subject of business model innovation is explored (Section 4.3.4). The reason is that we need to understand what is being innovated before being able to understand how we can develop this subject of innovation. The traditional MRO business model aims at explaining the core logic of how MROs conduct business and, simultaneously, builds the basis for understanding competitive advantage against manufacturers.

After outlining the multiple case study (Chapter 5), I explore the different strategic options that MROs can employ to cope with servitization in Chapter 6. To do so, I first define a portfolio of different configurations of their business model that MROs can develop to deal with servitization based on the two generic BMI paths of developing solutions and alliancing with manufacturers. To improve our understanding of the strategic options and their viability, I then examine how firms can compete in this industry, using Porter's (1980) generic competitive strategies as a conceptual lens. As a next step, I explore how competitive advantage between manufacturers and pure service firms can be explained by the respective business models. Understanding competitive advantage between both parties is essential for identifying the contingency factors that determine in which cases MROs cannot sustain competition but instead should choose to innovate their business model forming a type of OEM alliance. In the final part (Section 6.4), I explore the dynamic capabilities that MROs need to develop solutions and form alliances with manufacturers.

3.4 Literature Reviews

Theory building research via case studies starts with an exploration phase, to map and assess the existing body of knowledge (Dul & Hak, 2008). Two distinct systematic literature reviews (Tranfield et al., 2003) were conducted to determine the available knowledge stocks regarding solution-based business models and the role of pure service providers in servitization research.

The first systematic literature review (Section 2.3.5) aimed to synthesize the knowledge available on solution offerings into the Business Model Canvas. To identify the newest contributions of the business model perspective on hybrid value provisioning, a literature search was conducted in the ScienceDirect and EbscoHost database for the time frame 2013 until April 2016. Search terms included synonyms for "servitization"[2] and the term "business model" in title, abstract and keywords. The search resulted in 22 specific papers that were reviewed individually. Then, relevant, previously read studies were added from the author's database on solution provisioning, resulting in a total of 72 papers that were reviewed for the individual business model elements using an excel file. These elements were synthesized into the Business Model Canvas as an analytical tool, resulting in the Solution Business Model Canvas (Figure 2.8).

The fact that 50 papers were added to the literature that did not result from the initial search hints at a possible limitation inherent in the literature review that needs to be explained: Due to the lack of maturity of the topic, only a few publications explicitly make use of business models as conceptual foundation and hence include it in either title, keywords, or abstract. Thus, solely relying on these publications would give an incomplete picture of PSS business models, for which reason additional papers were included that did not match the initial search criteria. Due to the diversity of the topic, no specific inclusion criteria were used. Instead, papers were added if they helped to explain particular business model elements. The papers resulting from the initial search were however used to determine the maturity of servitization business model research.

The second systematic literature review in Section 2.3.7 aimed at consolidating the available knowledge regarding the role of pure service firms in the context of servi-

[2]Synonyms for servitization: service infusion; service-driven manufacturing; service addition; service transition; integrated solutions; high-value manufacturing; customer solutions; total solutions; business solutions; service orientation; service addition; service-driven.

tization. As servitization research has focused mostly on manufacturers, knowledge about traditional service providers in this context was scattered. To systematically and transparently aggregate these knowledge stocks, a systematic literature review (Tranfield et al., 2003) was conducted, with a focus on the following questions:

- *How does servitization literature portray competition between manufacturers that enter the service domain and pure service providers?*
- *Which distinctive sources of competitive advantage does each party possess?*
- *How do pure service firms innovate their business model in the context of servitization?*

Research was conducted on the databases ScienceDirect and EbscoHost searching for articles containing "servitization" and its synonyms[3] as well as and "traditional service providers" and its synonyms[4] in title, abstract and keywords from 1990 until August 2016. Since the search on ScienceDirect yielded no results with these parameters, synonyms for "traditional service providers" were allowed for in the whole document. A notification function, automatically informing about new publications matching the search terms was set up in both databases, which remained active until December 2017.

The synonyms for servitization are expected to be robust, since they are used in other servitization literature reviews (Baines & Lightfoot, 2013; Lightfoot et al., 2013; Reim et al., 2015). The synonyms for traditional service providers have been iteratively improved to achieve higher validity by adding synonyms used in identified papers to improve the search results. Exclusion of results due to synonyms for the term "provider" was avoided by excluding it and its synonyms from the search altogether. The search was not limited to scientific papers; however, all non-scientific papers were eliminated in the reduction phase. The initial search yielded 76 results, which were reduced to 22 after reviewing type, title, and abstract. An additional 15 papers were identified from prior research activity and during the revision process and then added to the sample, resulting in a total of 37 articles and conference proceedings, containing specific information on the topic. During the review process, these papers were analyzed in an excel spreadsheet to synthesize the available data. The comparatively high amount of papers added to the sample can be explained by the fact that only very few articles exist that explicitly target pure service firms in the context of servitization research. Except for their role as an alliance partner, the role of pure service firms is discussed mostly as a side-note and hence not included into title, abstract, or keywords of most articles.

[3]The same synonyms were used as in the first literature review.

[4]Synonyms for traditional service providers: incumbent service*; pure service*; traditional service*; third-party service*.

3.5 Multiple Case Study

A multiple case study was employed, as various cases typically provide a stronger basis for developing theories and concepts that are better grounded, more generalizable and more accurate (Eisenhardt & Graebner, 2007; Yin, 2009). Hence, they are especially suitable when little prior knowledge about the phenomenon under investigation is available (Miles & Huberman, 1984; Eisenhardt, 1989; Yin, 2011). As a multiple case study allows the researcher to perform in-case and cross-case analysis, this method enables abstraction from the idiosyncrasies of a single case, identifying common themes of business model innovation of pure service firms in the context of servitization (Miles & Huberman, 1984; Eisenhardt, 1989). Even more importantly, the identification of contingency factors with a single case study seems inappropriate, since these factors are either present or not present in a single case. Instead, factors influencing MRO business model innovation can only be identified by comparing differences and similarities between contrasting cases (Miles & Huberman, 1984).

Purposeful or theoretical sampling is the deliberate selection of cases and is preferred against random sampling in multiple case studies, as it allows for choosing replicating cases to strengthen the hypotheses and polar cases to generate a deeper level of theory (Miles & Huberman, 1984; Eisenhardt, 1989; Eisenhardt & Graebner, 2007). Three cases were chosen that differ in the critical aspects of (a) the underlying solution offer, (b) the perceived competitive advantage of MRO providers, and (c) the alliance configuration and the resulting configuration of the MRO business model (see Table 3.1).

Properties	Engine Case	Components Case	Aircraft Case
Solution offer	Engine Solutions: guaranteed availability of aircraft engines to a fixed price per flight hour.	Component Solutions: guaranteed availability of aircraft components at a fixed price per flight hour.	Aircraft Solutions: bundle of engineering and maintenance services to guarantee aircraft availability and reliability for a fixed price per flight hour.
Main OEM Competitor	Engine OEM	Aircraft OEM	Aircraft OEM
Perceived competitive positioning of MRO	• Entry barrier • Cost Disadvantage	• Cost Parity • Differentiation Advantage	• Cost Advantage • Differentiation Advantage
Alliance Strategy	Two types of alliances with Engine OEMs to ensure competitive survival on respective technology.	Alliance with Component OES to the improve competitive position against the airframer and avoid competing with the OES.	Deliberate decision to not form an alliance with the Aircraft OEM to not strengthen its solution offer but instead to compete with own solution offer
Business Model Innovation and resulting configurations	• Traditional MRO Business Model ▼ • OEM Workbench • Coopetitive Solutions	• Stand-alone Solution ▼ • Two-sided Solution	• Traditional MRO Business Model ▼ • Stand-alone Solution

Table 3.1: Case Comparison

The crucial first aspect is the type of solution offer: Engine-, Components-, and Aircraft Solutions represent the three main types of solution offers in the commercial aerospace industry. The offers differ considerably regarding the market structure, the nature of products and services inherent in the solution offer and the conducted business model innovation, ensuring a maximum of generalizability of findings beyond this industry.

The second key aspect is the perceived competitive advantage against the manufacturer. In the Engine Case, the MRO sees itself as being at a competitive disadvantage, and only able to ensure competitive survival by forming a sustainable alliance with the manufacturer. In the Component Case, the MRO successfully competes with its solution offer against the rival aircraft manufacturer, has however allied with a component manufacturer to strengthen its competitive position. Hence, this case provides an interesting duality in the alliance decision that allows for in-depth analysis and interpretation. In the Aircraft Case, the MRO provider perceives being at an advantage against the aircraft manufacturer, and its solution offers from both, a cost and differentiation perspective. This competitive advantage may, however, not be sustainable since the airframer erects entry barriers on new aircraft types.

The third key aspect is the underlying alliance configuration and the resulting configurations of the focal company's business model. These configurations are the empirical underpinning of the MRO business model portfolio (Figure 6.3) that is developed in Section 6.1. In the Engine Case, the MRO forms two distinct types of alliances with OEMs. In the first "OEM workbench" configuration, the MRO provides maintenance services directly to the manufacturer, while in the second "coopetitive solution" configuration, the MRO forms part of the manufacturer's service network and is capable of providing Engine Solutions directly to airline customers.

In the Component Case, the MRO also becomes network partner of the OEM, however in a third, "two-sided solution" configuration. In this case, the focal company takes over responsibility for the manufacturer's service business and simultaneously provides Component Solutions directly to the end customer, regularly without any involvement of the OEM. The term two-sided solution is derived from the fact that for the manufacturer, an aftermarket solution is provided as, as it can concentrate on its core business manufacturing, while simultaneously airlines can rely on the Components Solutions offering of the focal company.

In the Aircraft Case, the focal company deliberately decides not to form an OEM workbench type alliance with a competing aircraft manufacturer to provide solution offers, but to compete individually with its stand-alone solution offering. The three cases are described individually in more detail in Chapter 5. Each case description contains both, the changes in the respective MRO market segment induced by servitization, as well as the focal company's business model innovation efforts to react to these changes.

3.6 Data Collection

I employed mainly in-depth interviews for data collection, which were supported by the collection of company presentations, industry-specific periodicals, and the analysis of web pages. The sampling of interviewees was intentional and purposeful, which allowed me to identify further interview needs and suitable respondents to clarify aspects of business model innovation of MRO providers as part of data collection and analysis. This reflects the iterative process between data collection, analysis and theory (Strauss & Corbin, 1998; Dubois & Gadde, 2002).

The 41 in-depth interviews of the main study were held with interviewees from eight MRO firms, and eleven airlines from Europe, North America, Middle East, and Asia with a focus on the focal company. Airline 1 and MRO 1 were focal firms to which the author had privileged access, while the other airlines and MROs were mainly used for triangulation purposes and to improve the validity of the findings, widening the scope beyond the perception of these two firms. Interviewees were included from a variety of functions and management levels to ensure the generation of rich data from multiple perspectives. All interviewees were very knowledgeable and eager to contribute to the topic that was considered as of high interest. For 16 interviews, the researchers relied on the support of a specialized marketing firm that conducted the interviews via telephone. Companies and positions interviewed are summarized in Table 3.2. Additionally, I had the opportunity to participate in various strategy workshops with the focal MRO firm for the duration of half a year in 2016. This opportunity gave me a valuable insight into the servitization phenomenon in its real setting and the business model innovation process at first hand.

Company Type	No. of Interviews	Positions Interviewed
Airline 1	6	SVP Aircraft Maintenance, Repair and Overhaul, Director Corporate Sourcing, Director Aircraft Procurement, Manager Aircraft Procurement, Manager Engine Procurement, Lawyer
Airline 2-11	10	Senior VP Technical Operations, Head of Fleet Technical Management & Deputy Technical Director , Director Supply Chain and Logistics Operations, Director Aircraft Engineering, Senior Aircraft Maintenance Planning Engineer, Head of Engineering Projects, Transport Manager, Technical Operations and Maintenance Instructor, Maintenance Quality Manager, Engineer
MRO 1	26	CEO, SVP Business Unit 1, SVP Business Unit 3, SVP Alliance Function, VP Sales, VP Purchasing, Commercial Director Business Unit 1, Head of Corporate Strategy, Director Sales, Team Lead Aircraft Engineering, Managers and Senior Managers Alliance Function, Managers Business Development and Strategy, Managers Product Management, Managers Market Research, Manager Aircraft Lifecycle Management, Managers Procurement, Manager Repair Services
MRO 2-8	7	CEO, VP and General Manager, Executive VP, Director Finance, Director Sales, Product Sales and Key Account Management, Managers Business Development
University/Cargo Airline	1	Professor for Business Administration, Logistics and Aviation (former COO of a cargo airline)
Total	**50**	

Table 3.2: List of Interviewees

Subsequently, I structured my interview protocol (Yin, 2011) according to elements of the Business Model Canvas, Teece' (2007) dynamic capabilities framework, and considerations regarding competitive advantage as well as contingency factors for alliance development. In accordance with the systematic combining methodology (Dubois & Gadde, 2002), the interview protocol which included a priori frameworks were used to merely guide and structure but not determine the collection of data. The interview protocol is depicted in Table 3 in the Annex.

The semi-structured in-depth interviews had a duration between 48 and 95 minutes, were audio recorded, and transcribed partially by the researcher, partially by a professional transcription service provider. Secondary data was collected for triangulation (Yin, 2011), including both literature from aerospace periodicals, such as AviationWeek or MRO network as well as industry consultant reports aiming at completing the picture and validating the data.

Two follow-up interviews were conducted with exceptionally knowledgeable respondents to ensure the validity of the findings and clarify remaining questions. At this point, theoretical saturation was reached, as no more meaningful data was found that would add to the explanation of the phenomena (Strauss & Corbin, 1998).

After completing data analysis, a presentation of the initial findings was held at the focal company, giving the opportunity for further validation. In the workshop, the conceptualization and interpretation of the results, including competitive advantage, business model innovation paths, and the specific dynamic capabilities were covered, and the managerial implications for that particular company discussed. Additionally, one specifically knowledgeable senior manager provided helpful feedback after reviewing large parts of the manuscript which helped me to refine the findings further.

3.7 Data Analysis

Coding is an analytical process in which textual data is categorized into patterns and themes to facilitate in-depth analysis (Bryant & Charmaz, 2007). A combination of analytical coding (interpreting and reflecting on the meaning of the data) as well as topic coding (some codes are pre-defined based on concept definitions) was carried out (Dubois & Gadde, 2002). For topic coding, the Business Model Canvas by Osterwalder & Pigneur (2013) and the sensing, seizing, and reconfiguring framework by Teece (2007) were used as a draft template. Hence, the data analysis was guided by established theory, ensuring construct validity and providing valuable insights relevant to the phenomenon of interest (Eisenhardt, 1989; Dubois & Gibbert, 2010). I found both a priori frameworks sufficiently specific to be helpful for the initial sorting of codes but sufficiently generic not to limit the creative coding process. Further open codes were applied to the text, including the MRO market segments, servitization practices of manufacturers, and codes for performance outcomes. To enable cross-case analysis, (Miles & Huberman, 1984; Eisenhardt, 1989), which was especially helpful to identify contingency factors, case affiliation was additionally coded to each citation.

Analytical and topic coding was performed with the Atlas.ti^{TM} software, applying descriptive codes. During the coding of the individual documents, the contents and meaning of each code were refined in the commentary section of the program. I decided to include codes in the analytical process according to criteria similar to the ones used by Tuli et al. (2007), i.e. (a) applicability beyond the particular context, (b) mentioning by multiple participants, and (c) going beyond the obvious, providing interesting and useful conclusions. For example, the Key Resource "financial strength" met these criteria: While financial resources are obviously of use for most companies operating whatever commercial business model, an increase in financial requirements was detected in the aerospace industry beyond one specific case by multiple interviewees. Hence, it is reasonable to assume that increased financial resources are required by most service providers operating in industries with complex and evolving technology. In a second coding step similar to what Corbin & Strauss (1990) call axial coding, codes were summarized in partly pre-defined sub-categories, which were related to one another, guided by existing theoretical concepts. For example, dynamic capability codes were sorted into the predefined categories of sensing, seizing, and reconfiguring of the dynamic capabilities framework developed by Teece (2007). I found that this framework was sufficiently specific to be helpful for the initial sorting of codes but sufficiently generic not to limit the creative coding process. For example, the second coding step involved splitting the sensing, seizing, and reconfiguring categories into microfoundations of solution- and alliance-specific dynamic capabilities.

To explain competitive advantage between manufacturers and service firms, as well as contingencies of alliancing, I employed a final coding step similar to what Corbin & Strauss (1990) call selective coding. In this step, I integrated and related the previously defined (sub)categories into theoretically saturated frameworks. Contingency factors relevant to the business model innovation process of becoming an OEM network partner, I relied on systematic cross-case analysis (Miles & Huberman, 1984; Eisenhardt, 1989). As part of the analysis, I qualified the specific manifestation of each contingency factor in two ordinal scales ("low", "medium", "high" and "present", "not present") to qualify the effect on the alliance decision (Table 6.2). For qualification, I relied as much as possible on quantitative indicators to increase the validity of findings but had to make use of personal interpretation in many areas, which is common practice in qualitative research approaches (Miles & Huberman, 1984). Some of the identified factors were identified as being important by the interviewees but did, however, not differ in their manifestation in the respective case. These factors were included as contingency factors nonetheless, relying on the expertise of the interviewees. Factors were then aggregated into second level categories and third level dimensions following what Corbin & Strauss (1990) refer to as axial coding.

Overall, the systematic combining methodology, well-established coding process, and the ample empirical evidence consisting of 50 interviewees, a validation cycle and triangulation with industry-specific literature give me the confidence to derive reliable findings and conclusions about the business model innovation of MRO firms.

4

Structure and Development of the Aerospace Industry

Contents

The commercial aviation value chain can be structured from manufacturers to the passenger as the final customer into eight stages (Wittmer et al., 2011; Pearce, 2013).

- Manufacturers and their suppliers, which produce aircraft and their components
- Lessors which buy aircraft and lease them to the airlines
- Airports that deliver the infrastructure for air traffic
- Service providers, such as airport ground service providers, catering firms, baggage handlers, air navigation service providers (ANSPs), etc.
- Aircraft Maintenance, Repair, and Overhaul providers (MROs), which provide diverse maintenance services to ensure the airworthiness of aircraft
- Airlines, the central actor of the value chain, providing the flight services to customers
- Computer reservation systems which organize large parts of the distribution within the industry
- Travel agents or online platforms representing the face of the aviation industry to the customers

The actors of the value chain, their share (measured by turnover) and profitability are illustrated in Figure 4.1:

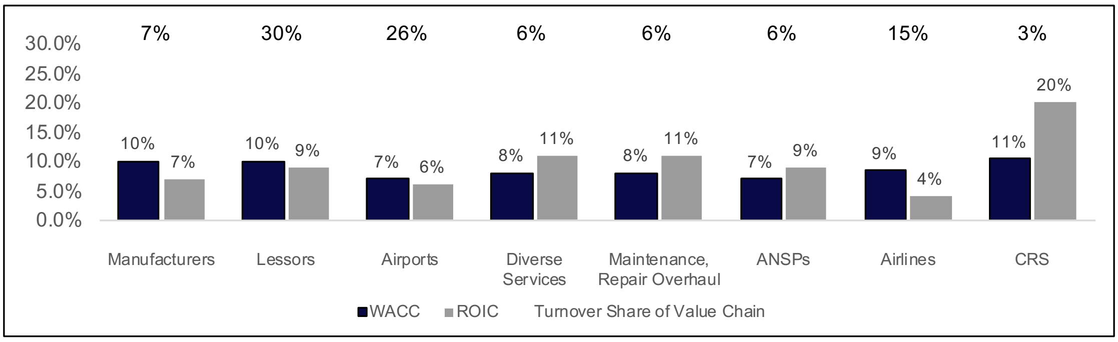


Figure 4.1: Actors and Their Profitability in the Commercial Aviation Value Chain[1]

Airlines are the central actor of this value chain, providing air travel services to the customers, however, they are also the least profitable, as they are regularly not able to

[1] Author's illustration based on Wittmer et al. (2011); Pearce (2013). WACC: Weighted average costs of capital, ROIC: return on invested capital, timeframe 2004 to 2011. Average WACC and ROIC figures for Airport Ground Service Providers and MRO.

earn their cost of capital. The chapter is structured as follows: First, the aerospace value chain and industry structure are introduced. Then, past and current business model innovation practices of airlines and manufacturers are summarized, as the drivers for MRO business model innovation.

4.1 Passenger and Cargo Transport

Air travel is one of the most important means of transportation today. Four billion passengers and 58 million tons of air freight travel per year with more than 37 million flights. Per minute, more than 100 flights take off and land around the globe, and up to 18,000 aircraft are simultaneously in the air.[2] Air travel allows us to reach any point on earth in less than 48h, it is the blood in the veins of our modern, globalized society.

Passengers profit from steadily decreasing costs for air travel, as prices have more than halved in the last 20 years, while the connected city pairs have more than doubled[3] (IATA, 2017a). As a result, passengers are expected to spend 1% of the global GDP in 2017 on air travel, making commercial aviation an essential global industry that provides 69 million jobs in its supply chain and $124bn of tax income for governments (IATA, 2017a).

Airline Profitability Airlines are the central actors of this value chain, operating the airplanes that make flying not a dream but reality. However, the airline industry is among the least profitable sectors that has hardly been able to earn their cost of capital, hence destroying value for investors and equity owners. Between 1965 and 2007, airlines have on average achieved a return on invested capital (ROIC)[4] of around 5%, which is 3% under their weighted average cost of capital (WACC)[5] and even slightly lower than low-risk government bonds. Leading industries in the same period were the pharmaceutical industry with an average of 25% ROIC and the software industry with around 20% (Pearce, 2013). This low profitability is critical, as airlines are expected to have difficulties in attracting sufficient capital to finance the 41,000 new aircraft deliveries with a market value of $6.1 trillion in the next 20 years (Boeing, 2017c). Recently, airlines have been able to increase their profitability, earning their capital costs in the period

[2]Based on IATA (2017b) and data from flightradar24.com.

[3]The average return fare is expected to be $353 in 2017, which is 64% lower than in 1996, adjusted for inflation. Connected city pairs is an indicator for the global connectivity, which is expected to reach 19,000 in 2017, doubling compared to 1996.

[4]For airlines the ROIC is the after-tax operating profit, adjusted for operating leases, expressed as a percentage of invested capital. It is the payment investors receive for providing debt and equity investors receive for bearing the risk (Pearce, 2013).

[5]Weighted Average Cost of Capital (WACC) is a weighted aggregation on the expected returns on equity and debt. The WACC is regularly determined by considering the opportunity cost, i.e., the estimated return on an investment with similar risks in the same country (Pearce, 2013).

from 2014 to 2017 with an ROIC between 8% and 10% (IATA, 2017a). Whether this is an upward trend that is there to stay, remains however to be seen.

Airline Industry Structure So, why is airline profitability so low? In its early times after the second world war, commercial air traffic was heavily regulated by governmental bodies. This regulation aimed at growing a safe, reliable, and efficient airline industry on a national scale and ensuring the public utility of air transport services (i.e., providing air traffic accessibility to the broad public). Besides safety and other regulations, fares between cities were regulated to prevent ruinous competition but also the abuse of oligopolistic or monopolistic market structures (Delfmann et al., 2005; Pompl, 2007). When in the 1970s the airline industry had become a mature industry with a sufficient number of carriers that were able to offer safe, reliable, and efficient air transport, the regulations where rather hampering than promoting innovation, efficiency gains, and ultimately consumer welfare.

Consequently, air traffic was deregulated first 1970 in the US and later step by step until 1984 in Europe. The deregulation enabled the entry of new carriers with different business models, the differentiation of transportation service offers, and pricing mechanisms that were based on demand and offer. At this point, airlines with new business models entered the market, such as low-cost carriers offering no-frills flights to low fares or regional carriers that filled niche routes which were not provided by larger airlines (Bermig, 2005; Pompl, 2007; Daft, 2015). In consequence, an industry with high levels of competition and dynamic growth was established that continues evolving today.

While different theoretical approaches exist that explain the profitability of firms, the industry structure analysis, also known as Porter's five forces (Porter, 1979) is one of the most established models to explain profitability in an industry.[6] In 2011, Michael Porter collaborated with the IATA, to perform an analysis of the structure of the airline industry, concluding that only a few industries existed in which the five forces were as strong as in the airline industry (Pearce, 2013):

- *High bargaining power of suppliers:* The airlines' supply chain is characterized of concentrated oligopolies in aircraft manufacturing, local monopolies at airports, air navigation service providers (ANSP) with powerful labor unions, persistently high fuel prices, and increasing concentration in the manufacturing and service supply chain.

- *High bargaining power of distribution channels and customers:* Global distribution

[6] Porter's industry structure analysis determines the potential for profitability of an industry by analyzing rivalry among existing competitors, the bargaining power of suppliers and customers, as well as the threats of substitution and new entrants (Porter, 1979).

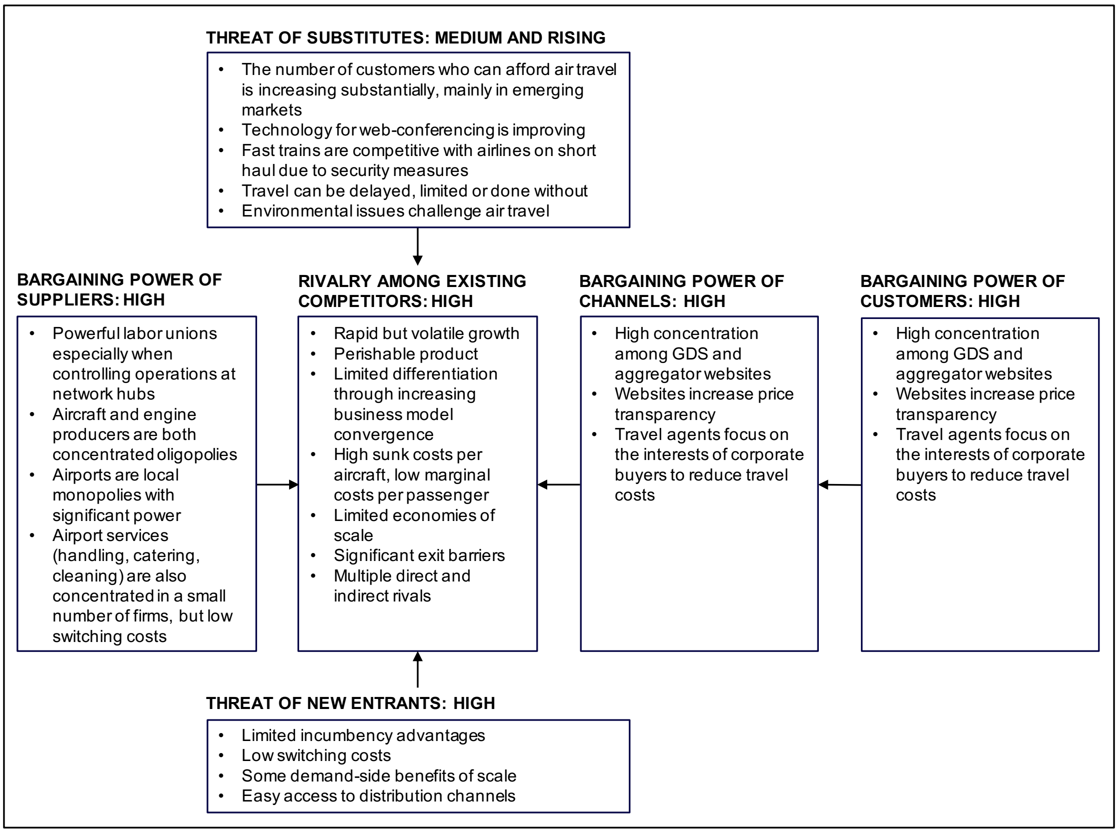


Figure 4.2: Airline Industry Structure (adapted from Pearce, 2013, p. 17)

systems (GDS) and computer reservation systems (CRS) are important distribution channels that are divided amongst three companies, each with high market power. Customers perceive air travel increasingly as a commodity, have low switching costs, and high transparency via flight comparison websites.

- *Medium but rising threat of substitutes:* improving web conference systems and high-speed trains can partly substitute air travel.

- *High threat of new entrants:* low switching costs for customers, easy access to distribution channels, leased aircraft and limited advantages for incumbents result in low market entry barriers.

- *High competition among airlines:* a perishable service, limited economies of scale, the low marginal cost per passenger and high fixed costs lead to high competition on many routes. Government constraints restrict consolidation of airlines, especially across borders, which leads to overcapacity.

In consequence, airline revenues have always followed unit costs closely, while price premiums have been quickly competed away by intense competition. This is illustrated by Figure 4.3 for the timeframe of the early 1960s up to the 2010s:

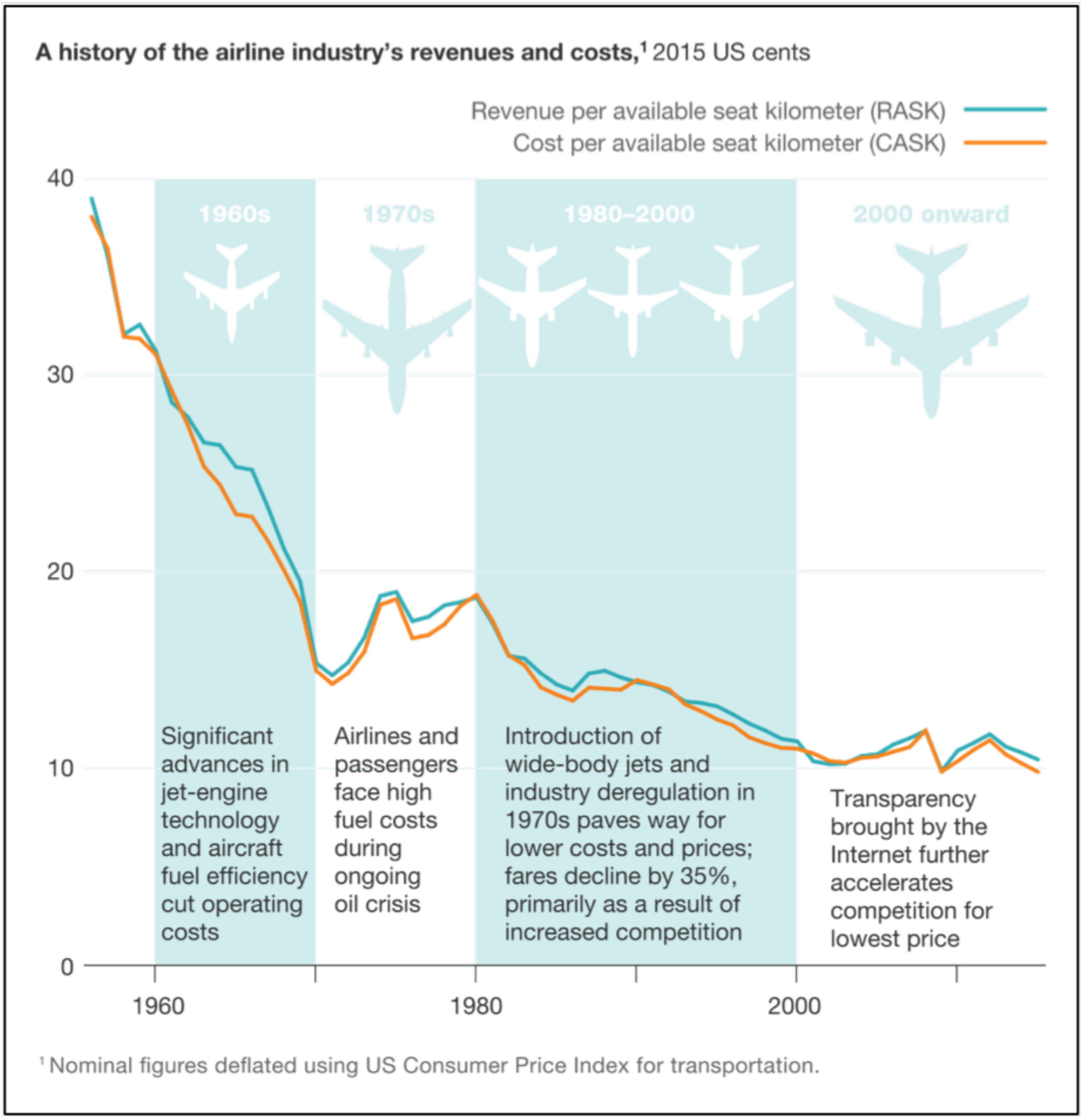


Figure 4.3: Airline Revenues and Unit Cost Development (Source: McKinsey Analysis, Saxon & Weber, 2017, p. 2.)

The Need for Cost Savings This industry structure results in a constant price pressure through heavy competition that results in yield deterioration, which often cannot be compensated by passenger growth (see Figure 4.3). Simultaneously, airlines face an annual increase in total operating costs of about 1% due to inflation, which is working steadily on decreasing profitability. As a consequence, many airlines pursue strict cost savings measures to retain or increase profitability.[7]

Options for lowering operating costs are however limited, as the major cost factors — fuel, taxes, and fees for e.g., landing or air traffic control — are non-negotiable. MRO services, on the other hand, are and accumulate to the considerable proportion of between 15-18% of airline's direct operating cost.[8] Thus, MRO services are often on top of the airlines cost-cutting priority list, as airlines try to improve their cost positions.

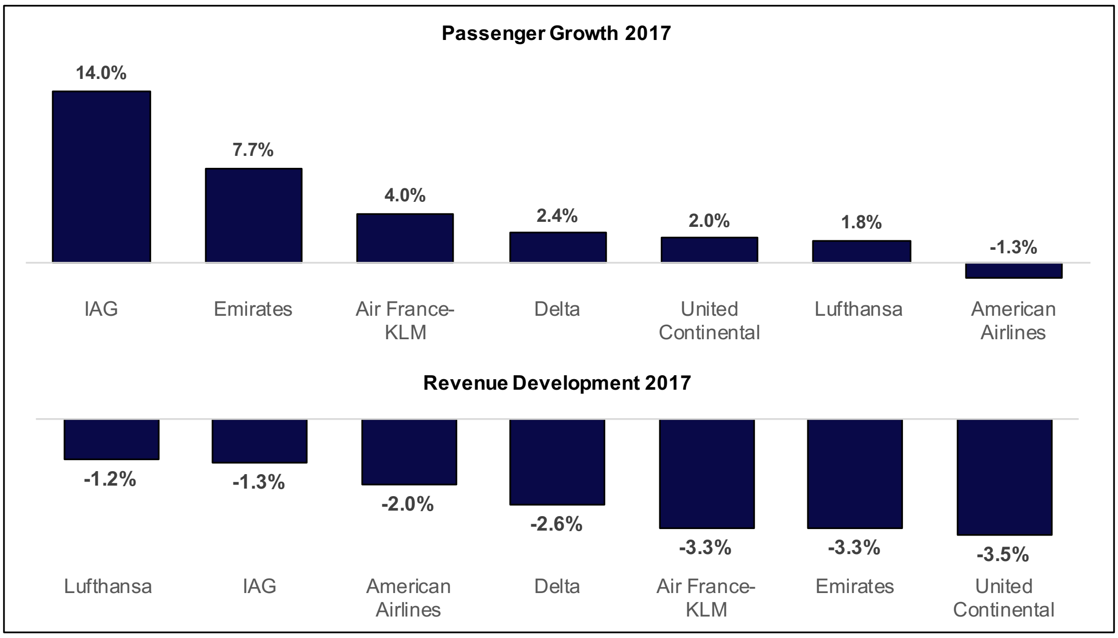


Figure 4.4: International Comparison of Development of Airlines' Passenger Growth and Revenues (Source: Koenen, 2017, p. 21)

For airlines, pure cost reduction efforts are however not the only efforts to undertake to increase profitability. Both network and low-cost carriers also increasingly innovate their business model to remain competitive. For example, the former German flag carrier Lufthansa outsourced all non-hub flights to its low-cost point-to-point platform Eurowings, while the low-cost carrier Ryanair introduced connecting flights into their portfolio. The resulting convergence of airlines business models may, however, lead to unintended, adverse effects on profitability as airlines may get stuck-in-the-middle

[7]Cost Savings programs of the main Network Carriers in Europe include: "SCORE" (Lufthansa), "Turbine" (Air Berlin, now bankrupt), "Transform 2015" (Air France) (Air France, 2012; Air Berlin, 2013; Lufthansa Group, 2013).

[8]Figure varies considerably, according to source, e.g. 7-12% (Henningsen, 2010), or 15-18% (Berger, 2014). Year-to-year MRO cost share of direct operating costs varies due to a high share (ca. 30%) of fluctuating fuel prices, and the performance of cost-intensive engine overhaul and base maintenance events. According to an Oliver Wyman Analysis, for NCs, MRO represents a 10% DOC share, for LCCs, 10.4% (Stalnaker et al., 2016, p. 32).

between price leadership and differentiation (Daft & Albers, 2015). Another important trend is the airline's concentration on the core competence of passenger transport, effectively outsourcing aircraft maintenance, repair, and overhaul and decreasing in-house capabilities (Schneider et al., 2013). The airline's business model innovation activities and their effect on the business model of MRO firms are discussed in detail in Section 4.4.

Buying the Big Jets Aircraft represent the most important asset of an airline, as they are the Key Resource in fleet planning, determining which destinations can be served with which cost structure. Also, aircraft financing costs make up around 8% of the cost structure of an airline (Berger, 2014).[9] Traditionally, the selection criteria of an aircraft depend on the airline's business model: While traditional carriers perceived airplanes as a vehicle for transporting their brand to the passenger, low-cost carriers instead perceived the aircraft as a commodity that delivers seat kilometers at lowest possible costs (Clark, 2007). Today, a shift of airlines towards cost savings (notably fuel and direct operating costs), and less focus on speed is noted, as sinking cruising speeds of aircraft from the 1970s to the 2000s show (Berrittella et al., 2007). For lessors, the aircraft is rather a financial than an operational tool, as they are more concerned with maintaining the asset's value than its operation (Clark, 2007). Nowadays, lessors have established themselves as a large customer segment of aircraft manufacturers, as in 2015, circa 42% of all aircraft worldwide were leased (FlightAscend Consultancy, 2016b).

In the aircraft procurement process, airlines typically buy the airframe and the engine separately to pit manufacturers against each other and achieve a maximum negotiation power. This possibility arises since airlines can choose between two engine options on most aircraft types. On newer jets some exceptions exist, as on the A350 airlines have to rely on the specifically developed Rolls-Royce Trent XWB engine, while on the B737NG only CFM56-7B is available (see Table 4.1 further down). Similarly, components such as wheels and brakes are procured from competing component OEMs in a vendor selection process for the same reasons.

[9] Consists of rental costs for leased aircraft and depreciation for owned aircraft. Cost-share depends on fluctuation of primary cost drivers such as fuel or major MRO events (e.g., Engine or Base Maintenance).

4.2 Aircraft Manufacturing

Design and Production

Commercial Aircraft are highly complex goods that consist of two to three million components, subcomponents, and piece parts (Canaday, 2017a). Hence, they represent the archetype of a complex product system (CoPS), involving many interdependent subsystems that can be considered themselves as complex product systems of high technology and capital intensity (see Figure 4.5, Davies & Hobday, 2005). The main parts of an aircraft are its airframe (incl. fuselage, wings, horizontal and vertical stabilizer), secondary structures (e.g., fairings, doors, and nacelles), engines, the auxiliary power unit, landing gears, and hundreds of other components such as avionics. Once assembled, the aircraft is completed with interiors including seats, galley, inflight entertainment systems, carpets, curtains, etc., and painted before final inspection and delivery to the customer (Esposito & Raffa, 2007).

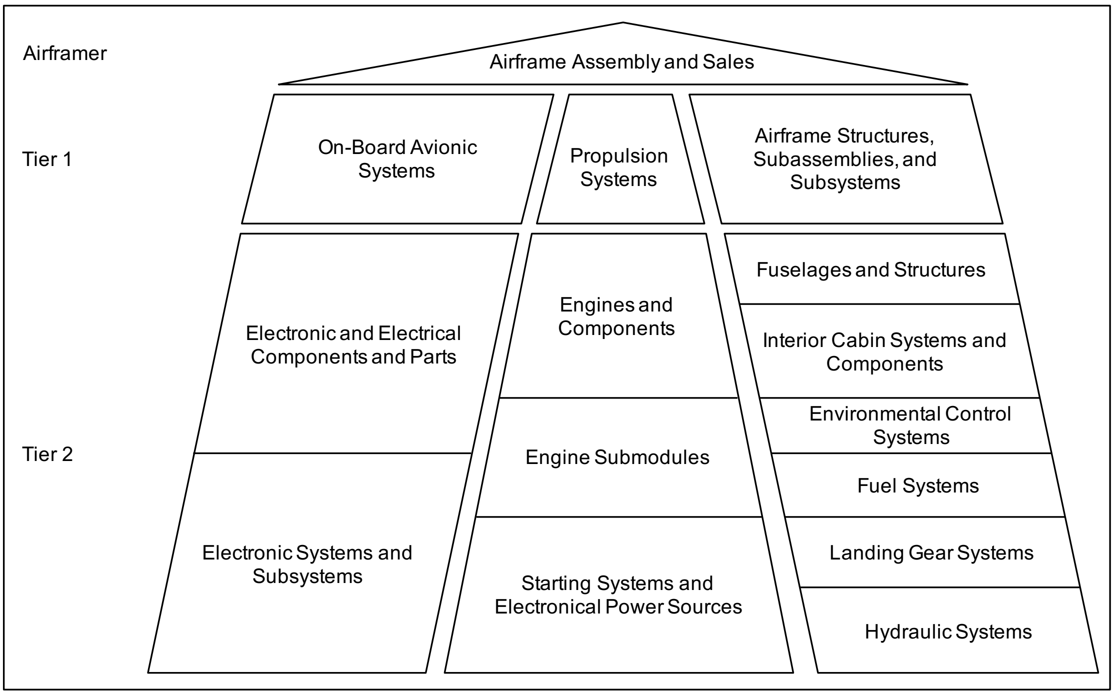


Figure 4.5: Aircraft Structure (adapted from Niosi & Zhegu, 2005, p. 8)

Due to the high complexity of aeronautical equipment, planning, monitoring, and controlling are crucial in aircraft manufacturing. Commercial aircraft such as the A320 or B737 are usually produced with large-scale production techniques such as flow-lines, while some smaller series are constructed using small-batch techniques (Hinsch, 2012). In summary, three critical success factors for developing and producing aircraft exist. These are: (a) a reasonable development of new aircraft types, balancing new technologies and development costs on one side with customer demand and willingness to pay on the other hand, (b) the adaption of platform concepts (e.g. the A319, A320, and A321) to realize economies of scale and allowing for efficient operations at airline by realization of commonalities (e.g. common type ratings, ground support equipment, spares, maintenance overheads, etc.), and (c) forming co-operations, especially with suppliers of technologically-intensive components (Clark, 2007; Esposito & Raffa, 2007; Wittmer et al., 2011).

Figure 4.6 illustrates the typical lifecycle of an aircraft program: It starts with the initial definition of the new aircraft type and ends when the last unit leaves the production line. A typical production program can last 30 - 40 or even more years. In the definition phase, which has a minimum duration of five years, the initial design and performance metrics are defined, resulting in the initial specifications. Then, the development phase commences, in which the aircraft undergoes further development, in which prototypes are built and thoroughly tested. One of the principal milestones is the first flight of the airplane, which is a major part of its certification.

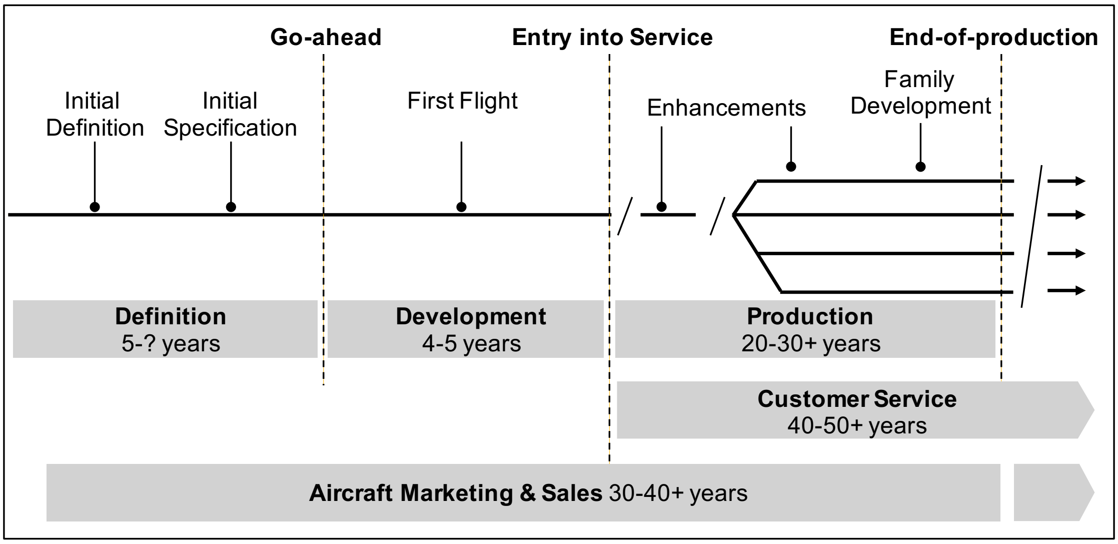


Figure 4.6: Lifecycle of Aircraft Production (Source: Clark, 2007, p. 9)

Subsequently, the airplane enters into the production phase. During this phase, further upgrades and enhancements are developed; often multiple versions of an aircraft (e.g., the A350-900 was followed by the stretched version A350-1000 in February 2018) or product families are launched (e.g., A319, A320, A321). As aircraft earn their initial development costs over extended periods of their lifecycle, usually spanning more than a decade, the aircraft manufacturer assumes significant financial, technological, and market-related risks with each aircraft program. The long amortization period is illustrated by the fact that even recent aircraft programs may suffer from less than expected success: For example, the A380 that has been developed since 1988 has supposedly just reached the break-even-point in 2016 (Clark, 2007; Tovey, 2016; Sato & de Freitas Chagas Jr, 2014) before Airbus decided to discontinue the program (Pfeifer & Kerr, 2019).

At the end of the lifecycle, manufacturers are obliged to continue support of their aircraft, as long as a fleet remains operational. With shifting technologies, one of the main risks in this context is obsolescence.[10]

Airframers rely heavily on a multi-tier supply chain to supply high-technology components, share financing needs and technological risks to produce aircraft. Also, engine manufacturers rely on a sophisticated multi-level supply chain, as the engine represents the most complex component with the highest impact on aircraft performance and efficiency. Besides, component manufacturers have evolved from providing single parts to assuming responsibility for the design and integration of entire systems (Horng, 2007). Due to increasing financial and technological requirements, the configuration and usage of the supply chain have developed dramatically along with the manufacturers' business models from early years of aircraft production to the latest aircraft such as the Boeing 787 (Esposito & Raffa, 2007). The business model innovation in the aviation manufacturing industry is further explored in Chapter 4.4.

The Aircraft Supply Market

Aircraft Manufacturers Aircraft manufacturers build a concentrated oligopoly (Pearce, 2013), due to high entry barriers such as technology and capital requirements. Widebody aircraft are provided by a duopoly of the pan-European manufacturer Airbus S.A.S. ("Airbus") and its American counterpart The Boeing Company ("Boeing") whose relationship is commonly characterized as an intense rivalry[11] resulting in periodic pricing of aircraft below static marginal costs (Benkard, 2000; Esposito, 2004; Pompl, 2007). Every year, both manufacturers try to outcompete each other with the amount of aircraft delivered and new sales acquired at airshows. For example, at the Dubai Airshow in 2017, Boeing was able to secure deals in the magnitude of $42bn order volume, selling 252 737MAX to Fly Dubai (Dubai's low-cost carrier) and 40 787-10 Dreamliners to Emirates. However, Airbus was also highly successful, being able to secure the biggest deal in company history, worth $49.2bn of order book value for 430 A320neo aircraft (Zhang & Banerji, 2017).[12]

[10] A component is obsolete, "when the technology that defines it is no longer implemented and, therefore, that component becomes no longer available from stock of own spares, procurable or produced by its supplier or manufacturer" (Rojo et al., 2010, p. 1235), as the production of some components may prematurely end when technology is outdated (e.g., CRT monitors that are used in cockpits are not produced anymore and need to be upgraded with newer displays, Rojo & Roy, 2009).

[11] For an extensive account on the competition between Airbus and Boeing see Lynn (1998).

[12] For orders of this size discounts on the order book value around 45% are typical in the industry (Zhang & Banerji, 2017).

In the past, both manufacturers have pursued different product strategies, with Airbus betting on the ultra-large A380 to connect big city pairs and Boeing with the smaller B787, providing seat capacity at lower total cost and comparable marginal cost per passenger. Airbus matched the B787 by developing the A350XWB (extra wide body), replacing the outdated A330 (Clark, 2007). In hindsight, Boeing's vision of the future seems to have more accurately predicted customer needs, as both B787 and A350 can spur considerable order volumes while Airbus decided to discontinue the production of the A380 in February 2019 (Pfeifer & Kerr, 2019).

Narrow body aircraft with less than 100 seats mostly used for regional routes were until recently provided by an oligopoly formed by the Canadian manufacturer Bombardier Inc. ("Bombardier"), the Brazilian manufacturer Embraer S.A. ("Embraer") and the French-Italian Joint Venture Avions de Transport Régional ("ATR").[13] The manufacturers of regional aircraft are tackling Boeing's B737 and Airbus' A320 in the middle segment of roughly 120 to 150 seaters from below with models as Bombardier's C-Series that carries between 108 to 133 passengers in the CS-100 configuration (Bombardier, 2016). Most recently, further consolidation has taken place as Airbus has just acquired the majority stake of Bombardier's C-Series program free of charge after heavy legal price-dumping assault by Boeing.[14] In reaction, Boeing signed a deal with Embraer, taking over 80% and operational control of its commercial aerospace program for $3.8bn. Both agreements effectively reduce the competitive landscape on western-built commercial jets from four to two, opening Airbus and Boeing the possibility to tap into the emerging new midsize aircraft market (Flottau, 2018).

However, new competition arises for the two giants from the Japanese Manufacturer Mitsubishi Aircraft Corporation ("Mitsubishi") that was founded in 2008 and the Chinese manufacturer Commercial Aircraft Corporation of China Ltd. ("Comac"), founded in 2008 in Shanghai. Mitsubishi is launching the Mitsubishi Regional Jet ("MRJ") in a 70-seater and 90-seater configuration. The first delivery is due in 2020, resulting in an eleven year development period, including five years delay (Perret, 2015a,b; Toh, 2017). Comac launched the C919 program in 2008, developing a regional to middle range aircraft, accommodating 156-168 passengers. Initially, an ambitious eight years development time was planned with the goal to deliver the first aircraft in 2014. However, this program has also was delayed to 2020 (Comac, 2016; Perrett, 2017). Whether these programs can crack the Airbus/Boeing duopoly with 120+ seaters remains to be seen. It is expected that COMAC will pursue a price leadership strategy to attract customers outside of China, which will be at a disadvantage as it is not supported by the economies of scale and learning curves that Airbus and Boeing possess. Another major issue will

[13] The world fleet also encompasses active aircraft by the manufacturers Fokker that filed bankruptcy in 1996 and McDonnell Douglas that was acquired by Boeing in 1996 (Cole, 1996; O'Toole, 1996).

[14] This has been a stunning competitive move by Airbus, improving its competitive positioning against Boeing, replacing its own A319 aircraft by the C-Series and further delaying the market entry of the Chinese manufacturer Comac that requires western certification knowledge to speed up its C919 program (Flottau et al., 2017; Michaels, 2017c).

be achieving Western certification, which is required to operate on the Western market. On the other hand, Comac can tap into a vast domestic Chinese market, Western-built engines and avionics, as well as massive support from the Chinese government (Goh & Hepher, 2017).

Suppliers Aircraft manufacturers rely on an extensive supply chain of suppliers that produce engines, components, systems, and other parts of the aircraft. Generally, three major types of suppliers can be discerned: engine manufacturers and original equipment suppliers (OES) that are located on the first tier of the production pyramid, as well as lower-tier suppliers that typically deliver components or subsystems to these tier 1 suppliers.

The market for aircraft engines has oligopolistic structures, since only the three manufacturers General Electric (GE), Rolls-Royce (RR), and Pratt & Whitney (P&W) manufacture complete engines for commercial aircraft. These are complemented by other manufacturers of major engine modules such as MTU Aero Engines (MTU) and Snecma, which however do not develop entire engine programs on their own (Herzog, 2010).

Airframer	Aircraft Type (excerpt)	Engine Type	Engine OEM / Consortium
Airbus	A318	PW6000 CFM56-5B	Pratt & Whitney CFM International
	A320	V2500-A5 CFM56-5A/5B	International Aero Engines CFM International
	A350XWB	Trent XWB (exclusively)	Rolls-Royce
	A380	GP7200 Trent900	Engine Alliance Rolls-Royce
Boeing	B737 NG	CFM56-7B (exclusively)	CFM International
	B747-8	GEnx-2B Trent1000	General Electric Rolls-Royce
	B777-200	GE90-94B PW4000-112 Trent800	General Electric Pratt & Whitney Rolls-Royce
	B787	GEnx-1B Trent1000	General Electric Rolls-Royce

Table 4.1: Selectable Engines on Modern Airbus and Boeing Aircraft (Source: Herzog, 2010, p. 99)

As engines are a typical example for complex product systems (COPS, Hobday et al., 2005), they involve enormous capital and technological requirements, as well as a high level of interdependencies of subsystems. To stem the capital requirements of typically $1bn involved in the development of a new engine program and share the risks in the development phase, engine manufacturers and system suppliers have founded a handful of joint ventures: the “Engine Alliance” (GE & P&W), “CFMI” (GE & Snecma) and “International Aero Engines” (IAE) (P&W, RR, MTU Aero Engines, and Japanese Aero Engines Corporation) (Pompl, 2007; Herzog, 2010). These engine manufacturers and consortia develop all engine programs of Airbus and Boeing aircraft, as Table 4.1 illustrates. Besides alliancing, engine manufacturers add services to their business model to finance the amortization period of 15 to 25 years (Lazonick & Prencipe, 2002) and reduce the commercial risk tied to the success of the aircraft. This service-led business model innovation is discussed in detail in Chapter 4.4.

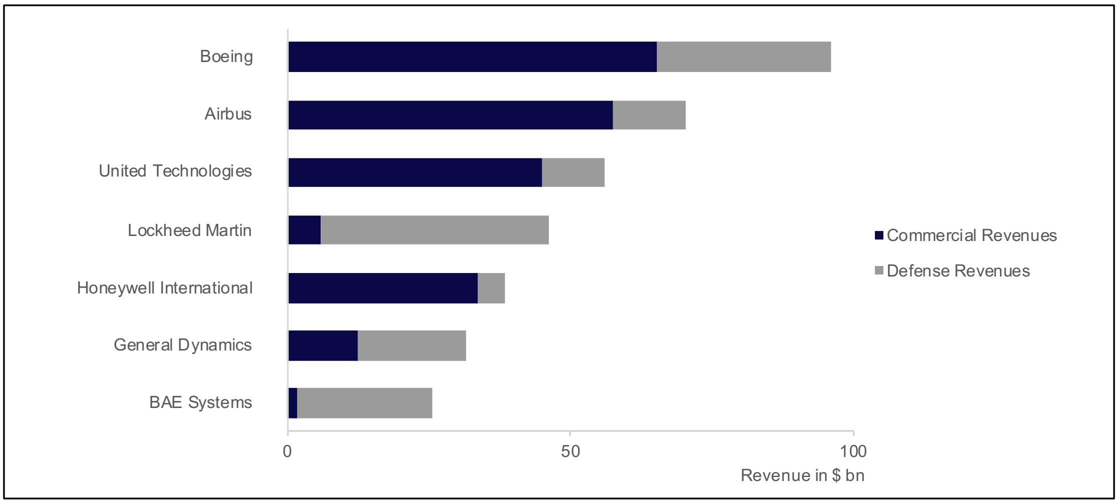


Figure 4.7: Top 7 Aerospace Companies[15]

The second type of tier 1 suppliers are original equipment suppliers[16] such as avionics producer Honeywell, airframe structures suppliers such as Goodrich, and major components suppliers such as the landing gear producer Messier-Dowty that has been integrated into the French Safran group (Niosi & Zhegu, 2005). While the market for aircraft systems is less concentrated than the engine market, a major consolidation can be observed in the last years, as large system manufacturers employ M&A programs to increase in-house system seller capabilities and secure larger shares of the aircraft systems market (Berger, 2013a).[17] This development is further fueled by the aircraft manufacturer's outsourcing of development by establishing risk-and-revenue-sharing partnerships, which will be further discussed in detail in Chapter 4.4.

Furthermore, it needs to be noted that commercial aerospace and the defense industry are intertwined, and major aerospace companies base their revenues in commercial aviation and defense, due to the high technological synergies between both applications. This is illustrated in Figure 4.7, which shows the top aerospace companies based on 2015 revenues.

[15] Author's evaluation based on data by Best (2016); Duddu (2016), Bombardier and Embraer are not consolidated into Airbus and Boeing.
[16] Also known as aircraft system suppliers.
[17] Among many examples of M&A activities of the last years are: UTC acquired tire supplier Goodrich, Zodiac purchased galley supplier Sell, Safran acquired Zodiac's seat division, and Transdigm Group acquired safety equipment supplier AmSafe.

4.3 Aircraft Maintenance, Repair, and Overhaul

4.3.1 Fundamentals

Definition and Early Development Aircraft require Maintenance, Repair, and Overhaul (MRO) services to ensure airworthiness and thus safety of flight operations. While in practice, the boundaries between maintenance, repair, and overhaul are at times blurry, the different types of activities can be delimited from one another: Maintenance activities are activities that limit wear and tear of the aircraft and its parts. Repair and overhaul include all measures that restore the aircraft or its components into their original state. Another main difference between repair and overhaul is that the latter is a more comprehensive activity (Hinsch, 2012). Modern maintenance programs aim to strike the balance between cost-efficiency and reliability by optimizing scheduled maintenance to minimize unscheduled events.

Historically, only little reliable data was available on which aircraft maintenance programs could be based, which is why they relied mostly on the experience of mechanics and often followed a paradigm "the more, the better". This changed only in the age of jets when aerospace agencies were founded and introduced condition-based maintenance schedules. Since the 1980s this philosophy has been further developed, considering the consequence of errors instead of their occurrence as units of analysis and considering economic factors. Today, three types of maintenance concepts can be differentiated: scheduled maintenance, which includes preventive and predictive maintenance concepts, as well as unscheduled maintenance. Preventive maintenance is a concept in which planned actions are predetermined at pre-set intervals in a maintenance program that aims to ensure the airworthiness of the aircraft. Predictive maintenance pursues the same target as preventive maintenance (i.e. keeping the aircraft and its parts in airworthy condition), relies however on data to schedule maintenance activities instead of pre-set intervals. Unscheduled maintenance requires non-routine maintenance processes that when a component demonstrates a failure in operation (Garg & Deshmukh, 2006; Hinsch, 2012).

In early times, MRO was conducted internally by airlines, who built most of the required MRO capabilities in-house in a specific MRO division. To achieve economies of scale on the small fleets that required extensive maintenance work compared to today's standards, airlines founded alliances. One example is the maintenance cooperation ATLAS between Air France, Alitalia, Lufthansa, Iberia, and Sabena Technics to ensure cost-efficient MRO services on the B747 in the 1970s (Henningsen, 2010). At this time, manufacturers offered only few services but provided extensive maintenance manuals instead. These enabled the certification of internal MRO divisions to provide all required maintenance services. As fleets grew, large legacy carriers as Turkish, Lufthansa, Delta Airlines, or Air France span-off their maintenance division to offer MRO services to other airlines, achieving higher cost-efficiency, economies of scale, and profitable third-party revenues (Garg & Deshmukh, 2006; Johnstone et al., 2009; Henningsen, 2010). As these MRO providers perform the same services often at lower costs than internal providers, they represented and still represent a competitive opportunity for outsourcing MRO services (Carpenter & Henderson, 2008).

The Development of the Maintenance Function Alongside the development of maintenance philosophies also the role of MRO for airlines has evolved considerably. Historically, MRO has been regarded as a mere cost center causing necessary expenses that were accounted for in the operating budget. Airlines relied on an internal division to maintain assets according to the break-it, fix-it logic (Garg & Deshmukh, 2006). Nowadays, maintenance has evolved from these antiquated views towards a core function that delivers value to the organization. In asset-intensive industries as the airline business[18], a capable maintenance organization is a driver of firm performance, as it ensures asset safety, reliability, and availability (Tsang, 2002) in a cost-effective manner. In comparison to other industries, maintenance is of especially high importance in the airline business, due to fact that safety is an imperative and that passenger transportation is a service that needs to be provided just-in-time, since, unlike products, it cannot be stored (Auramo & Ala-risku, 2005). While all Western airlines possess high levels of safety, reliability and punctuality are less straight forward (Rieple & Helm, 2008). Here, MRO services play an important role, as they are one of the key factors determining the airlines' punctuality: although technical problems account only for 5% of the delays, the caused delays have a larger duration (40 to 100 minutes) than delays caused by other incidents. Punctuality is an important factor for airline profitability, as airlines lose in between 0.6 and 2.4% of their revenues due to unpunctuality, and the fact that punctual airlines are in general more profitable (Niehues et al., 2001). Additionally, unpunctuality and flight cancellations impact the customer's future airline choice (Al-kaabi et al., 2007b) and a steadily rising percentage of compensation claims especially in the last years. Last but not least, MRO services are an important cost factor for airlines, as they represent around 10% of their direct operating costs.[19]

Rules and Regulations for Continuous Airworthiness Airlines are legally obliged to assume the responsibility of their aircrafts' airworthiness through active involvement and control. To fulfill this responsibility, they are required to possess an adequate, dedicated Continuous Airworthiness Management Organization (CAMO) and an individual occupying the position of the Postholder Maintenance to control internal and external

[18] Asset intensity has been measured as gross book value of assets / revenues (Hambrick, 1983). In the airline industry, values may vary considerably due to differences in the ownership/leasing structure. However, the airline business can be considered as being asset-intensive, no matter which financing option is chosen.

[19] As discussed previously, year-to-year cost share depends on factors such as variability of fuel price and the performance of the cost-intensive engine and base maintenance events.

maintenance processes.[20]

However, airlines do not need to perform all airworthiness tasks internally but are permitted to subcontract airworthiness tasks to external parties that hold the CAMO approval if an interface allowing direct involvement and control is established. The subcontracted services are referred to as Subcontracted Airworthiness Management Tasks (SCAMT) and involve mainly engineering tasks such as job card creation and planning tasks such as conceptualizing the maintenance schedule.

For MRO firms, the rules for the continuing airworthiness and maintenance of aircraft that are stated in Regulation No 2042/2004 of the European Commission are among the most relevant. According to this regulation, MRO firms are organizations that ensure continuing airworthiness of aircraft and thus require certification as maintenance organizations according to the rules and regulations stipulated in EASA Part-145 Maintenance Organization Approvals. These extensive regulations include technical, organizational, and personnel requirements such as appropriate facilities and tools, as well as qualified staff, and an appropriate qualification system. Furthermore, the MRO firm is required to possess a system for production planning, control, and quality assurance (Hinsch, 2012). Also, all maintenance tasks need to be conducted according to approved maintenance manuals (Instructions for Continuous Airworthiness, ICA) that are provided by a certified production organization (EASA Part 21/G), typically the manufacturer (Hinsch, 2012).[21]

MRO Firms and Market The development of the global demand for MRO is induced by the development of commercial air travel. Air travel, typically measured by revenue passenger kilometers (RPKs), increased by approximately 6.2% in 2016 and is projected to grow about 6.0% annually over the next 20 years. The largest gains are expected in the regions of Africa, Asia, the Middle East, and Latin America as these regions benefit from increased incomes, open-skies agreements, improved service quality, and additional routes (Cooper, 2017). MRO for commercial aircraft is predicted to grow accordingly at a healthy compound annual growth rate (CAGR) of 3.8% over the next 10 years, growing from the current demand of $75.6bn to just over $109bn by 2027 (Cooper, 2017). The difference in MRO and airline growth rate is explained by the fact that new aircraft types require less maintenance than older types due to advances in technology. For example, the use of carbon fibers on new the A350 and B787 allows for stretching Base Maintenance intervals from six to twelve years (Cooper, 2017).[22]

[20] In Europe, EASA Part M is applicable; the FAA and other authorities have released similar regulations. See Hinsch (2012, p. 33-36).

[21] For a detailed description of maintenance organization approvals in Europe, see Hinsch (2012, p. 28-33) or Continuing Airworthiness EASA Part 145. The FAA and other civil aviation authorities have released similar regulations.

[22] Details regarding predicted growth regions, aircraft types, market segment and hence opportunities for growth are discussed in the Revenue Streams section of the MRO business model.

In comparison to the aircraft manufacturing market, the market for MRO services is more dispersed (see Figure 4.8). Some airline third-party MRO providers such as SIA Engineering Company (Singapore Airlines), AFI KLM Engineering and Maintenance (AFI KLM), or Lufthansa Technik (Lufthansa) have grown to provide services on a global scale. Other, independent MRO providers that mostly focus on one or some of the MRO segments, such as HAECO, a Hong Kong-based Base Maintenance Provider, or AAR Corp., who provide Component, Landing Gear and Base Maintenance in more than 100 countries. The third type of competitor are manufacturers that have entered the MRO market and are now gaining an ever-increasing market share with their component-, engine-, and aircraft service and solution offers.

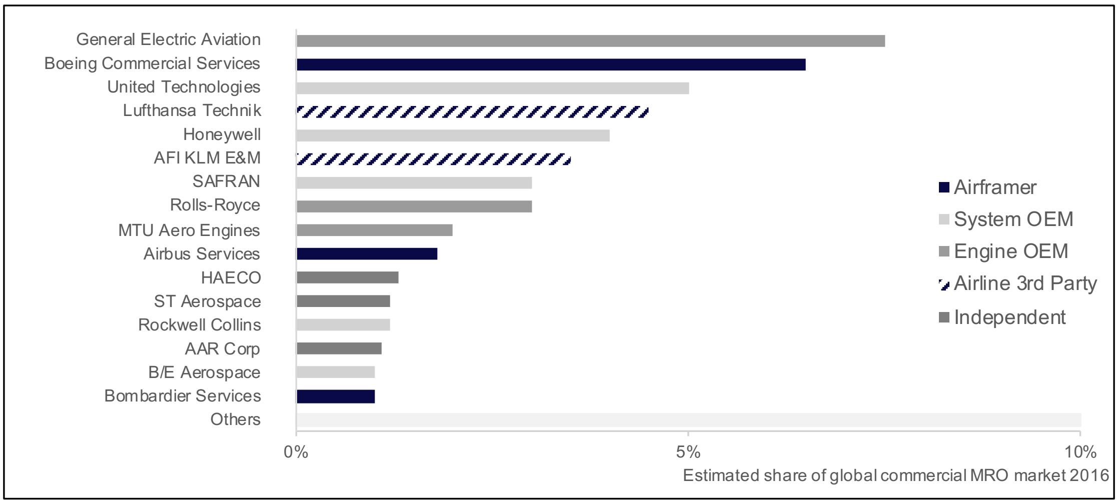


Figure 4.8: Top MRO Companies by Type and Revenue Share in 2016[23]

4.3.2 The MRO Market Segments

The MRO market is commonly divided into the four market segments Line Maintenance, Base Maintenance, Engine Overhaul, and Component Maintenance.[24] MRO firms can choose to serve all segments as "one-stop-shops" (e.g., Air France Industries, Lufthansa Technik, Delta Tech Ops), or focus on single market segments such as the component maintenance specialist AJ Walter (Tegtmeier, 2009).[25]

[23]Source: Cannacord Genuity estimates (Herbert & Morales, 2016, p.4). Revenues for airline groups include service for in-house carrier and third parties. Estimates have been used where commercial maintenance revenues are not published, MRO revenue of manufacturers may include spare parts revenues.

[24]Other niche services exist, such as converting passenger to freighter aircraft or the cabin completion services for VIP aircraft, which are not considered part of the analysis. Modification services for commercial airlines are considered part of Base Maintenance.

[25]In the MRO business model, I conceptualize performing a particular service, as, e.g., Component Maintenance as a Key Activity. Hence, Component Maintenance may either refer to the market segment or the service itself.

Since all segments form part of the MRO industry, they have many trends in common that are induced by developments in the adjacent airline and aircraft manufacturing business. However, the market segments, competitors, resources, and capabilities required to offer the different MRO services differ considerably between the segments (Carpenter & Henderson, 2008), for which reason they are introduced separately.

The MRO market has an estimated volume of $75.6bn in 2017, with Engine Overhaul having the largest share ($29.6bn), followed by Base Maintenance ($17.7bn), Component Maintenance ($15.5bn), and Line Maintenance at $12.8 bn.

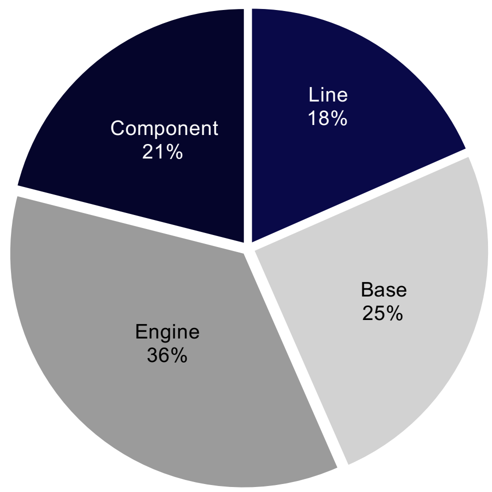


Figure 4.9: Market Share of MRO Segments[26]

Line Maintenance Line Maintenance describes all minor checks of the aircraft that are regularly performed between to ensure its airworthiness, such as diagnosing errors and minor troubleshooting. The primary aim of Line Maintenance is to solve any problems without causing delays or affecting the flight schedule (Kinnison & Siddiqui, 2004).

Line Maintenance is categorized into Transit Checks, Daily-/48 hours/Weekly-, and A-Checks (see Table 4.2). Modern maintenance schedules aim at increasing aircraft availability by reducing the time that the aircraft is removed from service. Maximum availability is achieved by modularizing maintenance tasks that formerly belonged to Base Maintenance Activities (e.g., C-Checks) into smaller work packages that can be performed in weekly or A-Checks, thus lowering the time the aircraft is parked for Base Maintenance. These measures and the fact that new composite aircraft as the B787 are serviced in larger Base Maintenance intervals, increasingly blur the boundaries between Line and Base Maintenance.

[26]Author's illustration based on Oliver Wyman's 2017 Global MRO and Fleet Forecast (Cooper, 2017, p.4).

Check	Frequency	Labor / Costs	Description	Examples
Transit Check	Each flight cycle	1-4 MH $75-350	• Sometimes described as turn-around check • Visual inspection of aircraft ("walk-around"), checking for obvious damage and deterioration	• Check fluid levels of equipment, inspect wheels and brakes, troubleshooting
Daily / 48h / Weekly Checks	Daily: 24-48h Weekly: 4-8 days	Daily: 5-10 MH Weekly: 10-30 MH $150-500 per day	• Daily checks at intervals of 24-36 hours, sometimes described as overnight checks • Weekly checks include 7/8day checks and 3/4day checks • Additional work may be specified for the aircraft downtime by the maintenance planners e.g., defect rectification, out-of- phase checks	• Tire change, refueling lubricants, minor repairs • Inflight entertainment and cabin maintenance
A-Check	Regional: 350-500 FH Narrow- & Widebody 500-700 FH (~2 months)	Regional: 150-250 MH Narrow- & Widebody 250-500 MH $15-50 per FH	• Accomplished at a designated maintenance station and includes the opening of access panels to check and service certain items. • Additional work may be specified for the aircraft downtime by the maintenance planners e.g., defect rectification, out-of-phase checks • Some limited special tooling, servicing, and test equipment is required.	• General external visual inspection of aircraft structure for evidence of damage, deformation, corrosion, missing parts • Crew oxygen system pressure check; operationally check emergency lights; lubricate nose gear retract actuator; check parking brake accumulator pressure; perform Built-in Test Equipment (BITE) test of Flap/Slat Electronics Unit.
B-Check	~1,100 FH	200 – 700 MH	• A slightly more detailed check of components and systems.	• Special equipment and tests may be required. • Does not involve detailed disassembly or removal of components.

Table 4.2: Types of Line Maintenance Checks[27]

Compared to other maintenance services, Line Maintenance is of a very manual, decentralized nature, comprising around 50% of non-routine activity. Since Line Maintenance is performed between each flight, it is highly intertwined with airline operations and critical for airline operations. Highly qualified mechanics understanding the aircraft's complex system of electronics, engine, hydraulics, emergency equipment, cabin systems, with high troubleshooting capabilities are essential to ensure a quick turnaround of the aircraft. Since Line Maintenance is performed at every turn-around, staff is needed both on the airline's line stations (e.g., the hub or other dedicated sites on which the aircraft are based) and outstations (the destinations served). As Line Maintenance is essential for aircraft reliability and availability, most airlines consider Line Maintenance a core competence and are reluctant to outsource this service entirely. Instead, they aim at bundling most work (approx. 80%) on line stations through internal staff and only the required tasks (i.e., pre-flight-, transit-, daily-, and overnight checks) through external staff on outstations, where limited operations do not warrant own staff (Henningsen, 2010; Aeronautical Repair Station Association, 2013; Brown, 2015).

Further efficiency gains in Line Maintenance can be achieved by improving capacity utilization and efficiency of labor through the optimization of the maintenance schedule, efficient troubleshooting, and selling spare capacity to third-party airlines (Henningsen, 2010). On outstations, Line Maintenance tasks such as turn-around checks are mostly performed by local MRO providers or airport operators such as Swissport. As the IATA standard ground handling agreement standardizes most of the contents

[27] Adapted from Aeronautical Repair Station Association (2013, p. 20) and Vieira & Loures (2016, p. 23). FH: flight hours, MH: man-hours.

and pricing of these services, in general, little negotiation potential exists on these stations.

Base Maintenance Base Maintenance (also referred to as airframe or heavy maintenance) characterizes major checks and including structural repairs of the aircraft that are usually performed at a hangar or specialized Base Maintenance facility (Kinnison & Siddiqui, 2004). Base Maintenance can be divided into C-Checks, which are major checks that are performed yearly or bi-yearly depending on the aircraft type and operational profile and D-checks, which are the most comprehensive maintenance activity on the aircraft (see Table 4.3).

Check	Frequency	Duration/ Labor	Description	Examples
C-Check	Every 2.500 - 4,000 FH or 12 - 20 months	72h - 7+ days 2,000 - 4,000 MH	• Detailed, scheduled inspections, maintenance, preventive maintenance and alteration of the airframe, components and accessories and portions of applicable corrosion prevention programs • Requires extensive tooling, test equipment, and special skill levels. • C-checks remove the airplane from the operations for 3 to 5 days. • Modern maintenance schedules shorten C-checks by modularizing work packages and including them into A- or B-checks.	• Visually check flight compartment escape ropes for condition and security; check operation of DC bus tie control unit; visually check the condition of entry door seals; operationally check flap asymmetry system; pressure decay check APU fuel line shroud; inspect engine inlet TAI ducting for cracks.
D-Check	20,000 - 25,000 FH or 6 - 12 years	30 days 10,000 - 50,000+ MH	• Comprehensive maintenance, preventive maintenance, and alteration of the entire aircraft, intending to return it to its original condition (to the extent possible) with interiors and components removed and replaced. • Includes detailed visual and other non-destructive test inspections of the aircraft structure. • Requires a hangar, special equipment, and is very labor-intensive.	• Inspect stabilizer attach bolts; inspect floor beams; detailed inspection of wing box structure. • Often installation of new cabin equipment, landing gears, or other major aircraft modifications.

Table 4.3: Types of Base Maintenance Checks[28]

The requirement for Base Maintenance is significantly decreased for new aircraft types due to modularization of work packages (see the previous section) and new aircraft technology. For example, a B787 requires three C-Checks and one D-Check during 12 years of operation, compared to a B767, that still needed six C-Checks and two D-Checks. In total, this enables savings of approximately 65% maintenance work (62,000 MH) and 90 additional days the aircraft is available (Brown, 2016).

Base Maintenance is very labor cost-driven with approximately 70% labor, 20% material, and 10% for repair and specialty services. Currently, airlines outsource more than half (54%) of their Base Maintenance work to independent MRO providers and 2% to airframe OEMs, while 44% are performed internally (Aeronautical Repair Station Association, 2013).

[28] Adapted from Aeronautical Repair Station Association (2013, p. 4) and Vieira & Loures (2016, p. 23). FH: flight hours, MH: man-hours.

The market for Base Maintenance services is highly price-competitive and commoditized. Thus, most Base Maintenance providers have established a cost leadership strategy, centering their Value Proposition around providing the quality stipulated by the authorities at a competitive price. Input-based pricing is the predominant form of pricing for Base Maintenance events. For each type of check, work packages and required man-hours are defined. These are priced according to a regionally established market price, the so-called man-hour rate (MHR). The MHR greatly varies per region, with China and Southeast Asia offering the lowest MHRs, lying roughly 36% below North America and 50% below Western Europe (Spafford & Rose, 2013). It is uncertain, whether a further decline will take place, e.g., via movement of facilities into countries with yet lower costs, or whether increasing wages in low-cost countries will stabilize or even raise the MHR.

Although competition in Base Maintenance is very cost-driven, opportunities for competitive differentiation exist: first, shortening the duration of the maintenance event (the so-called turn-around-time, TAT) decreases the number of days the aircraft is removed from service.[29] Second, the MRO provider's ability to constantly deliver the aircraft within the previously agreed TAT is measured through the KPI on-time-performance (OTP).[30] A provider with a high OTP provides value to the airline by reducing uncertainty and costs for the operator: When an aircraft is not overhauled on time, the operator needs to either organize a replacement aircraft through leasing or its maintenance reserves, or cancel the flight and rebook the passengers. OTP is especially vital if the MRO performs several subsequent base maintenance events for his customer ("nose-to-tail operations"), since summing up delays lead to substantial increases of the total TAT and disruptions of the airline's operation. Other opportunities for differentiation are guaranteeing homogeneous quality and providing base maintenance services locally, which avoids time and costs associated with ferry flights.[31]

Engine Overhaul Engine Overhaul includes all maintenance, repair, and overhaul tasks done on a dismounted engine (off-wing). In contrast, all engine-related tasks that are performed on-wing are usually categorized as Line Maintenance activities. For commercial airlines, the overhaul is performed on an as-needed (on condition) basis, except for the replacement of life-limited parts (LLP) which are replaced at fixed times stipulated by the national aviation authority (Kinnison & Siddiqui, 2004; Aeronautical Repair Station Association, 2013). Advances in technology have increased the ser-

[29] For an exemplary calculation, please refer to Section 1 in the Annex. The value of aircraft availability varies throughout the year due to the seasonality of the commercial passenger transport business. Availability is especially valuable in the summer months during peak travel times, while in winter aircraft utilization is generally lower.

[30] OTP: percentage of overhaul events finished within the stipulated TAT.

[31] An intra-European ferry flight of an A320 with the duration of 3 block hours results in one-way costs of circa 14,000 USD (see Section 2 in the Annex) and results in lower aircraft availability, since the aircraft cannot be used for commercial operations during the ferry flight.

vice life[32] of engines from previously 4,500 FH to 24,000 FH on modern engine types. Depending on the size of the engine, costs for the overhaul of a single engine lie in between $450,000 and more than $5 million (Aeronautical Repair Station Association, 2013). Consequently, airlines may incur substantial costs, if they are required to perform Engine Overhaul of a whole fleet in a single period.[33]

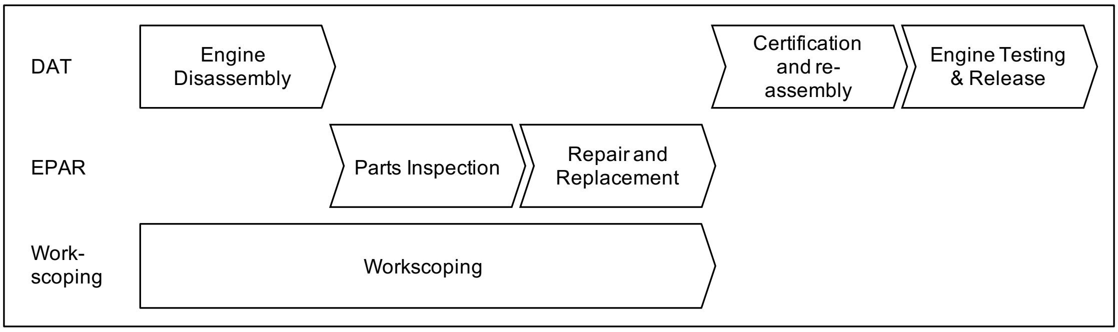


Figure 4.10: Engine Overhaul Process[34]

Typically, Engine Overhaul is divided into three inter-related sub-processes, shown in Figure 4.10. Engine disassembly, assembly, and test (DAT) is performed in flow lines, in which the engine is dismantled into its sub-modules as it travels from station to station. If necessary, these submodules are subsequently disassembled into single piece parts. After cleaning and an initial inspection, e.g., with non-destructive testing methods, blades, vanes, and engine parts are repaired in specialized workshops. Engine Parts Repair (EPAR) aims to return worn engine parts to their original or even into an improved state. Workscoping determines the scope of the overhaul, and which parts are to be repaired or replaced. Workscoping is a critical activity in Engine Overhaul, as it determines the costs and time required for the overhaul event. Finally, the engine is re-assembled in the flow line as part of the DAT process, re-certified, tested, and released into service (Kinnison & Siddiqui, 2004; Aeronautical Repair Station Association, 2013).

Engine Overhaul is a very material-driven MRO service, as spares and material constitute roughly 68% of all overhaul costs, while labor and facilities take a considerably smaller share with 22% and 10%, respectively (Aeronautical Repair Station Association, 2013). It represents the largest of the MRO market segments, accounting for 36% of its value (Cooper, 2017). In this segment, Engine OEMs have already successfully established themselves with a 55% market share, while 20% is performed by airlines

[32] The service life of the engine is the timeframe between overhaul events. It is commonly measured as Mean Time between Shop Visits (MTBSV) in flight hours. The service life is determined mostly by the construction and technology used by the manufacturer, the environment in which the airline operates and the maintenance and engineering services performed.

[33] Assuming $5 million per engine overhaul, a small airline with 12 single-aisle aircraft (24 engines) incurs a one-time operative expenditure of $120 million in a single year.

[34] Source: own illustration. DAT: Disassembly, Assembly, Test. EPAR: Engine Parts Repair.

in-house, and 25% by third-party MRO providers (Brown, 2015). With the growing fleet of next-generation aircraft (Airbus A320neo, A350, A330neo, Boeing B737MAX, B777X, B787), engine manufacturers' market share in engine services is expected to increase even further to in between 65% and 90% (Bourke, 2018).

Component Maintenance Component maintenance describes repairs, replacement, and testing of the components that provide the aircraft with its basic functionalities such control and navigation, steering, communications, electrical power, cabin air conditioning, landing, and braking. An aircraft includes many different categories of components such as avionics (e.g., navigation and communication systems), hydraulics (e.g., pumps and actuators), the auxiliary power unit (APU) and electrical distribution systems (see Figure 4.4). Components need to be repaired either due to wear and tear resulting from regular operations, limited lifetimes determined by the manufacturer, or sporadic defects. Wheels and brakes, for example, require a regular exchange of the brake pads due to wear and tear, while avionics equipment is overhauled at regular intervals and if an erratic failure occurs.

The MRO component market segments and their average cost share are shown in Table 4.4). Wheels and brakes cause the highest costs due to the wear they sustain in each aircraft landing. They are followed by the maintenance of avionics equipment and APU.

Market Segment	Maintenance Activities	% of Component MRO Costs
Wheels & Brakes	Brake pad, servo valve, wheel maintenance, antiskid maintenance	25%
Avionics	Maintenance of displays, communications equipment, navigation systems, and autopilot	14%
Auxiliary Power Unit	Maintenance of the aircraft's auxiliary power unit including accessories	9%
Fuel Systems	Maintenance of engine fuel controls and aircraft fuel systems	8%
Thrust Reversers	Maintenance of aircraft thrust reversers, including actuation and surfaces	6%
Landing Gear	Maintenance of aircraft's landing gear systems	6%
Equipment/ Furnishings	Maintenance of removable items of equipment and furnishings externally mounted on the aircraft or contained in the flight and passenger components	5%
Flight Controls	Maintenance of primary and secondary flight control actuators	4%
Hydraulic Power	Maintenance of hydraulic pumps and conveyance hardware	3%
Electrical	Maintenance of electrical generation and distribution systems	3%
Other	Maintenance of myriad other systems including environmental control, in-flight entertainment, safety, water & waste, and pneumatics	17%

Table 4.4: Component MRO Segments[35]

As the aircraft consists of hundreds of different components of dozens of different system suppliers, the market for component services is very fragmented compared to Engine Overhaul or Base Maintenance (Aeronautical Repair Station Association, 2013). In

[35]Source: Aeronautical Repair Station Association (2013, p. 14).

total, independent service providers hold a market share of 40%, followed by 25% of airline in-house work, and 35% of subcontracting to OEMs (Brown, 2015).

Due to the diversity of the components, the maintenance cost structure varies between the different major categories (see Figure 4.11). The most labor-intensive activities include electrical power systems, landing gear, thrust reverser repair, and fuel systems, while wheels and brakes, avionics, and APUs are rather material-driven. Overall, labor is approximately 35% of component MRO spending; materials represent 60% and outside services 5% (Aeronautical Repair Station Association, 2013).

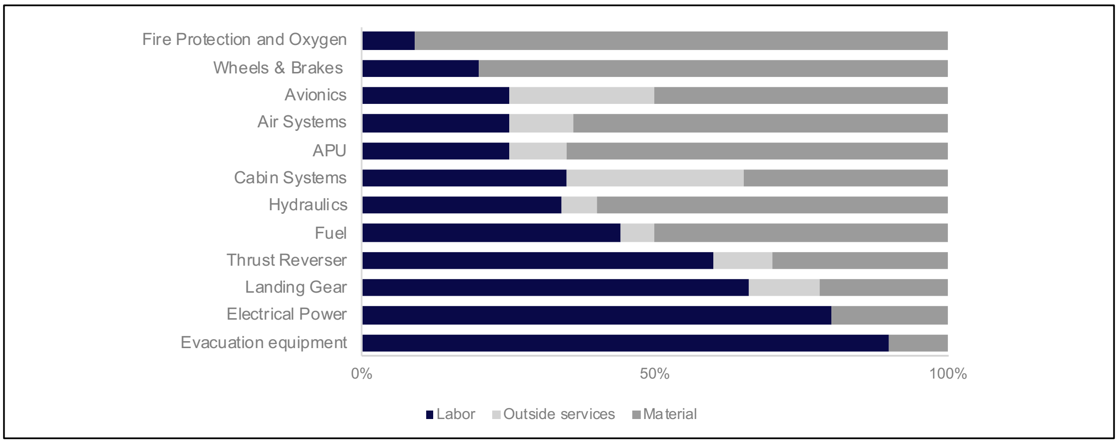


Figure 4.11: Component Maintenance Cost Share of Major Component Categories[36]

Two main types of Component Maintenance contracts need to be distinguished: Single Component Maintenance contracts and Pooling contracts.[37] Single Component Maintenance contracts cover the repair of single components at a negotiated price and turn-around-time. In these types of contracts, the airline sends the removed unserviceable component to the repair station, where it is repaired and sent back to the customer. Pooling Contracts allow the airline to gain access to a component pool, guaranteeing the availability of a set of components in a specific timeframe. Here, the airline sends the unserviceable component to the repair station, which provides an exchange unit from a pool of serviceable parts. Pooling contracts are a specific type of solution offering that is covered in detail in Chapter 5.

While the former type of contract is provided by the system suppliers, airline third-party, and independent MROs, the latter requires an integrator that manages a pool across the different system and maintenance suppliers. Hence, pooling contracts are provided by either independent and airline-third party MROs, or the airframers as part of their service-led growth strategy.

[36]Source: Aeronautical Repair Station Association (2013, p. 16).

[37]For reasons of simplicity, contractual agreements in between these two types are not further elaborated here.

4.3.3 The MRO Industry Structure

Michael Porter argues in his seminal article that the nature and degree of competition and profitability within an industry depends on the industry structure, which is determined by five forces (Porter, 1979). These forces are the bargaining power of suppliers, bargaining power of customers, the threat of new entrants, the threat of substitutes and the level of rivalry within the industry. Each of the five forces has the potential to lower the profitability of the industry and be a determinant of strategy formulation (Porter, 1979). While the industry's impact on companies' profitability has been under discussion with varying results (e.g., Rumelt, 1991; McGahan & Porter, 1997), Porter's industry structure analysis depicted has become a widely used framework for analyzing industries (Grant, 2010). Due to its ability to identify the relevant features of an industry's structure and its implications on competitive behavior as well as the positioning of a firm relative to the market forces (Grant, 2010), I use Porter's approach to organize the MRO market analysis (see Figure 4.12).

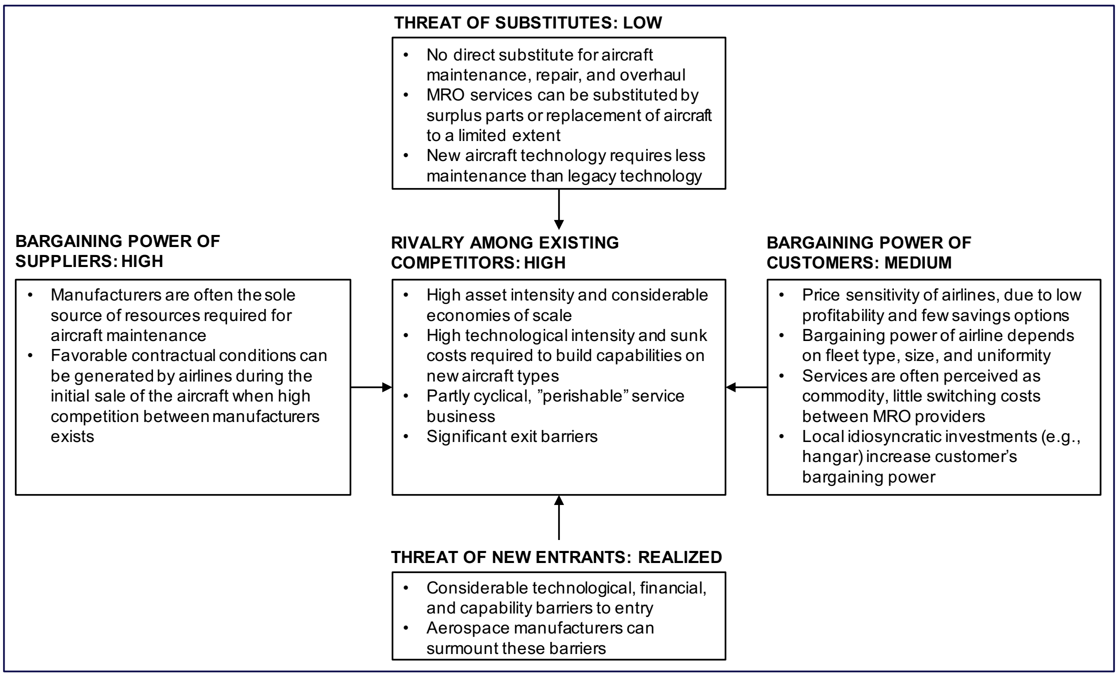


Figure 4.12: MRO Industry Structure Analysis (based on Porter, 1979, p. 141)

Bargaining Power of Suppliers High bargaining power of suppliers may limit the profitability of an industry, as surplus shifts to the supplying companies. Different conditions exist that increase suppliers' bargaining power, such as a high concentration of the supply market by few companies, concentrated offerings, or only a few or no available other sources. Suppliers may also increase their bargaining power by imposing switching costs on customers. Buyers can decrease the bargaining power of their suppliers by establishing alternative sources or making a credible threat of backward integration (Porter, 1979; Cox, 2001; Grant, 2010).

To perform MRO services, firms require specific resources such as spare parts, test equipment, tooling, and instructions for continuous airworthiness (ICA) such as Component Maintenance Manuals (CMMs) to provide MRO services. These resources are procured from different sources in the Aircraft and MRO value chain, which is illustrated in Figure 4.13.

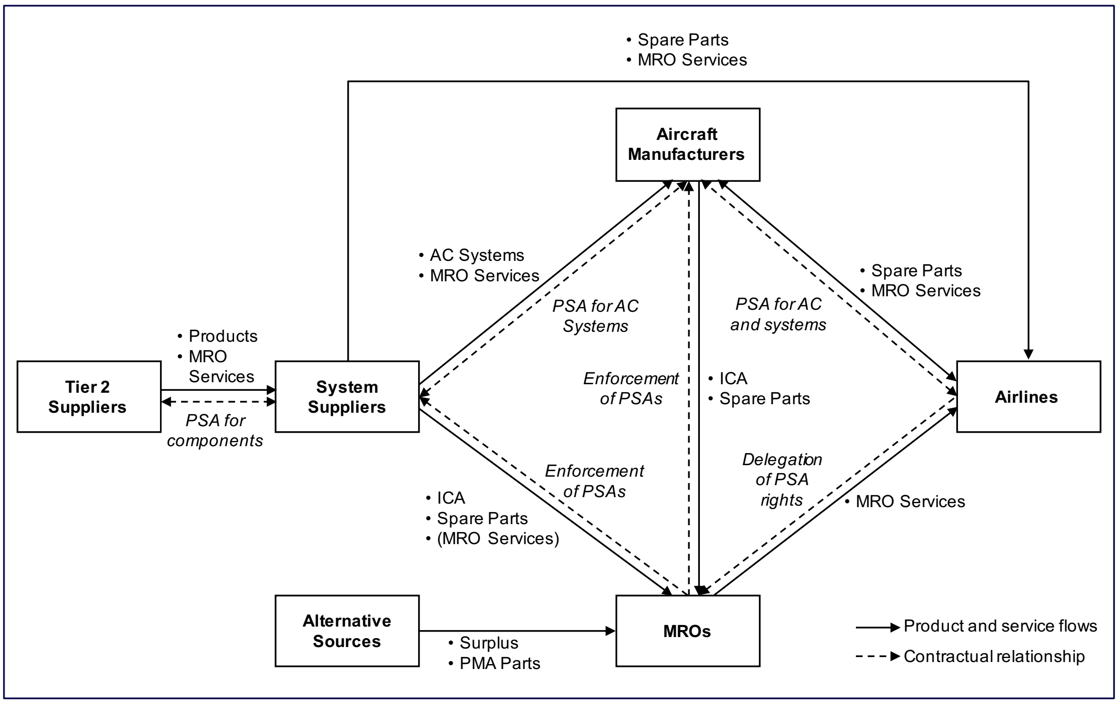


Figure 4.13: Aircraft and MRO Value Chain[38]

For some of those resources, manufacturers are the sole source, whereas in other cases, multiple opportunities for either procuring or making these resources exist. As manufacturers can largely determine pricing and access to resources on which they are possess a monopoly, they generally have high bargaining power in the aftermarket against MRO firms and airlines. The OEM's bargaining power is however limited by Product Support Agreements (PSAs). PSAs are parts of the purchasing agreements between airline and airframer that grant airlines access to ICA, warranty terms, spare parts, and pricing conditions. Airlines can delegate the rights from the PSA to their MRO provider of choice, who can then procure the respective resources from the manufacturer according to the airline's conditions stipulated in the PSA. These rights are not limited

[38] Author's illustration. ICA: Instructions for continuing airworthiness, PSA: Product support agreements. Distributors that sell spare parts or surplus on behalf of the manufacturers or independently have been excluded from the figure for the purpose of clarity.

to the airframer but also contain regulations regarding the system suppliers and their vendors. Since typically a high level of competition exists during aircraft purchase (Airbus versus Boeing models), airlines still possess significant negotiation power that is partly transferred into the aftermarket through the PSA. Once airlines have decided which aircraft to buy, they become locked-in however due to the high switching costs involved in switching fleets. Hence, it is crucial to take MRO costs into account, as they accumulate over the decades a fleet is in operation. Once the aircraft purchasing contract has been closed, PSAs can only realistically be influenced when performing new aircraft procurement campaigns.

Surplus and so-called Parts Manufacturer Approval (PMA) parts represent alternative sources to the manufacturer's spare parts. Surplus materials are second-hand parts that are removed from retired aircraft that are restored to serviceable conditions and re-installed in aircraft. Typically, surplus parts are available from specialized surplus dealers that operate a business model of purchasing retired aircraft, performing teardown, removing and possibly repairing/re-certifying its parts. Alternatively, new surplus material is available if airlines or MRO providers sell their excess stocks that have not been installed in the aircraft yet. Surplus materials are an important alternative source to manufacturers' spare parts as they typically enable savings of approximately 50% in pricing (Broderick, 2013b).

PMA parts are approved to comply with airworthiness standards under US Federal Aviation Administration (FAA) Parts Manufacturer Approval order. These parts can be built into aircraft without any changes necessary in the Type Certificate or Supplemental Type Certificate. The USA is historically the major PMA market, but since PMA certified parts were approved by the EASA as well, usage of PMA parts has increased worldwide (Avia Solutions Group, 2017). As surplus and PMA materials limit the manufacturer's spare part revenue streams and aftermarket bargaining power, they heavily oppose their usage. Also, lessors mostly do not allow PMAs on their aircraft to protect the value of their assets (Broderick, 2014). The role that surplus and PMA parts play in the MRO's business model and their effects on the MRO's cost structure is further elaborated in Section 4.3.4.

In conclusion, manufacturers possess high levels of bargaining power against MRO service firms, which can, however, be offset by airlines during the aircraft purchasing campaigns. The prerequisite is however that airlines take the total lifecycle costs into account and negotiate favorable conditions for the aftermarket with manufacturers and system suppliers.

Threat of Substitutes Substitutes are products or services that for the customer perform the same function as the product or service of the industry under analysis. Substitutes often emerge from other industries and can sometimes entirely replace the original product, if it provides a better price-performance trade-off (Porter, 1979).

Because airplanes need regular MRO services to be maintained in airworthy condition, no substitute for MRO services is per se available. However, some MRO services can be substituted by using spare parts and vice versa. For example, unserviceable components or engine parts can be replaced with surplus material, which may be a more economical option, depending on the state of the component and the availability of these alternative sources.

As some major events such as Base Maintenance events and Engine Overhauls are required in larger timespans, typically between six and eight years, airlines may forgo these events by retiring the aircraft before these services are necessary. However, the decision of whether to prematurely renew the fleet is a complex one, as trade-offs between higher capital, versus lower maintenance and fuel costs need to be considered.

Bargaining Power of Customers The customers' bargaining power over their suppliers is increased in situations in which the suppliers are dependent on their customer, e.g., when only a few buyers exist, and these procure large quantities of their supplier's production. In industries with high fixed costs, dependence may be caused by idiosyncratic investments by the supplier which cause high sunk or switching costs, when the relationship ends. Customers with low profitability that procure commodities demonstrate a higher price-sensitivity than customers that procure products or services that add considerable value to their offering or decrease its costs. In these cases, the customers' bargaining power is increased by the fact that they can procure these items regularly from multiple competitors that enter in price-based competition (Cox, 2001; Crook & Combs, 2007; Porter, 1998).

Airlines show a high price-sensitivity in procurement, due to their generally low profitability. As MRO services make up a considerable share of 15-18% of direct operating costs, airlines continuously search for ways to reduce that expense (McFadden & Worrells, 2012). Their price sensitivity is increased by the fact that large other portions of direct operating costs, such as fuel, airport charges, and staff are challenging to influence. For low-cost carriers, low operating costs and hence low MRO costs is even one of the three main strategic priorities[39]. Network carriers are under increased price pressure on through the market entry of their low-cost counterpart, which is why they take measures to close the MRO cost-gap (see Figure 4.14). However, it needs to be noted that the difference in maintenance expenses per block hour between LCCs and NCs is difficult to compare, as it is influenced by the following factors: First, LCCs typically operate younger fleets that require less maintenance. Second, LCCs operate narrowbody aircraft with only two engines, which cause considerable less MRO costs. Third, the stage length, which is often used to adjust to compare DOC (Saxon & Weber, 2017) differs between both types of carriers (Belobaba et al., 2009). Ultimately, different accounting procedures between carriers and their internal maintenance divisions also

[39]Simple product, positioning, low operating costs (Klaas & Delfmann, 2005).

significantly limit the comparability of airline operating costs between carriers (Saxon & Weber, 2017).

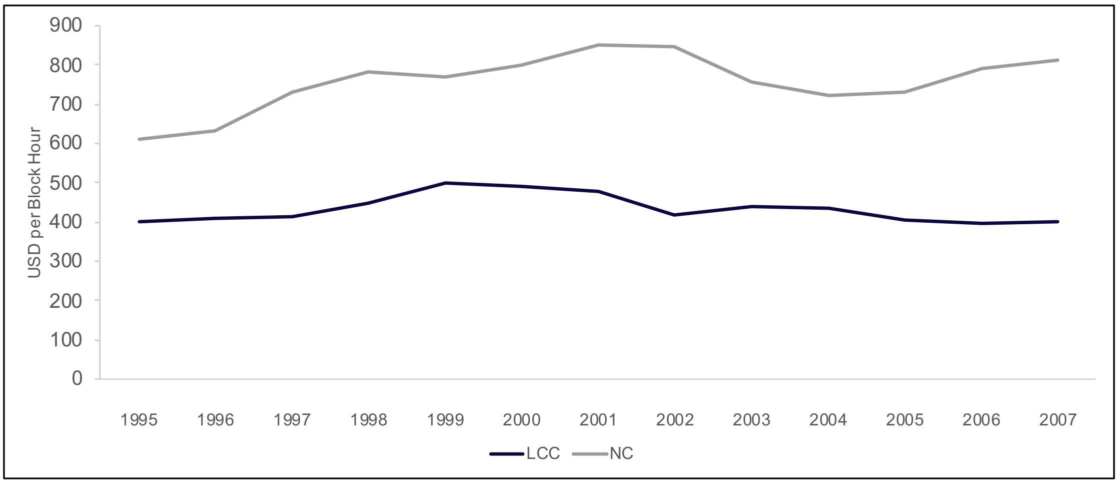


Figure 4.14: Maintenance Cost Gap US LCC and Network Carriers 1995 - 2007[40]

For MRO services, the airline's bargaining power depends on different factors such as the type of service procured, the fleet type, and its size. In general, MRO services are perceived as a commodity with limited potential for competitive differentiation (more details in Section 6.1.1). For example, Line Maintenance on outstations is generally regarded as a commodity, with often more than two suppliers per airport. As simultaneously only limited switching costs exist, these contracts are often re-tendered frequently to gain the best conditions. On other services, such as Engine Overhaul, only a few (or in extreme cases only one) supplier exists, which severely limits the airlines bargaining power. The fleet type operated by the airline shows an effect on bargaining power, as for very common fleets such as the A320 or B737, many different suppliers with capabilities exist around the world. On "niche" fleets such as the A380 however, only a few suppliers for e.g., component maintenance exist, which potentially have higher bargaining power. Airlines that possess larger, more uniform fleets enjoy higher negotiation power, as these are more attractive to MRO providers since they allow for the provisioning of standardized services and predictable capacity utilization.

Threat of Entrants Supernormal profits within an industry attract entrants that can capture market shares and lower prices, reducing the profitability of the industry. If entry and exit barriers are sufficiently low, a contestable market exists, which makes firms vulnerable to hit-and-run attacks (Baumol, 1982). Therefore, firms are forced to charge a deterrent price, inhibiting attacks from potential entrants and lowering market profitability (Porter, 1998). However, in most industries, entry and exit barriers limit the

[40]Source: Belobaba et al. (2009, p. 127).

threat of entry (Grant, 2010). These include capital requirements (e.g., research and development and production facilities), economies of scale needed for achieving lower unit costs or absolute cost advantages, e.g., from low-cost sources of materials or a favorable position on the learning curve. Other barriers of entry are access to distribution channels, legal barriers, e.g., in regulated industries, or the entrant's expectation of retaliation in the same or different markets (Grant, 2010). Companies may also erect entry barriers by increasing switching costs for their customers or by establishing proprietary standards in an industry, which gives them the ability to charge license fees or pursue a monopolist strategy (Porter, 1998; Scherm & Borowicz, 2001).

In the MRO industries, considerable barriers to entry are present, such as technical complexity, certification and financial requirements (Hinsch, 2012), as well as important economies of scale, due to the abovementioned asset intensity. Another barrier is the existence of learning curves that are generally present in service industries, as services often involve tacit knowledge and room for optimization (Darr et al., 1995). For these reasons, it is unlikely that competitors from other, unrelated industries enter the MRO service market. Airframer, engine OEMs, and system suppliers are however well poised to invade the service market through servitization: Being the manufacturer of the equipment, they possess much of the relevant certification required for maintenance, have invested in production facilities, and understand the technology that is underlying the service offer (Ulaga & Reinartz, 2011). On the other hand, manufacturers need to overcome significant barriers, such as adaptions in organization, culture, and the underlying business model to successfully enter the service business, (as discussed in Chapter 2.3.4).

In practice, airframers such as Airbus and Boeing, engine manufacturers such as Rolls-Royce, and system suppliers such as Honeywell or Rockwell Collins have added services to their business model. Servitization was an appealing strategy as the profitability of the aerospace service business is comparatively higher compared to manufacturing with a WACC of 11%, while manufacturers were able to achieve only 9% (see Figure 4.1). In consequence, the threat of entry of manufacturers is now no longer just a threat but has already materialized, leading to "intense price wars" (Schneider et al., 2013, p. 297). Hence, MROs need to adapt their business model to cope with the new entrants and combat the suffering profitability of their current business model.

Rivalry Among Existing Competitors An intense rivalry between established competitors within an industry may lead to more competitive moves such as price wars that can negatively affect the profitability of an industry. The rivalry may depend on structural, product-specific, and other factors. Structural factors such as numerous equally balanced competitors and slow industry growth may lead to high competition between rivals (Porter, 1998). However, the effect of seller concentration within an industry on profitability is considered weak (Schmalensee, 1989). Product-specific factors, such as high fixed or storage costs, a lack of switching costs, or product differentiation as well as the ability to increase production only in large increments increase competition. Industries with durable and specialized resources such as the airline industry may face substantial barriers of exit, which lead to intense price wars in times of recession (Grant, 2010). Diverse competitors with different goals and strategic stakes may also lead to intense competition on a market, as these competitors may continually "run head-on into each other" (Porter, 1979).

In the MRO industry, rivalry inside the industry is increased by various factors. First, MRO is an asset-intensive industry that requires workshops (e.g., for component and engine overhaul) as well as hangars/docks for Line and Base Maintenance. Especially for Base Maintenance, a large quantity of mechanics is required, which cause fixed costs. Likewise, the technology-intensity of the aerospace industry implies that considerable financial effort is needed to build MRO capabilities on new aircraft types. These factors cause substantial economies of scale that in turn require firms to secure a certain market share, to ensure profitability. Hence, competition for large contracts is intensely carried out on a global scale, as each firm aims to improve its competitive position.

At the same time, economies of scale and synergies between MRO services constitute significant exit barriers. In consequence, firms are reluctant to abandon capabilities or entire business units, as this also endangers their ability to offer MRO services as a one-stop-shop. For example, aircraft painting services are difficult to competitively perform in Germany, due to high price pressure and environmental standards compared to other countries, e.g., in Eastern Europe. As a consequence, Lufthansa Technik decided to relinquish this capability in 2011, which in turn left them with high sunk costs for the modern painting facility and the incapacity to offer Base Maintenance and painting as integrated services from a single location (Kranz, 2011). Six years later, the Base Maintenance facility in Hamburg was closed as well, permanently abolishing all Base Maintenance capabilities in Hamburg (Preuß, 2017). The closure, in turn, has adverse effects on the still present VIP completion business, since now seasonality cannot be balanced anymore between both services with very similar underlying resource base. This is not to say that either of these decisions was wrong from a managerial point of view, as aircraft are mobile and can be overhauled in other, more competitive locations. However, it does illustrate the significant synergies and economies of scale present in the MRO industry.

Another factor that limits competitive differentiation and fosters price-based competition is the fact that MRO services underlie strict regulations and standardizations that lead to a natural commoditization. For repair and overhaul service, the input, output and large shares of the conducted repair processes are standardized: the input is an unserviceable part, the repair process is performed according to the manufacturer's manual, the output is a serviceable part. Differentiation is, however, possible through process innovation (e.g., improvement of repair methods) and performance parameters inherent in the service offers such as turn-around-time (TAT, i.e., the time required for the repair), or the mean-time-before-removal (MTBR, i.e., the time the component remains on average in serviceable condition). Advanced services such as engineering and cabin modifications are less commoditized and hence present more opportunities for differentiation.

The entry of manufacturers into the MRO market represents the situation mentioned above in which diverse competitors with different backgrounds and strategic goals compete differently on the same market, leading to a steep increase in competition (Schneider et al., 2013). Hence, it can be concluded that a high level of rivalry and competitive pressure exists within the industry.

4.3.4 The Traditional MRO Business Model

The traditional MRO business model (Figure 4.15) explains how Maintenance Repair and Overhaul firms do business on the strategic (corporate core logic), structural (value chain activities), and resource level (assets), following a systemic, multi-level approach (Osterwalder & Pigneur, 2013). It abstracts the complex reality of MRO providers into a comprehensible model that enables to describe and understand the firm's core logic of creating value (Shafer et al., 2005; Rentmeister & Klein, 2003). Besides, the traditional MRO business model is the basis of what is being innovated, when developing solution- and alliance-based business models.

The Engine, Components, and Aircraft Case deliver in-depth information on the core logic of MRO providers that offer traditional service offers (the focus of this section), solutions, and alliances with manufacturers. All interviews have been coded with the nine business model elements, aiming to identify the items that were regarded as most important in each dimension. These empirical findings are triangulated with industry-specific literature (e.g., the yearly MRO studies by Oliver Wyman, and various articles from periodical outlets such as AviationWeek or MRO-Network) and internal documents of the focal company to further substantiate each business model element.

Thus, a comprehensive modular system based on theoretical concepts and practice is formed. Practitioners may use the MRO business model's elements to combine Value Propositions, Customer Segments and existing or to be developed Key Resources, Activities and Partners into new, viable business models.

Value Proposition

MRO providers make a set of Value Propositions to their customers that are delivered through traditional MRO services such as Engine, Component, or Base Maintenance.

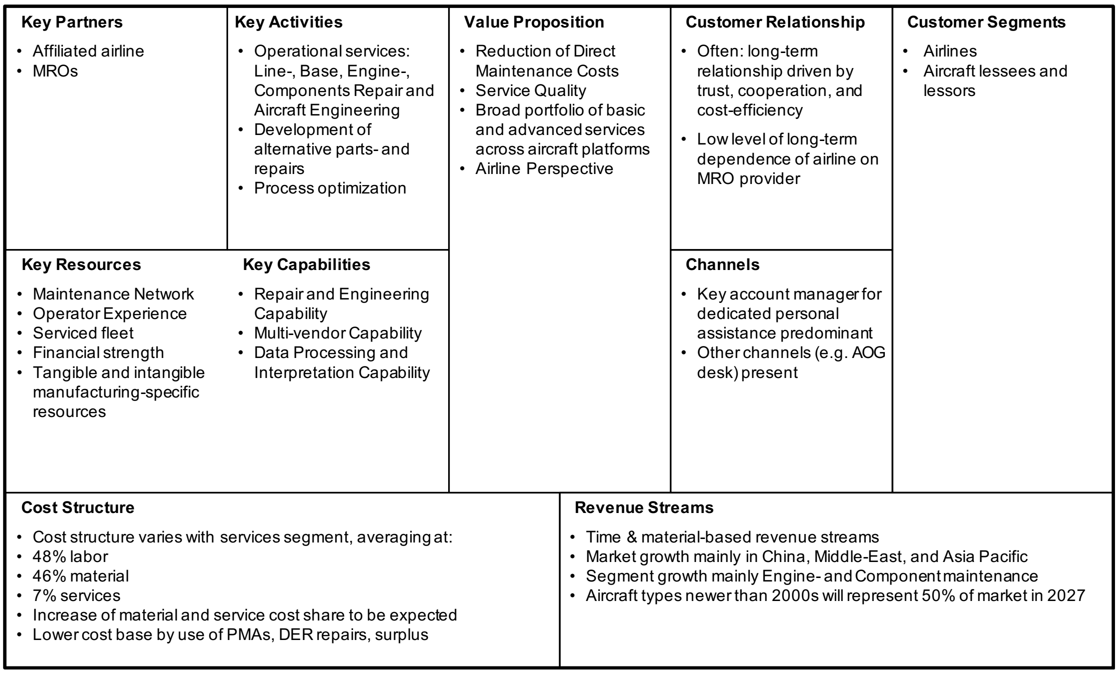


Figure 4.15: The Traditional MRO Business Model

As in traditional offers, the MRO does not assume responsibility for the airline's processes and risks associated with the service offers, the value that MROs can provide is mainly limited to a competitive cost position at decent service quality. Additionally, customers value a broad service portfolio and a provider who can understand their specific needs.

Reduction of Direct Maintenance Costs As previously described, airlines face heavy pressure to reduce their cost base every year, to combat the annual yield decrease of tickets. Options for lowering an airline's direct operating costs (DOC) are minimal, since the primary cost factors fuel, taxes, and fees, e.g., for landing or air traffic control are non-negotiable. The airline's direct maintenance costs (DMCs), are one of the few negotiable elements of DOC and accumulate to the considerable proportion of between 15-18% (Berger, 2014).[41] The importance of maintenance costs for airlines becomes evident, considering that it even has been described as one of the two *"major yardsticks of airline and civil aircraft performance"* (Knotts, 1999, p. 336).

DMC are typically benchmarked between airlines per flight-hour (FH), flight-cycle (FC), and aircraft (AC). A 2014 IATA benchmark comprising 47 airlines calculated average

[41] Annual airline maintenance spend as a % of total cost fluctuates depending on the timing of major visits (e.g., heavy airframe checks & engine overhauls), fleet age, size, mix and composition and changes in the fuel price.

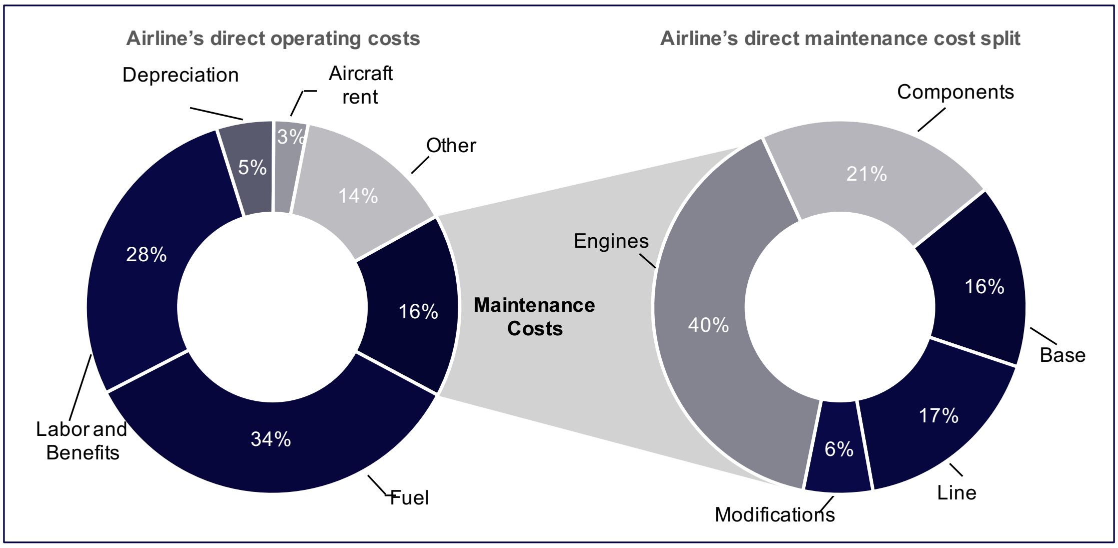


Figure 4.16: Airline Direct Operating and Maintenance Cost Split (own illustration based on Berger, 2014)

DMC of $1,082/FH, $3,518/FC, and $3.06m/AC per year (Cros, 2015).

Maintenance Costs can be split into direct maintenance costs (DMC) and indirect maintenance costs (IMC), which accrue to total maintenance costs at an approximate 50/50 share (see Figure 4.17). In traditional service offerings, MROs can only influence direct maintenance costs, as the airline retains overhead for fleet and asset management functions internally and thus also determines spares and inventory costs.

Broad Portfolio of Basic and Advanced Services Across Aircraft Platforms Airlines seldom contract all necessary MRO services as an integrated package at the point of aircraft sales but prefer individual sourcing of MRO services, when the need arises (interviewees 5, 11, 15, 22, 23, 24). In their MRO sourcing decision, airlines prefer providers with an ample service portfolio, as choosing such a provider allows them to contract additional services at a later point in time with their trusted provider. Manager Product Management MRO 1 explains: *"interestingly, some [airlines] have bought our product keeping in mind that we can do more than just that. And that was a decisive point. As to say, I am buying now from you spare parts provisioning and I buy it from you because you can send an engineering order if necessary or repair my nacelle ... and I can talk to you about Base Maintenance in two, three years."*

Customers with multiple fleets value the MRO's capacity to offer a set of services (e.g., an antenna installation) out of one hand. *"So, the differentiation exists actually in the product portfolio that you offer. Because the biggest value that airlines still see at an established*

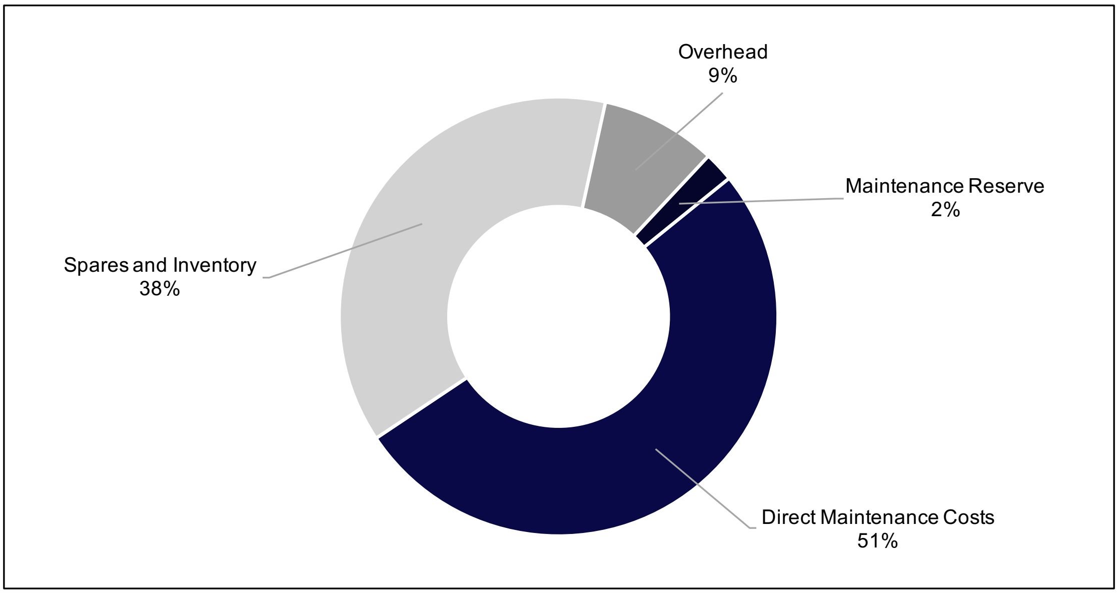


Figure 4.17: Airline's Total Maintenance Cost Split (own illustration based on Cros, 2015)

MRO provider [is] that we first of all offer across aircraft types, since regularly the customer's fleet consists of various types and that we find fast and flexible solutions. Especially regarding engineering." (–Manager Product Management MRO 1).

Thus, providing a broad portfolio of basic and advanced services supporting the product and the client forms an essential part of the MRO value proposition. The service portfolio may include services supporting the whole aircraft life cycle, such as entry-into-service, aircraft modification, and lease return. Also, services supporting the customer, such as engineering, consulting, and support services (e.g., AOG[42] support or warranty management) may be provided.

Service Quality Most definitions of service quality focus on meeting the customers' needs and requirements and how well the service delivered matches the customers' expectations of it (Namukasa, 2013). Customers may judge or evaluate service quality through a comparison between their experiences and expectations over several quality attributes (Grönroos, 2000). Service quality (in the sense of adherence to what is promised or expected from a service offering such as delivery dates) forms an integral part of the MRO's Value Proposition (interviewees 3, 4, 5, 8, 11, 13, 15, 19, 20, 22). However, service quality is rather an enabler of business relationships than a means of competitive differentiation. Hence, it is likely to enable only gaining a small price

[42]AOG: Aircraft on Ground, a situation in which an aircraft is grounded typically for technical reasons (e.g., a faulty component) that requires urgent support by the airline to restore airworthy conditions and resume operations.

premium over more price-competitive offers. Pricing is accordingly perceived as the main differentiator in most of the cases, as Manager Engine Repair Services reports for the engine segment: *"The quality is basically defined, the turn-around-time is defined so that it fits in the timeline of the overhaul. And the topic of pricing, well the one with the cheapest price is awarded"*. The same is reported for Line Maintenance services on outstations by SVP Fleet Management Airline 1: *"you can fly today even into the deepest east and get A320 Line Maintenance any time. That thing is a commodity."*

Airline Perspective Five interviewees named the airline perspective as a vital Value Proposition, best described as: *"we think and act like an airline"* (Team Lead Aircraft Engineering Services). This airline perspective allows MROs to act in the best interest of their customers. For example, the economic viability of Service Bulletins recommended by the manufacturers can be assessed individually for each customer regarding its effects on costs, reliability, and availability. This Value Proposition is especially crucial for smaller airlines that do not have access to MRO data and whose purchasing team can easily underestimate the leverage of certain modifications (Henningsen, 2010). Both, the affiliated airline and operator experience strengthen the airline perspective, as they allow the MRO to deepen its understanding of its customer.

Key Resources

Maintenance Network MRO providers are legally obliged to continuously fulfill the TOP-requirements (Technical, Organizational, Personnel) stipulated by the applicable aviation authority (Hinsch, 2012). To fulfill these requirements, the MRO needs to possess a set of resources and organize them in an appropriate way.[43]

Technical requirements include ensuring a proper working environment, tools, procedures, and material. For example, hangers are to be used to ensure protection from weather and climatic influences as well as to provide proper lighting of the working environment. The MRO needs to make available appropriate, calibrated equipment required for the conducted tasks as stipulated in the respective repair manuals. Also, materials require proper storage, which includes the separation of serviceable and unserviceable materials, and the tracking of the service life of life-limited parts (Hinsch, 2012).

Organizational requirements stipulate that the MRO needs to implement an appropriate organizational structure for the conducted tasks. Additionally, a quality manage-

[43]The legally required resources are not sufficient to make an MRO business model work and do not capture the essence of how MROs conduct business. Hence, the Key Resources presented in this section focus less on detailed legal requirements but aim at capturing the core and often intangible logic of the business.

ment system that ensures that employees perform tasks according to the latest applicable version of documents (e.g., maintenance manuals) needs to be installed. Personnel requirements stipulate that sufficient qualified personnel (e.g., mechanics, engineers, material planners) needs to be available to perform all tasks (Hinsch, 2012). A properly configured enterprise resource planning and maintenance information system can improve efficiency in the management of the complex MRO supply chain (Kashyap, 2012).

The extent, to which this network has to be available on a local, regional, or global scale, differs per maintenance segment. While turn-around checks are performed at virtually every airport in the world by local providers, major internal capabilities for *Line Maintenance* are concentrated at the operator's home base located at the bigger stations or hubs.

Base Maintenance in contrast, requires a hangar, dock and ground support equipment for performing work packages on all sides of the aircraft, nearby shops for the repair or refurbishing of the removed cabin material, lavatories and ample commissioning space for to be installed equipment such as seats or antennas. To limit ferry costs, Base Maintenance hangars are constructed predominantly in countries of each region with the lowest available labor costs, such as Malta for Europe, Puerto Rico for America, or the Philippines for Asia. Widebody aircraft are placed regularly at stations that offer comparatively lower maintenance costs in China or Southeast Asia (Spafford & Rose, 2013), leading to the Asia Pacific being a net exporter of roughly 30% of its supply to North America, Europe, Middle East and Africa (Aeronautical Repair Station Association, 2013).

Engine Maintenance requires a regional to global infrastructure of specialized workshops, since engines are large, high-value assets, inflicting considerable shipping and capital costs. The workshops are typically split to the performed activities such as Disassembly, Assembly, Testing, Engine Parts Repair, or inspection. Europe, Middle East, and Africa supply the largest proportion of the engine overhaul market, with 61% for domestic purposes and 29% export (Aeronautical Repair Station Association, 2013).

Component Maintenance is performed predominantly on a global scale, since most[44] components are inexpensive to ship. MRO providers that rely on a regional infrastructure can however benefit from reduced shipping times and costs and may potentially leverage labor costs advantages. In contrast to workshops, the underlying logistics system (also known as components asset supply system) has to be designed to ensure components availability at the customer's destinations in a short delivery time. Thus, an MRO provider requires worldwide logistics infrastructure such as warehouses and cooperative agreements with logistics providers.

[44]Does not apply for large components such as landing gears and airframe-related components.

Human resources in particular include skilled mechanics and engineers that understand the aircraft's complex systems in varying breadths and depths. As outlined above, sufficient qualified staff is essential for complying with the TOP-requirements and the aeronautical certification of the MRO provider. Also, a professional purchasing organization needs to be considered a Key Resource, as on average 46% of MRO costs result from components and materials that are procured from a highly concentrated supply market.

The qualification of mechanics and engineers differs somewhat per service segment, which is why specific qualification systems need to be developed. While Base Maintenance relies on mechanics specialized on aircraft systems, such as electrical or avionics, mechanics performing Component and Engine Maintenance are specialized on the repair of the respective system. Line Maintenance mechanics require a rather broad and holistic understanding of the aircraft: *"[The mechanics] has to have a holistic understanding of the system, an aircraft is very, very complex. You are on an outstation without great technical support, he has to master electric, master engines, master cabin, hydraulic, emergency equipment, pressure system, he has to be good more or less at everything, and that is the difference to the experts in an overhaul or workshop for components or engines, that's why it is a different job profile"* (SVP Fleet Management Airline 1). Although modern aircraft implement mature and reliable technology that requires less maintenance, qualified technicians are at a shortage. On an international scale, Boeing predicts that repair stations will require 609,000 technicians in the next 20 years for their workforce (Shay, 2015a). For example, in the US 45% of all technical workforce in between 45 and 54 in the year 2011 (Spafford & Rose, 2013). In consequence, MROs are forced to use aggressive hiring techniques to achieve a sufficient number of qualified applicants, especially in Western Europe (Spafford & Rose, 2014).

Engineers are one of the MRO's most important (human) resources, since they are required for most MRO services and play a key role in optimizing costs and TAT of the service offers. In Base Maintenance, for example, engineers plan each event, design all types modifications, issue work orders amongst other tasks. In Engine Maintenance, workscoping, the development of part repair methods, the planning and continuous management of each overhaul event is among their tasks. Depending on the findings, engineers need to develop and certify custom repairs to ensure engine overhaul on time and in budget. In Component Maintenance, engineers develop alternative repair methods, PMAs, and improvements to components.

Operator Experience (OE) is the Key Resource that has received the most robust qualitative empiric support being mentioned by 16 interviewees. I define OE as the tacit experience and data gained by maintenance, repair, or overhaul of an aircraft or its components in operation. Operator experience is essential, as it enables MRO providers to build and improve their repair and engineering capabilities. By gaining OE, the MRO can develop an understanding of the operations of an airline, which enables it to fulfill the airline's needs better. Thus, OE is the prerequisite for the Airline Perspective Value Proposition.

OE is gathered through direct physical contact with the aircraft in operation and can be estimated by the number of flight hours the serviced fleet has completed under contract. Besides, MROs can realize learning curves (Darr et al., 1995) by gaining operator experience, which enable them to increase their efficiency and cost-effectiveness.

Serviced Fleet The serviced fleet (named by seven interviewees) is the number of aircraft or engines of a particular type (e.g., B787, LEAP-1A) an MRO performs services on.[45] Thus, it closely resembles the installed base concept known from servitization literature (Wise & Baumgartner, 1999).

The serviced fleet is one of the most important resources for an MRO due to various reasons: building repair capability for a specific aircraft type requires multi-million initial investments in infrastructure and capabilities that are amortized via a sufficiently-sized customer base during the life cycle of the aircraft. Also, significant economies of scale are present in most MRO segments: Component Maintenance is the most obvious example, due to the pooling effect but also Base and Engine Maintenance require a high capacity utilization that can be achieved only via a sufficiently-sized serviced fleet. Thus, MROs need to make the capability building decision early in the aircraft's life cycle to amortize initial investments by winning the highest possible market share. Besides, the serviced fleet determines the extent to which MROs can build operator experience and strengthen their repair and engineering capabilities.

Financial Strength Aircraft are high-value, complex technological products and systems (CoPS) (Acha et al., 2007) and consequently require considerable *financial resources* of all actors in the supply chain (Esposito, 2004). For example, the development costs carried by the aircraft manufacturers for the B787 and the A350 amount to $20bn each (Aaronson et al., 2016). While financial exposure may be obvious for manufacturers, MROs require sufficient capital to build repair and engineering capabilities on new aircraft technologies, pursuing innovation in new materials, repair technology, digitization, and additive manufacturing, as well as for forming partnerships with OEMs.

Building capabilities to serve new aircraft types require immense financial strength and hence sufficient profitability on current aircraft types, acting as an entry barrier for small and medium enterprises (SMEs). As the CEO of MRO 1 explains: *"if you look how many aircraft you need today, respectively the resulting repairs, to even buy some of the*

[45] In some cases, commonalities between aircraft and engine types are present. The A330 and A340 are a prominent example of high commonalities between aircraft types.

test equipment, to develop [it], or to develop or buy the associated software, you can't do it. I don't know how many of these small mom and pop shops in the US; they make ten part numbers. They can't [stem] an investment of 30 million. They will never earn that."

Tangible and Intangible Manufacturing-specific Resources

MROs need manufacturing-specific resources such as spare parts, test equipment, tooling, and instructions for continuous airworthiness (ICA) to perform MRO services. The most important examples of ICA are the Aircraft Maintenance Manual (AMM), Component Maintenance Manuals (CMMs), the Engine Manual (EM), and the Structure Repair Manual (SRM). These manuals indicate the required actions to be performed to return the aircraft and its components to a serviceable state. MROs are required to perform maintenance, repair, and overhaul services based on these legally binding instructions provided by the design organization (typically the manufacturer) (Hinsch, 2012)

Spare parts are another essential type of manufacturing-specific Key Resource for MROs that constitutes a considerable cost share for MROs. Simultaneously, spares also represent one of the main OEM revenue streams. Prices paid for spare parts by airlines and MRO are significantly higher than the production prices, leading to healthy margins at manufacturers (Vieira & Loures, 2016).

Key Capabilities

MRO providers require a set of operational capabilities to operate their traditional business model and a set of dynamic capabilities to adapt it to changing environments and pursue business model innovation. As dynamic capabilities are required for transforming, not operating a business model, I do not include them into the Key Capabilities section.

Repair and Engineering Capability

The repair and engineering capability is the capacity of the organization to plan, perform, and optimize MRO and modification activities such as Line, Base, Engine, and Component Maintenance. MROs typically provide capability lists, detailing which services are offered per aircraft type. The repair capability is inherent in the organization through certified mechanics, engineers, repair manuals, and knowledge management systems, which are operationalized through the maintenance network.

Repair capabilities are increased through learning curves realized with operator experience, meaning that a mechanic having performed hundreds of repairs of a particular component will be able to repair it more efficiently. Similarly, the organization loses repair capability if it is not used since mechanics need to renew their certification.[46] The extent to which repair capabilities can be transferred from one aircraft or engine type to another depends on the level of commonality between the assets. Commonalities exist not only as previously discussed between airplanes but also between engine types, as a Manager Alliance Function at MRO 1 explains: *"we don't know only one engine, we know many, and we can steal ideas like crazy."*. In summary, MROs with a broad and well-developed set of repair and engineering capabilities are more likely to be able to benefit from spillover effects across different types of equipment.

Multi-vendor Capability This capability is similar to what is known in solution literature as the capacity "to specify and integrate a competitor's technology if the customer demands it or it provides a superior solution." (Davies et al., 2006, p. 42). However, also in traditional service offers, the multi-vendor capability adds value to the MRO's offerings, as it can provide services for different types of fleets operated by the customer. For example, MRO providers can provide repair and engineering service for Airbus, Boeing, and other OEMs' aircraft. Also, they can make use of alternative, more price-competitive materials, while manufacturers rely on their proprietary parts.

Data Processing and Interpretation Capability The data processing and interpretation capability refers to the solution provider's capacity to analyze data resulting from usage of the installed base to develop offerings that allow for productivity gains and cost reductions (Ulaga & Reinartz, 2011). In aerospace, MRO providers require the data processing and interpretation capability to offer additional services such as predictive maintenance and aircraft health monitoring that aim at increasing the performance and cost-efficiency of the aircraft. Access to operational data is a much-debated topic in the aerospace industry (Spafford et al., 2015) and is further elaborated in the competitive advantage section.

Predictive maintenance departs from traditional *preventive maintenance*, where a component is replaced after a pre-set interval and *unscheduled maintenance*, where a part is exchanged upon failure (Hinsch, 2012). When using predictive maintenance methods, MROs rely on data to replace a part before breakdown, avoiding unscheduled maintenance (Spafford et al., 2015). The share of predictive maintenance services is estimated to cut between 15-20% of today's spending on MRO services by 2020 (Spafford et al., 2015), which underlines the importance of this capability. Engine condition monitoring is one example of advanced predictive services that predict maintenance intervals by monitoring different parameters of the engine, such as fuel burn and exhaust gas temperature to ensure that spare parts are available at the destination if required (Pozzi,

[46] Learning curves and the depreciation of knowledge gained through learning-by-doing in service industries has been discussed by (Darr et al., 1995).

2017b).

New aircraft types are capable of measuring, storing and transmitting approximately thirty times more data than their more mature counterparts. For example, a B777 generates less than 1MB of data per flight, while the B787 measures 100,000 aircraft health parameters, creating approximately 28MB of data per flight. In total, the amount of data available will increase 1,100% from 2012 to 2022 from around 11TB to 137TB (Brown, 2015). Simultaneously, blockchain technology may enable a fully verifiable and trustworthy history of asset lifecycles in real time, improving data accuracy and quality (Canaday, 2017a).

These developments increase the importance of data processing and interpretation capabilities to improve aircraft reliability at lower costs. In practice, many MROs such as Lufthansa Technik, ST Aerospace, HAECO, and AAR have started to invest to build these digital capabilities (Shay, 2017b). At the same time, the required platforms that facilitate the interchange of data between the different parties have been established by a variety of MRO software developers, OEMs, and MROs (Shay, 2017c).

Key Partners

Traditionally, MROs typically form some cooperative agreements with other firms, of which some may become Key Partners. A special case are MRO providers that form part of an airline group and thus are affiliated with an airline.

Affiliated Airline For the traditional MRO business model, the affiliated airline represents a Key Partner, as it allows the MRO to develop and test services internally, rely on a serviced fleet, and gain operator experience.

If the affiliated airline is an early customer of a new aircraft type, the MRO can aim at capturing a sufficiently-sized share of the aftermarket which justifies the investment required for capacity building and allows gaining operator experience and economies of scale.[47] The affiliated airline also enables the MRO to enter discussions with other airlines on equal footing and not as a mere supplier or even competitor for their MRO division. Finally, successfully servicing the affiliated fleet makes for a strong sales argument.

This airline-MRO relationship is however not only beneficial for the MRO, but also the airline can benefit strongly from an affiliated MRO provider. One contribution of an

[47] On the other hand, an MRO may also be required to build capabilities for fleets owned by the affiliated airline that do not result in any profitable business.

internal MRO provider is a profitable third-party revenue that can bolster the airline's profits with an on average superior margin. For example, Air France KLM Engineering & Maintenance earned 16.8% of AFI-KLM's revenues, contributing a considerable 22.7% of the operating result in 2016.[48]

Second, the internal MRO provider may achieve more cost-competitive services for the airline by achieving economies of scale with third parties, given that the appropriate costing model is defined. Third, the airline also benefits from reduced dependency on the OEM through increased in-house MRO competency, as the example of an uncontained engine failure of a Trent 900 engine on flight QF32 from London to Sydney shows: *"all operators of the Trent 900 engine had a power-by-the-hour contract with Rolls-Royce. And when the motor blew up [. . .] the market claimed to know how the engine worked. We knew nothing, <u>we knew nothing</u>. And if we wouldn't have built our own knowledge, Rolls-Royce would have <u>pulled us on the nose ring</u> through the technical and commercial arena."* (SVP Fleet Management Airline 1, emphasis added by author).

MROs In the traditional business model of MRO firms, some alliances between MROs exist, albeit on a somewhat peripheral level. One example is explained by a Manager Business Development MRO 8: *"Spairliners is a joint venture between AirFrance/KLM and Lufthansa Technik. The company offers the security of supply [for components and C&Es] not just for small fleets but also for the A380 or E-Jet fleet segments of large airlines. The idea behind this is to reduce cost, increase capability and capture market share."* A cooperation within market segments with small fleets such as the above-mentioned is reasonable since only a significant market share allows the MRO to amortize investments.

Besides these selective collaborations, alliances between MROs are not very common in the Aerospace industry, yet. Whether or not these types of partnerships are a viable response to servitization is discussed in Chapter 6.1.3.

Customer Segments

The main customer segments that can potentially be served by MROs in their traditional business model are the different types of airlines and to some extent lessors. Airlines could be further segmented between commercial, and cargo airlines, private, government, and military clients. The emphasis here is on MRO for commercial operators, special needs of private operators such as VIPs and government-owned aircraft are not considered.

[48]Including internal revenues with Air France KLM. Air France KLM Group: 24,844m€ revenues, 1,049m€ operating margin. E&M Division: 4,182m€ Revenues (of which 1,834m€ (43.9%) third-party business), 238m€ operating margin. Source: Air France KLM (2017).

Airlines Airlines are by far the most important Customer Segment in the traditional MRO business model. As previously discussed, airlines are typically segmented according to their business model, which counter-intuitively has proved little helpful for MROs, as Manager Engine Product Management, MRO 1 explains:

"In our product management, we have clustered the customers for a long time, according to legacy carrier vs. start-up and low-cost carrier. We don't do that anymore, because how do they differ? Supposedly the cost pressure, but then I would say that a DLH would have less cost pressure as possibly an EasyJet. That, I could not confirm now. All have cost pressure. So, we are rather saying, how do they differ in their purchasing behavior? Well, and Emirates has, for example, a huge purchasing organization. If they're up for it, they can buy each screw individually and negotiate the optimum, and then such a big procurement department is worth it. And on the other side, I think it's Wizz Air that says 'I want to negotiate once and then have my peace of mind.' And then they outsource quasi all MRO, or at least all components and engines. And the rest of the world is somewhere in between."(Emphasis added by author).

To determine the specific demands of their customers, MROs also need to consider the characteristics of the fleet in question. When a small fleet is operated, airlines can achieve cost-efficiency by contracting more comprehensive services. New types of aircraft promise greater cost-efficiency but also imply more pronounced risks, which an airline can partly mitigate by performance-based contracting.

Another relevant segmentation criterion emerging with servitization is the OEM-mindedness of airlines, which is their tendency to prefer OEM versus MRO offers. While Airbus and Boeing have been most successful with their service offers in Asia, interviewees point out that some airlines deliberately forego OEM offerings to limit the dependence on the manufacturer.

In conclusion, MROs can segment airline according to their purchasing setup, the fleet in question, and their OEM-mindedness. Besides these aerospace-specific criteria, general market segmentation criteria such as geographical location and growth can be applied to identify markets and customers of interest.

Aircraft Lessees and Lessors Since operators of leased aircraft have special requirements, they are named as a distinct customer segment. Lessees[49] are generally restricted in the usage of PMA parts or alternative repair methods because lessors require the use of original equipment only to maintain the asset value (Broderick, 2014). Lessees are a steadily increasing customer segment for MRO providers, considering that the rate of leased aircraft has risen from 7% in 1985 to 42% in 2015 as Figure 4.18

[49] Operating under long-term finance leasing agreements. For discerning this type of leasing from short-term dry- and wet-lease contracts, which are usually used to overcome shortages in capacity, please refer to (Pompl, 2007; Conrady et al., 2012).

illustrates.

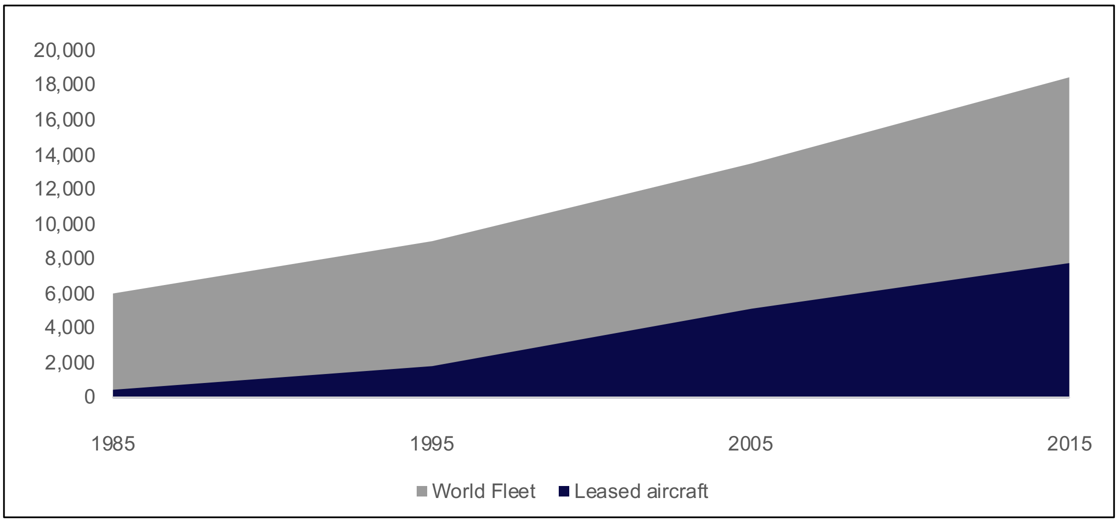


Figure 4.18: Development of World Fleet and Share of Leased Aircraft[50]

Lessees provide MROs with the opportunities to offer specialized services, as they are required to return the aircraft to the lessor in a contractually predefined state. The lessee's main interests lie in (a) leasing the aircraft to the best possible conditions, (b) high aircraft reliability and availability during operations, and (c) a smooth lease return of short duration that inflicts no additional costs.

Lessors, on the other hand, have different but partly overlapping concerns. Their primary interest is maintaining a maximum asset value safeguarded by the usage of OEM parts and MRO services of a certain standard, as this influences the future reliability of the aircraft for the next lessee. Also, lessors require complete and transparent documentation of the components and life-limited parts (LLPs)[51] installed in the aircraft upon lease return. The documentation needs to include all cases of non-compliance with the lease agreement, as well. Just as the airline, lessors should prefer a smooth and on-time lease return to make the aircraft available to the next customer.

Considering these partly overlapping, partly contrary interests, the MRO can aim at establishing itself as a neutral party or an "arbitrator of interests" between Lessor and airline. In that position, the MRO can ensure both asset value and a smooth, transparent, and quick lease return. In this lease return service, the MRO provider handles the lease return of the aircraft, assuming responsibility for all communications, ensuring proper and transparent certification, and the finalization of all required maintenance

[50]Only western-built, non-regional aircraft considered. Source: based on data by FlightAscend Consultancy (2016a).

[51]LLPs are parts that need to be replaced when they have been in service for a defined period which is usually measured in flight hours, flight cycles, or days (Hinsch, 2012).

activities on time (interviewees 23, 24, 26).[52]

Relationships and Channels

Relationships As MRO services are delivered continuously to the client and consist of many interdependent activities, complex customer relationships consisting of multiple channels evolve between airline and MRO (Hsu & Liou, 2013). In these relationships, airlines and MROs need to work as an integrated team, so that the service provider sees and understands the business issues and requirements for the airlines and can find adequate solutions to everyday problems (Jenner, 2009).

Also, interviewees report that the MRO-airline relationship should be long-term and driven by trust, cooperation, and cost-efficiency. Airlines benefit from this type of relationship since they can identify cost savings and efficiency improvements by cooperating with MROs in everyday operations. The interviewed former COO of Cargo Airline 1 remarks that a cooperative relationship will deliver better results: *"If everybody works against each other, we don't get anywhere. If I optimally work together from the airline, via the MRO to the OEM, then I have the chance, not the certainty, but the chance to leverage scale economies really well, achieve high reliability, and let's say, differentiate yourself cost-wise from third parties."*

In general, airlines want to work with reliable MROs that know their business and need little oversight, as the Director Sales of MRO 7 describes: *"The MRO understands exactly what the requirements of the customer are and the airline understands what the MRO needs, and then the job just gets done. There is trust that has been built up over time so that the airline does not have to keep probing the MRO and scrutinizing because the quality speaks for itself"*.

The CEO of MRO 4 believes that the small size of the MRO industry plays a decisive role in determining the relationships are due to the small size of the industry with only a handful of players: *"It is usually a long-term relationship; it is not about the lowest cost. The reason is that there are very few players in the industry. With the large fleet of aircraft, you need to work with your vendors like they are partners. So, it is very important to develop these long-term relationships"*.

Nonetheless, the level of long-term dependency between airlines and MRO providers can be characterized as low in Base, Component, and Engine Maintenance, where airlines need to make only a few idiosyncratic investments and can easily switch suppliers, once a contract ends, given that alternative providers are available in the market

[52] Alternatively, the MRO could also aim at providing consultancy services to especially inexperienced airlines, aiming at optimizing leasing contracts. In this scenario, the MRO would not assume a neutral but rather airline-sided position.

(Al-kaabi et al., 2007a).[53]

Channels MRO providers use a variety of communication and service delivery channels, such as telephone (e.g., an AOG help desk), email, trade fairs, customer service representatives, and interconnected IT systems. The probably most important of these is the key account manager that acts as a single personal point of contact for the MRO's major customers. Due to the high value of the exchange relationships, a personal representative is often present at the customer's site. Depending on the location of service provisioning, the customer may also place a representative at the MRO's site. For example, customers place regularly their own staff at the MRO provider to supervise Base Maintenance events or send a team to inspect the aircraft before handover.

Key Activities

The MRO provider needs to perform a set of Key Activities to make its business model work, which include the offered MRO services, development of alternative parts and repairs, and process optimization.[54]

Providing Operational Services In the traditional MRO Business model, performing the MRO service modules Line, Base, Engine, and Component Maintenance, as well as Aircraft Engineering Services are the most important Key Activities. As these services have been described already in the introduction into the Commercial Aerospace Industry, they are not further elaborated at this point.

Development of Alternative Parts and Repair Methods While design and manufacturing are generally of the manufacturer's domain, the MRO performs a variety of alternative part and repair development activities that belong to this field.

PMAs are parts that are approved by the FAA to comply with airworthiness standards under the Parts Manufacturer Approval. They can be built into an aircraft without any changes in the Type Certificate or Supplemental Type Certificate and allow for cost reductions of typically 20-30% compared to OEM parts (Avia Solutions Group, 2017; IATA, 2015). MROs can either buy or internally develop PMA parts to create an alternative to the OEM's part to lower the costs of their service offers.

[53] For Engine Maintenance, this statement is only valid for legacy aircraft types, where multiple engine OEMs and MROs exist.

[54] General Key Activities as sales and marketing are omitted at this point since they are not specific to the MRO industry or servitization.

DER repairs are non-OEM repair methods that are approved by a Designated Engineering Representative of a Civil Aviation Authority. MROs can develop DER repairs to reduce material costs since repair is often a more economical option than replacement with a new part. Some private DER consulting firms offer a selection of DER repairs, which the MROs can obtain the right to use these repair designs by paying a fee or royalty (IATA, 2015). In cases in which manufacturer-approved repairs exist, DER repairs still may be more economical or improve the life cycle costs of the part in question. According to (Avia Solutions Group, 2017), DERs may offer cost reductions of approximately 7% on an engine overhaul event. Engine Parts repair techniques use additive manufacturing techniques to restore parts such as fan blades to their initial or even improved shape.

Besides lowering cost structure, the increasing barriers raised by manufacturers to support their move downstream act as a driver for MROs to increase design and manufacturing activities through re-engineering of ICA and testing equipment. However, these activities are becoming increasingly complex and challenging to perform due to the use of more electronic and fewer purely mechanical components. Other engineering activities such as the development of PMAs and DER repairs constitute a type of backward integration towards manufacturing and are performed in all service segments aiming at lowering repair costs and increasing parts reliability.

Process Optimization Process optimization is the action of increasing service productivity, i.e., making service processes more effective and efficient (Grönroos & Ojasalo, 2004), for example through the employment of lean methods. Process optimization is capable of improving competitiveness through the reduction of labor costs, improved TATs, and an improved OTP. While it can be considered of general importance in manufacturing and service industries, it is of special interest in the MRO business due to the high complexity of aircraft and their repairs and the global footprint, often involving multiple service stations across the globe.

For manufacturers, a set of widely used productivity concepts and measurements are available. In service industries, however underlying assumptions of these models do not hold (Grönroos & Ojasalo, 2004). In repair services, the state of the system and thus the tasks required to return parts into a serviceable condition are unknown before the inspection of the failed component. Therefore, MRO is less plannable then production and consequently more difficult to optimize. However, preventive and predictive maintenance methods can be employed to prevent unplanned failure with planned maintenance events. These methods are worthwhile pursuing when the costs of planned maintenance are lower than the costs of unexpected equipment failure (Chen & Trivedi, 2005).

Process optimization is effective in all four MRO segments: In Line Maintenance, competitiveness is determined mainly by the capacity utilization and efficiency of labor, which are improved through the optimization of the maintenance schedule and efficient troubleshooting (Henningsen, 2010). In Base Maintenance, efficient processes are of particular importance, since they aim at reducing the man-hours required for an overhaul event, which constitutes 70% of the total costs. In Engine Maintenance, efficient workscoping can be employed to reduce the material, man-hours and time spent on each overhaul event. Lastly, In Component Maintenance, efficient processes influence the TAT required to repair each part. At the focal company, considerable results have been achieved, reducing the TAT to about 30% of its original value. Because unserviceable assets are repaired and returned to the pool faster, the total amount of asset required for the pool could be reduced, considerably lowering capital costs. Just as alternative parts and repair methods, process optimization is a Key Activity aiming at lowering the MRO's cost base.

Cost Structure

The MRO's typical cost structure for service provisioning varies with the type of service provided. While Line and Base Maintenance are mainly labor-driven, Engine Maintenance is driven strongly by material costs. The weighted average results in 48% labor, 46% material and 7% services (see Figure 4.19). The share of labor will likely decrease in the future due to two trends: First, new technology requires fewer maintenance activities at larger maintenance intervals at the expense of typically higher material costs. Second, OEMs increasingly limit the MROs' repair capabilities to favor in-house repair. Therefore, the share of labor will decrease, while material and costs for externally provided services will be of increasing importance.

To reach improved competitiveness in the highly cost-driven airline industry, MROs undertake a variety of tactics to lower their cost position. Regarding labor, *off or near-shoring* of particularly labor-intensive services such as Base Maintenance into low-cost countries is common practice. Thus, Base Maintenance facilities in low-cost countries close to operations such as Malta for Europe, Puerto Rico for America, or the Philippines for Asia are founded (Aeronautical Repair Station Association, 2013; Spafford & Rose, 2013), while established stations such as LHT's facility in Hamburg, Germany are forced to close their gates (Preuß, 2017). These practices are also performed in less labor-intensive segments such as Engine Maintenance, in which manual activities such as disassembly, assembly, and testing are conducted in facilities with low labor rates (Preuß, 2017). Realizing *economies of scale* is a vital lever to achieve lower unit costs. In fact, improved capacity utilization and economies of scale were the initial drivers for airlines to provide MRO services to 3rd party airlines (Henningsen, 2010). Due to the asset intensity of the MRO business, economies of scale are present in each MRO segment. The component pool in which each airline requires fewer assets to supply the fleet with serviceable components is the most obvious example of scale economies.

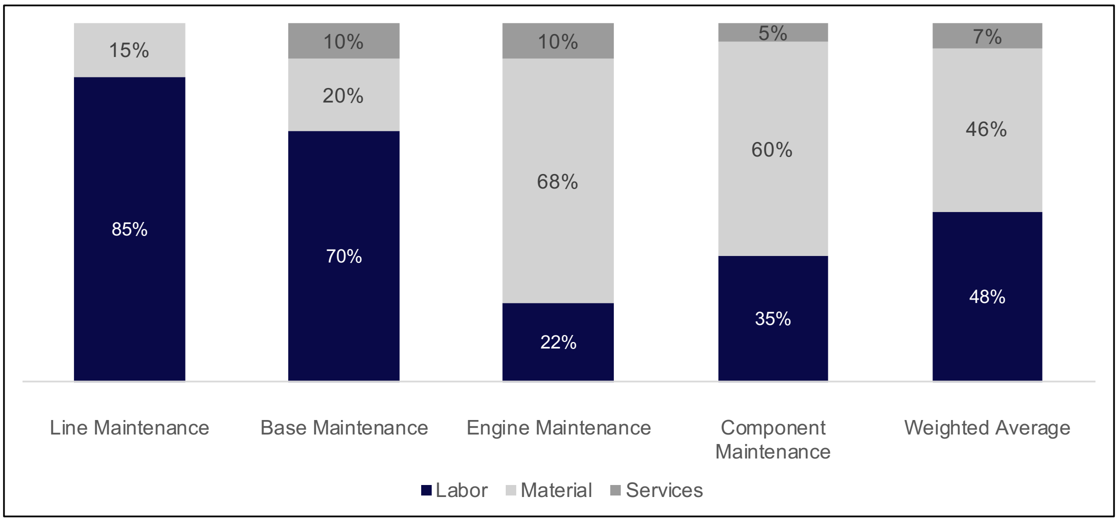


Figure 4.19: Cost Share per MRO Segment (own illustration based on Aeronautical Repair Station Association, 2013; TeamSai, 2014)

However, also Base and Engine Maintenance require a high capacity utilization of maintenance facilities, which can be realized by serving more aircraft with the respective service. Scale economies are also present in engineering services, where many efforts required to perform tasks such as modifications typically arise wholly only once per aircraft type. Thus, providing engineering services for large fleets or fleets with high commonalities is generally considered more cost-efficient. To realize economies of scale, MRO providers aim at contracting large, uniform fleets and achieving a high market share in the respective market segment. The VP Purchasing of MRO 1 gives a vivid testimony: *"The whole MRO business has very strong economies of scale. [...] The larger I am, the more engineering I can do, the more PMAs I can develop, repairs... That leads to a better cost position. And when I can do that, then I can offer a lower price. There is a high possibility that I can earn higher margins compared to others. So, it is not a winner-takes-it-all situation, but there are strong economies of scale that lead to an ever-stronger concentration to big [players]."*

Material constitutes a substantial share (ca. 46%) of MRO costs and an important revenue stream for OEMs who escalate prices yearly on average by 3-5%[55]. MROs can reduce their cost base by developing or using alternatives to the OEM material, such as PMAs, DER repairs, and surplus material.

PMAs allow for considerable cost reductions amounting to 20-30% compared to OEM parts (Avia Solutions Group, 2017; IATA, 2015). Overall, the usage of PMAs is estimated

[55]Interviewees reported that even higher material price escalations of 7% or more are not uncommon. These are decoupled from the development of other price indexes such as labor or material and are commonly employed to improve the profitability of aftermarket programs.

to grow at 4% per year to a total volume of $740m by 2023, especially with a focus on legacy engine parts (Brown, 2014b). *DER repairs* are another viable option to lower repair costs for engines, components or the aircraft itself. The aviation consulting firm Avia Solutions Group (2017) estimates that DER repairs may offer cost reductions of approximately 7% on an engine overhaul event.

Surplus material can be in new or used condition and results from the tear-down of retired aircraft and the sales of spares such as engines, landing gears, and the component pool. Currently, 600 - 700 aircraft are retired each year, which represents approximately 2 - 2.5% of the global fleet and a total market volume of around $3bn (Berger, 2013b). Sources for surplus parts are airlines, lessors, specialized surplus dealers, and aircraft manufacturers that often need to take back their or their competitors' aircraft when an order for new aircraft is placed. Just as PMAs, surplus material can reduce material costs significantly, savings of 50% compared to new parts are common (the price for surplus material depends on supply and demand).

PMAs, DER repairs, and surplus material are especially useful in Engine and Component Maintenance, where more OEM material and less Consumables & Expandables (C&E) are used. The options for MRO providers to use alternative sources to OEM material are however becoming increasingly limited. One driver is the increase in leased aircraft (see Figure 4.18). Since leasing companies typically require the use of only OEM material to maintain the asset value, PMAs cannot be used on the increasing share of leased aircrafts (Broderick, 2014).

A second driver is the growing reliance of manufacturers on aftermarket revenues to sustain their business model. Manufacturers fiercely oppose the use of alternative materials and repair methods, raising concerns of decreased safety and reliability. These concerns are however regularly dispelled by aviation authorities (Avia Solutions Group, 2017). OEMs are actively shaping the surplus market by the foundation of affiliated surplus companies such as Rockwell Collins' Intertrade (Rockwell Collins, 2013). In doing so, OEMs a) participate from the revenue potential of the surplus market and b) actively limit the supply of surplus material for MROs and airlines. The latter tactic is used to increase sales margins on surplus parts and to boosting the high-margin sales of new spare parts (Spafford & Rose, 2014, Manager Procurement MRO 1,). If an MRO aims at allying with the OEM, it is mostly forced to cease the usage of alternatives to OEM material. In compensation, typically MRO and OEM agree upon rebates on OEM material. Thus, it is to be predicted that the use of alternative materials and repair methods will decrease on new aircraft types, limiting competitive options for MRO providers and airlines, while the market for surplus and PMAs will thrive mainly on legacy aircraft types (Cooper, 2017). Once today's new aircraft types enter the second and third life-cycle, it is to be estimated that increasing surplus material will be available. Whether PMAs and DERs can be developed and warrant the required efforts on these aircraft types, remains however subject to speculation.

Revenue Streams

In their traditional business model, MROs earn most revenues on an input so-called "time & material" (t&m) basis. In t&m contracts, the customer agrees to pay for the man-hours and material required to perform the service task (Johnstone et al., 2009). The MRO creates profits through margins on both elements. Also, even this type of basic contracts contains a risk-capping clause that limits the risk of exceeding maintenance costs for the customer.

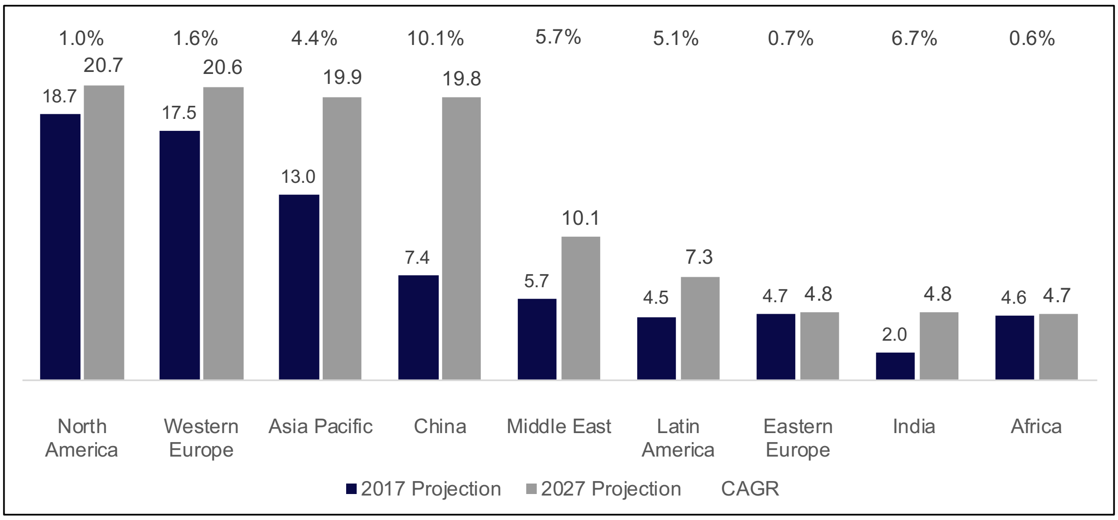


Figure 4.20: Predicted MRO Market Volume in Billion USD and Growth per Region (own illustration based on Cooper, 2017)

The development of commercial air travel induces the growth of the global demand for MRO. Air travel, as typically measured by revenue passenger kilometers (RPKs), increased by approximately 6.2% in 2016 and is projected to grow about 6.0% annually over the next 20 years. The most substantial gains are expected in the regions of Africa, Asia, the Middle East, and Latin America as these regions benefit from increased incomes, open-skies agreements, improved service quality, and additional routes (Cooper, 2017).

These developments induce a healthy growth of the MRO market especially in China (10.1% CAGR), India (6.7% CAGR), Middle East (5.7% CAGR), and Latin America (5.1% CAGR). Since the development on the North American, European, and African Market are expected to be flat with low growth rates, China and Asia Pacific will reach approximately the same market volumes as North America and Western Europe (see Figure 4.20). Growth also varies between the four MRO market segments (see Figure 4.20): Engine Maintenance is expected to have the most substantial growth (4.9% CAGR) due to higher operating temperatures and -pressures which require more expensive materials. The share of component and Line Maintenance is expected to be more or less stable

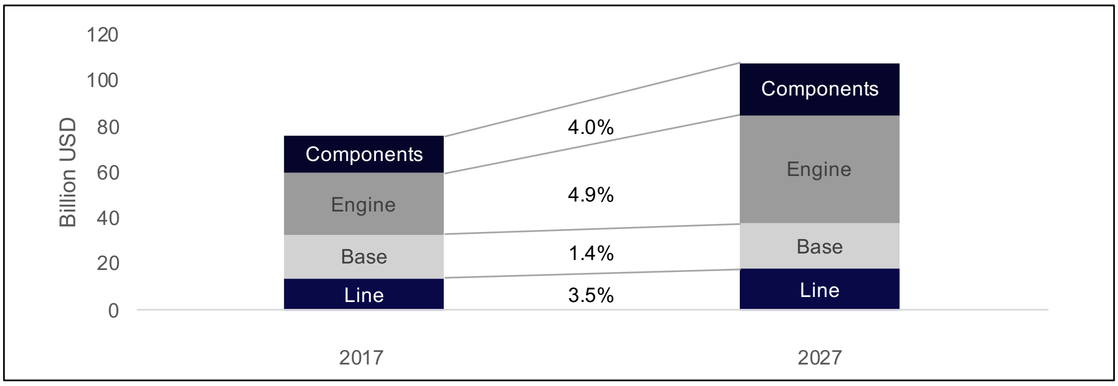


Figure 4.21: Predicted MRO Market Growth in Billion USD and Growth per Segment (own illustration based on Cooper, 2017)

with a CAGR or 4.0% and 3.5%, respectively. The use of carbon fibers on new aircraft types allows for stretching Base Maintenance intervals to twelve years, which restrains growth to 1.4% per year (Cooper, 2017).

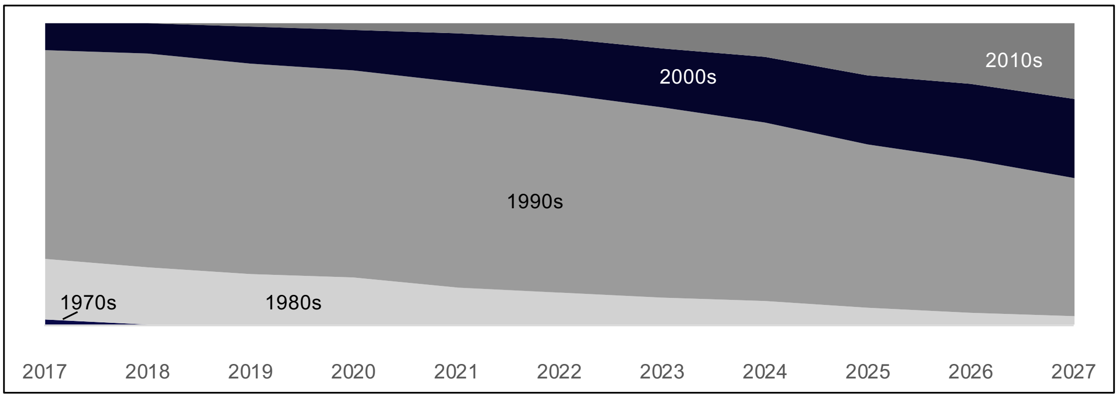


Figure 4.22: Development of Total MRO Spend by Aircraft Vintage[56]

More important than the relatively stable growth rates of the maintenance segments, is the shift of the global fleet towards new aircraft types. The reason is that MRO providers need to invest heavily in building repair capabilities for new technologies, such as carbon fibers for Line and Base Maintenance, new test equipment and licenses for Component Maintenance and the forming of OEM-alliances to remain in the Engine Maintenance market. Oliver Wyman expects that new aircraft types from the 2000s and 2010s will represent 50% of the MRO market in only ten years (see Figure 4.22).

[56]Own illustration based on Cooper (2017). Examples of 2010s aircraft types: A350, A330neo, B787, B777X, A320neo, B737MAX, C-Series; 2000s aircraft types: A380, B777ER, B737-700; 1990s aircraft types: A330, A340, B777.

4.4 Business Model Innovation in the Commercial Aerospace Industry

Just as the commercial aerospace industry has undergone some major changes, so have the business models of their actors, manufacturers, and airlines alike. As MRO firms are placed in the value chain between manufacturers and airlines they are affected by the changes in their suppliers' and customers' business models. In the next sections, each type of actor (airline, airframer, engine manufacturer, and system supplier) and the major changes to their business models are discussed, then interim conclusions regarding effects on the MRO's business models are drawn.

4.4.1 Airlines

Innovation and Convergence of Airline Business Models

Airlines are commonly classified into five different business models: (a) traditional airline or full-service carrier (fully integrated), (b) aviation group (separate business units, such as passenger transport, catering, MRO), (c) Low-cost-carrier[57] (d) charter carrier, and (e) regional carrier (Scott et al., 2005; Doganis, 2010; Daft, 2015; Saxon & Weber, 2017).

The different carrier's attempts to improve profitability through business model innovation have received broad attention both in practice and academia. Especially the entrance of the Low-cost carriers (LCCs) that have severely challenged established carriers with a "virtual airline" business model has been present in academia and public media alike. LCCs offer simple, no-frills services at a significantly lower cost-structure, based on the use of secondary airports, high seat density, and aircraft utilization, a standardized fleet, direct online sales channels, and partly precarious employment conditions for their pilots, cabin-, and ground staff (Klaas & Delfmann, 2005). In this manner, they are able to reduce their unit costs considerably[58] while earning an increasing share of their revenues with ancillary revenues for checked baggage, onboard catering, extra legroom, priority boarding, transportation from and to the airport, hotels, and other revenue sources.

As a result, established network carriers increasingly adapt their business model to lower the price gap towards LCCs, for example by charging for checked baggage. At the same time, LCCs innovate their business model, by including more and more elements of Network Carriers. One example is Ryanair that added connecting flights to

[57] Also called virtual airline or as of lately value carrier.

[58] In 2005, Ryanair's unit costs (CASKs) where 40% and easyJet's 50% of the unit costs of established European Network carriers (Doganis, 2010).

their point-to-point offerings for over 20 routes throughout 2017 and 2018 (O'Halloran, 2017). In consequence, traditional and low-cost airline business models increasingly converge, which may lead to unintended, adverse effects on profitability as airlines may get stuck-in-the-middle in between a price leadership and differentiation strategy (Daft, 2015).

Another imaginative approach is the use of platform-based business models in the aviation industry: The former German flag carrier Lufthansa chose this approach with the foundation of Eurowings, a low-cost platform for its own and former competitors' point-to-point traffic. As thoroughly discussing all types of business model innovations of the different types of airlines is beyond the scope of this book, only the main developments relevant to maintenance, repair, and overhaul are discussed.

Maintenance, Repair, and Overhaul: An Airline Core Capability or Candidate for Outsourcing?

For more than a decade, outsourcing has become a critical business practice for airlines to cope with increasing global price pressure. Many large carriers go through a process of de-integration, contracting-out large parts of their business model in pursuit of greater efficiency and effectiveness (Rieple & Helm, 2008). Maintenance, Repair, and Overhaul is one of the functions affected by this practice as airlines increasingly outsource MRO services to external providers (Brown, 2015). For modern post-regulation airlines, MRO is a function that can range from being an elementary part of their business model up to being outsourced almost completely (McFadden & Worrells, 2012).

Airline MRO Configurations Al-kaabi et al. (2007a) identify different configurations of strategic MRO outsourcing approaches that are typically employed by airlines that are operating different business models (see Figure 4.23 and Table 4.5).

Traditional Airlines and Aviation Groups typically employ the fully integrated configuration, in which all MRO services are provided internally, except for very few or specialized services. This type of airlines has successfully created an in-house maintenance division capable of delivering most MRO services for the passenger transport division as well as third-party customers. Many large legacy carriers have taken the traditional airline business model one step further. By spinning-off their maintenance division to offer MRO services to other airlines, they were able to build diversified aviation groups. For these aviation groups, the MRO function represents a strategic business unit, with internal and external benefits. Internally, the MRO provider can achieve

[59] Author's illustration, based on Al-kaabi et al. (2007a, p. 220). Dashed lines cutting through maintenance segments indicate that these are typically partially outsourced.

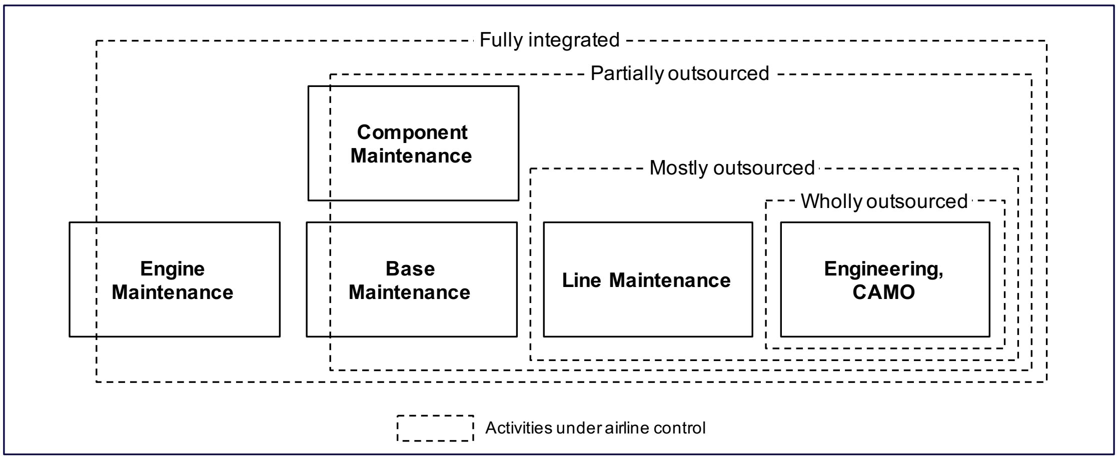


Figure 4.23: Airline MRO Configurations[59]

higher cost-efficiency and economies of scale through complementary business, while the third-party business adds profitable revenues and to the aviation group's business model (Scott et al., 2005; Garg & Deshmukh, 2006; Johnstone et al., 2009; Henningsen, 2010).

Configuration	Fully Integrated	Partly Outsourced	Mostly Outsourced	Wholly Outsourced
Description	• Provides most MRO services internally • Either internal MRO division or independent subsidiary providing services to airline and third-party customers	• Maintain most MRO capability in-house, outsourcing some non-core MRO activity, typically Engine Maintenance • Typically internal MRO division	• Rely mostly on external MRO providers but either retain or insource some MRO capabilities, typically Line Maintenance and Engineering	• Consider MRO as non-core activity and retain only the minimum capabilities required to ensure airworthiness and sourcing of MRO services in-house
Typical Business Model	• Aviation Groups • Traditional Carriers	• Traditional Carriers	• Low-Cost Carriers	• Low-Cost Carriers • Startup-Airlines
Examples	Lufthansa Group: Aviation group with independent internal MRO subsidiary Lufthansa Technik that provides all MRO services for Lufthansa and third-party customers	Delta Airlines: Traditional carrier with internal MRO division Delta Tech Ops that provides approximately half of Delta's MRO demand and caters to third-party customers	EasyJet: Most MRO services outsourced, Line Maintenance partly insourced, retain engineering capabilities in-house	Wizz Air: All MRO services, including engineering and Line Maintenance outsourced

Table 4.5: Airline MRO Configurations

Traditional Airlines often employ the partially outsourced configuration in which they maintain most of their MRO capabilities internally, with some limited outsourcing of MRO services. Typically, Engine Maintenance is the first candidate to be outsourced, followed by Component and then Base Maintenance (Al-kaabi et al., 2007b). Airlines that employ this configuration still provide MRO overcapacity to other airlines to increase utilization of hangars and staff. Delta Airlines can be seen as an airline adhering to this configuration, as it outsourced almost half of its MRO work, including Engine and Line Maintenance (Field, 2005).

The mostly outsourced configuration is typical for Low-Cost Carrier, smaller airlines, and airlines that have successfully transitioned through their start-up phase. These airlines retain Line Maintenance internally due to its high impact on punctuality or insource this function once the sufficient capabilities have been built (Seidenman & Spanovich, 2005). However, anomalies exist: For example, the large US carrier Continental outsources about 60% of its maintenance, aiming at providing the base load in-house and outsourcing the peaks — a policy that allows Continental to keep its experienced mechanics and Key Capabilities in-house (Rieple & Helm, 2008).

The wholly outsourced MRO model is preferred by airlines that consider MRO as a non-core activity or Start-up Carriers that do not possess the required capabilities to perform Line Maintenance and Engineering in-house. While it has been proposed that the wholly outsourced configuration is a common approach for LCCs (e.g., Al-kaabi et al., 2007b), in practice many LCCs retain Line Maintenance internally and thus adhere to the mostly outsourced configuration. EasyJet is a very illustrative example of a typical low-cost carrier. During its start-up phase, easyJet outsourced most of its maintenance activities including Line Maintenance even at its main stations to third-party providers (Keller, 2012), retaining only engineering capabilities internally. When easyJet grew, the engineering and maintenance team grew as well from 7 to 140 people, so the airline set up an internal technical fleet management unit in 2010 to increase control and achieve cost savings (Gubisch, 2013; Wild, 2014). As of today, easyJet still relies on the MRO provider SR Technics to provide substantial proportions of Line and Base Maintenance both in the UK and Switzerland (SR Technics, 2016).

Ryanair chose a similar path, relying first on comprehensive MRO services from the MRO provider Lufthansa Technik (N.N., 2009), which was followed by insourcing and the subsequent extension of maintenance capabilities, also including Base Maintenance up to the C-Check level (Pozzi, 2015). However, other LCCs stick more firmly to the concept of a virtual airline. For example, Wizz Air recently renewed a strategic partnership with Lufthansa Technik as it grew beyond the start-up phase, now operating more than 100 aircraft. In this partnership, LHT provides Wizz Air with comprehensive MRO solutions, including Line Maintenance and Engineering Services such as fleet monitoring (Wizz Air, 2015).

In summary, most start-up airlines rely on Aircraft Solutions in a wholly outsourced setup to benefit from simplicity in operations, plannable maintenance costs and the expertise of established MRO providers. When carriers grow in size, they increasingly insource CAMO, Engineering, and Line Maintenance to internally drive cost-savings and limit dependence on external providers.

The-Make-or-Buy Decision While these strategic outsourcing approaches deliver a general guideline for airlines, technical fleet management departments are confronted with the task to ensure competitive Line, Base, Engine, and Component Maintenance services for their entire fleet, possibly encompassing different aircraft types, vintages, and technology. Managing this task involves the monitoring of the competitiveness of both internal and external service providers and revising the reallocation of services in the case that competitive conditions are not met. Consequently, airlines require a strategic sourcing approach to the make-or-buy decision of MRO services, especially as switching suppliers can have a significant impact on direct operating costs (Bazargan, 2016) and punctuality.

Maintenance Management and strategic sourcing literature informs about different factors that have to be taken into account in the MRO decision: Al-kaabi et al. (2007b) provide a strategic MRO outsourcing framework for Airlines, incorporating the following factors: (a) criticality of service, (b) quantity of internal demand, (c) internal MRO capabilities, (d) production capacity to satisfy the internal demand. Further, the outsourcing decision is also affected by fleet-specific factors such as size, -mix, and percentage of leased aircraft (Al-kaabi et al., 2007b).

This approach is however rather a tactical, short- to mid-term approach, which does not take long-term strategic targets into account. For example, internal engine maintenance capabilities on new engine types are costly to develop internally, which would lead to the decision to outsource this service. However, engine manufacturers may emerge as the only source of these engine services, which would result in their increased bargaining power, making the establishment of alternative sources a preferable scenario (Humphreys et al., 2000; Cox, 2015). Hence, building internal MRO capabilities may lead to a lower total cost of ownership, reduced OEM dependence throughout the lifecycle of the engine, and attractive third-party revenues in this scenario.

Tsang (2002) rightly criticizes the lack of a strategic approach typical for many organizations that still perceive maintenance management rather as an operating expense than a strategic lever to increase business performance. The author recommends outsourcing of MRO services only if they do not represent a core competence of the firm (Hamel & Prahalad, 1990), i.e. (a) result in a competitive edge if performed internally, or (b) result in strategic vulnerability through either a powerful supplier or lack of internal capabilities to manage this supplier. If the external market provides these critical types of services more price-competitive or at a higher performance, it is preferable to drive the internal organization to close the performance gaps to external suppliers than outsourcing the service (Tsang, 2002).

Another driving factor behind the make-or-buy decision is the airline's business model as it determines the present in-house capabilities and implications of the outsourcing decision. Low-cost carriers possess typically little internal MRO capabilities but have instead built capabilities to select and monitor external providers. For them, the make-or-buy decision is not one of out-, but instead of insourcing.

Traditional airlines typically have ample internal MRO capabilities at their disposal, combined with a fleet size and diversity that warrants the internal provisioning of MRO services. Traditional airlines that wish to outsource MRO services need to consider corporate social responsibility aspects if outsourcing cannot be compensated by growth. For example, Delta's move to outsourcing resulted in the threat of 2,000 people losing their employment (Field, 2005).

For aviation groups, the outsourcing decision is very complex due to path dependencies that affect the internally available capabilities and the external competitiveness of the affiliated MRO firm. Hence, outsourcing of a previously in-house conducted service is a strategic decision with considerable long-term implications that need to be taken into account. First, the internal and external business may synergistically produce economies of scale that make the internal provision competitive. In this case, the loss of capacity utilization by the internal customer may have severe implications, rendering even external business uncompetitive. Second, synergies between the different service segments or between different fleets may be more difficult to reap, if certain services are outsourced to external providers. Third, image effects need to be considered in the outsourcing decision, as the affiliated MRO firms may be regarded as uncompetitive by third parties if its aviation group does not rely on its services for a specific fleet or service segment.

For these reasons, an internal provider may be required to make considerable concessions to its aviation group to retain business internally. On the other hand, outsourcing of internally provided MRO services may have adverse effects on the performance of the whole aviation group. Besides, the airline's technical fleet management division is most likely required to build extensive additional procurement capabilities to outsource, monitor, and manage external MRO firms (Bazargan, 2016). For example, the precise description of the elements contracted in the services and KPI to measure costs and performance are paramount to be able to compare different MRO providers. This challenge is amplified if switching from internal to external service provisioning, as separate elements of a service may have been provided complimentary or not even be labeled as a service at all.

In summary, each sourcing decision for aircraft MRO services is a complex decision that can affect airline performance and thus should involve both strategic and tactical considerations on behalf of the technical fleet management team.

MRO Solutions: a Start-up Support or Industry Trend? The general outsourcing trend of MRO services compared to the pre-2000 levels is indisputable (Brown, 2015). Major American carriers have outsourced on average of 64% of their airframe maintenance expenses in 2008, compared to only 37% in 1996 (McFadden & Worrells, 2012). This trend is supported by recent studies that estimate an increasing share of outsourced work in Line Maintenance, Base Maintenance, and Engine Maintenance.

In Line Maintenance, experts estimate that outsourcing will slightly increase from 21% in 2013 to 24% in 2020 (Berger, 2014). In Base Maintenance already higher levels of outsourcing are the norm, as airlines outsource more than half (54%) of their Base Maintenance work (Aeronautical Repair Station Association, 2013). The engine segment displays the highest level of outsourcing, as 80% of all maintenance work is outsourced to either OEMs (55%) or independent MROs (25%), while only 20% is performed internally by airlines (Brown, 2015).

Does this also mean that airlines rely increasingly on comprehensive MRO solutions? Some evidence of this trend exists, as the increasing success of Airbus FHS, with Asian carriers such as Singapore Airlines, Tiger Airways, Asiana, Malaysia Airlines and Vietnam Airlines (Airbus, 2015, 2017c,d,e). Also, larger Airlines such as Wizz Air are reported to divert from the mantra to keep engineering and Line Maintenance in-house but rely increasingly on solution packages, to concentrate on their core competencies (Carpenter & Henderson, 2008; Johnstone et al., 2009; Schneider et al., 2013).

In addition, industry experts report the increasing importance of MRO solutions. For example, Jim Sokol, president of MRO services for Haeco Americas states: *"There is increasing interest in full turnkey MRO packages, and the competition to do this is definitely between the airframe OEMs and the independent MROs. I have seen this within the last few years, as airlines have asked us to offer more complex maintenance services"* (Seidenman & Spanovich, 2016a, p.3-4). Another testimony is given by network carrier SAS' CEO Jurgen Lindegaard: *"Outsourcing in the (maintenance and repair operations) industry will move from a niche management tool to a mainstream, strategic weapon for many firms and as the move to a multi-sourced environment accelerates, outsourcing will become the next new business-critical process"* (Rieple & Helm, 2008, p. 283).

These developments have some implications for MRO firms. First, internal MRO divisions need to strive for competitiveness, as their affiliated carriers increasingly consider the outsourcing option for all non-core MRO services. For these carriers, MROs need to develop specific Value Propositions that differentiate them from external, often more price competitive providers. Second, MROs need to innovate their business model to be able to cater to the demand for those airlines that increasingly demand solution packages, guaranteeing aircraft availability, and reliability at a fixed rate per flight hour. As these type of offers deviate considerably from traditional, input-based MRO services, developing solutions represents an organizational challenge that involves multiple elements of the MRO's business model.

4.4.2 Manufacturers

Historically, aircraft OEMs commonly were vertically highly integrated, to handle the high efforts required for certification. In this setup, aircraft OEMs designed and manufactured airplanes mostly in-house, only a small part of the value creation was outsourced to suppliers, who usually delivered standard parts (MacPherson & Pritchard, 2007). In modern times, this traditional setup has changed drastically, as described in the next two chapters.[60]

The 1990s: Build-to-Print Setup

With the introduction of the A380 in 1990, Airbus introduced the "build-to-print" setup. Besides steady airline cost pressure, four different factors led to the introduction of the new production setup (Esposito & Raffa, 2007):

1. A high technological level of aircraft parts leads to huge potential losses if an erroneous combination of technological and price level is selected. This challenge fostered the selection of specialized partners and the cooperation with airlines to determine the optimal technological level and resulting cost base.

2. A high technological complexity resulting from the combination of different technologies (materials, engines, avionics, etc.) combined with pervasive[61] technologies (electronics, ICT), high required reliability, and cumulative knowledge regarding products. Therefore, firms were obliged to focus their development efforts on small technological areas.

3. High financing needs of estimated $15bn for the development of the A380 made it necessary to minimize the risk of cost increase through the selection of the right partners.

4. Due to the late break-even point (usually 15 years after the beginning of the program) and limited national markets, aircraft manufacturers needed to maximize the number of customers. By selecting international production partner, market barriers were overcome, and consequently, the customer based was amplified.

In the build-to-print setup, Airbus was still responsible for large parts of the design but asked its major suppliers to cover about 25% of the development costs (A.T. Kearney Inc., 2003). To deal with the complexities described above, Airbus created a consortium that was responsible for the manufacturing process (see Figure 4.24). The consortium

[60]For further reading: Scott et al. (2005) provide an in-depth analysis of aerospace business models.
[61]Pervasive refers to technologies migrating from outside areas (e.g., consumer electronics) into the aerospace industry.

was built of the four companies EADS-SPAIN, EADS-FRANCE, EADS-GERMANY, and BAE Systems. While EADS-FRANCE led the consortium and carried out the final assembly, the other members were responsible for one part of the production line. In their responsibility, they could decide whether to manufacture parts in-house or subcontract them to other suppliers.

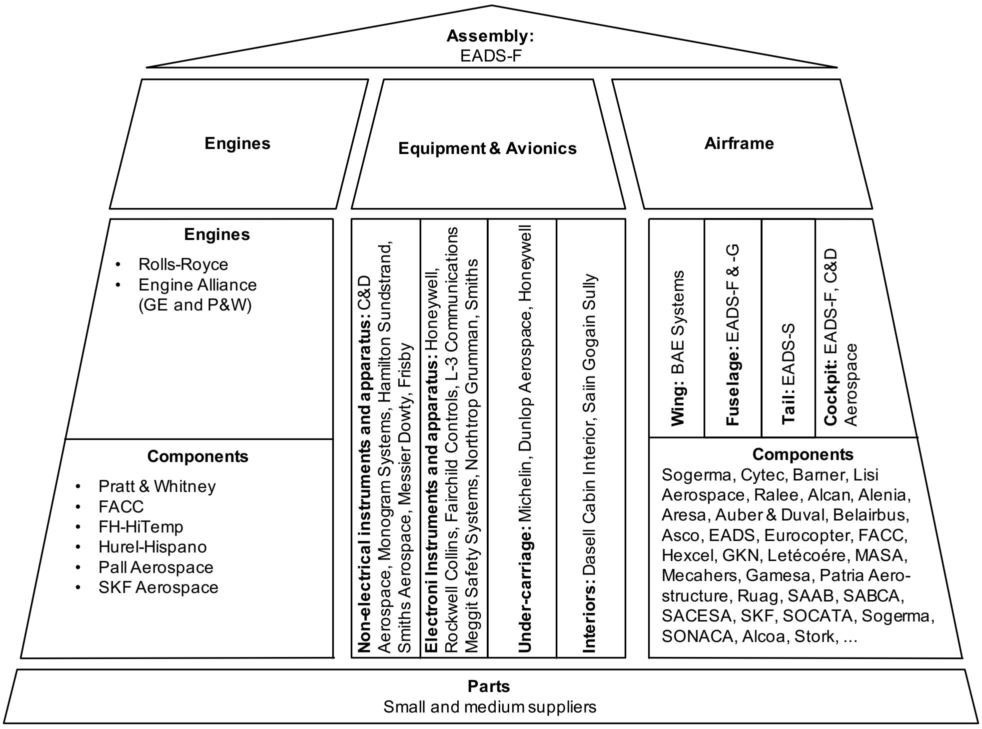


Figure 4.24: Airbus A380 Production Pyramid (Source: Esposito & Raffa, 2007, p. 177)

The result of this setup is a complex network of relationships in the supply chain, comprising strategic alliances between the first level firms and buyer-supplier relationships between the other levels. These strategic alliances create the above-mentioned benefits for the OEM; however, they also lead to an increase in dependency towards his partners and enables former lower tier suppliers to move up the supply chain and potentially compete against him in the future. As a result, complex relationships between the leading companies in the aerospace supply chain in which cooperation and competition co-exist have developed (Esposito & Raffa, 2007).

The 2000s: Risk-and-Revenue-Sharing Partnerships

On modern aircraft as the A350 or the B787, the aircraft manufacturers have continued the outsourcing trend, changing the contractual terms of longstanding buyer-supplier relationships towards Risk-and-Revenue-Sharing Partnerships (RRSPs). This practice has at least partly been induced by airlines that, under steady cost pressure from LCC and high competition, demand more fuel and cost-effective aircraft (Rossetti & Choi, 2008; Krol, 2011). Rose-Anderssen et al. (2015) state as additional factors that aircraft manufacturers realized that they needed to involve their supply chain to advance from incremental to radical improvements, satisfy customer demand, and gain a competitive advantage. These factors seem to be in line with the findings of Esposito & Raffa (2007) that initially led to the creation of the build-to-print setup.

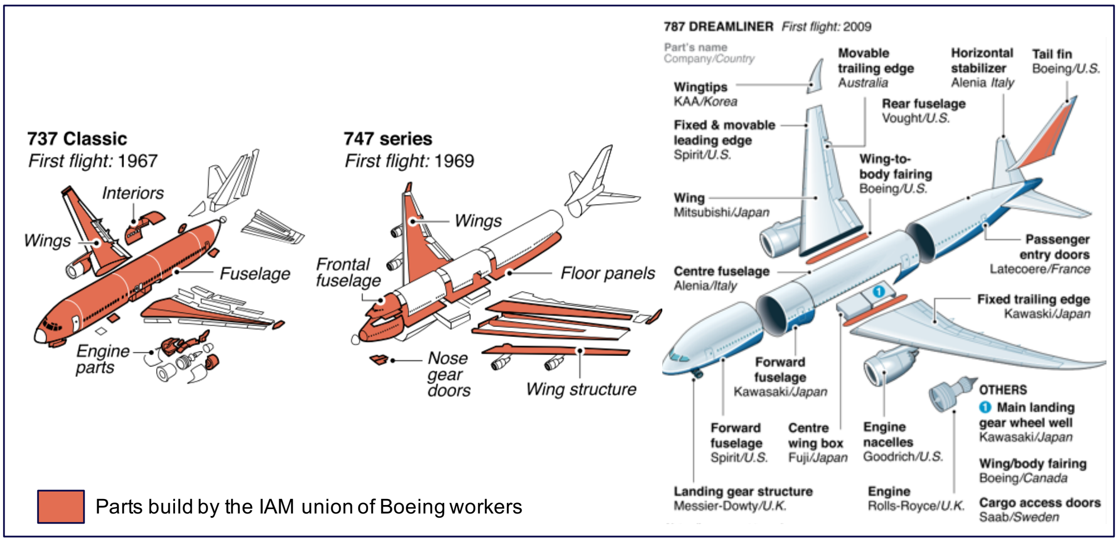


Figure 4.25: Boeing's Shift towards RRSPs (adapted from Peterson, 2011)

In RRSPs, the aircraft OEM takes a system integrator approach (Davies et al., 2007), defining requirements for structure, systems, and cabin of the aircraft, while subcontracting large component groups to his tier 1 suppliers. Full control is given to the suppliers for their component group and the administration of the necessary value network. They carry all the cost for the development, sourcing, manufacturing, and assembly of systems (e.g., pilot control system) and sub-assemblies (e.g., forward fuselage) and bear the risks associated with the development, testing and certification, production, and sales of the component. As compensation, payment is conducted according to the share of value-added to the aircraft once operational. Additionally, the intellectual property rights from the system development are granted by the aircraft OEM to remain with the supplier (Horng, 2007). Since the start of this process in the 90s, formerly unthinkable dimensions have been reached, in which up to 80% of the aircraft (as measured by its parts) is developed by suppliers (Krol, 2011; Wallin, 2013b).

Manufacturers have also formed RRSPs for middle-range and short-haul jets. Airbus maintains a dual-source strategy for engines on the A320neo (new engine option) offering the PW1100 by Pratt & Whitney and the LEAP-1A by CFM International (Airbus, 2017a). In the cabin, Airbus reduces complexity by introducing a system called Airbus Catalog Supplier (ACS), in which airlines' interior choice is restricted to pre-certified suppliers. On the B737MAX, Boeing has selected the CFM LEAP-1B as single engine option (Boeing, 2017a), limiting development costs but also airlines' choice and aftermarket competition. On its middle range aircraft C-Series[62], Bombardier is following the strategy to outsource great parts of the value creation to risk-and-revenue-sharing partners. Embraer has established risk-and-revenue-sharing-partnerships with its suppliers for the short haul E-Jet 1 Family. In both cases, RRSPs become single-sources of equipment, limiting aftermarket competition the engine, avionics, and many aircraft systems (Krol, 2011).

Risk-and-revenue-sharing partners are selected by aircraft OEMs on a global scale, leading to a globalization of the aerospace supply chain. A good example is the B787 in which suppliers from Japan have been selected for parts of the final assembly, the full wing, landing gear production, and various components (see Figure 4.25). Outsourcing has transferred research, development, and production together with jobs and knowledge from the aircraft manufacturer to its suppliers. Tacit, industry-specific knowledge transferred and further developed by the international suppliers will enable new, partly government-funded players to enter the market. One example is Mitsubishi Heavy Industries which is running an R&D program partially funded by the government aiming to introduce its first regional Jet the MRJ in 2020 at the time of writing (MacPherson & Pritchard, 2007; Perret, 2015b; Rexroth, 2018). Outsourcing practices and the downturn in US aerospace sector has let to severe job losses in the US, where jobs in the aerospace products and parts manufacturing industry (NAICS 33640) were almost cut in half from 840,000 in 1990 to 490,000 in 2014 (Bureau of Labor Statistics, 2014).

Similar to aircraft manufacturers, engine OEMs are facing the same challenges of high complexity and development costs that are associated with engine development. Consequently, they also employ RRSPs outsourcing an estimated 30% to 70% of value creation to their suppliers (Hygate, 2013a). Currently, aircraft OEMs start reversing RRSPs through insourcing of high-value components and multi-sourcing strategies to improve their bargaining power in the supply chain and profitability at the time of writing (Aaronson et al., 2016).

Today: Servitization

Today, OEMs have moved downstream into service provisioning, offering comprehensive service and solution to airline customers. Drivers that have spurred the OEMs include increased price pressure, technological maturity, increased product life-cycles, customer demand, and the predicted $100bn annual revenue potential of the MRO mar-

[62]The C-Series has been re-named into A220 after Airbus' takeover of the program (Eislein, 2018).

ket in 2025 (Schneider et al., 2013; Spafford & Rose, 2014; Spafford et al., 2015).

As Figure 4.26 illustrates, engine manufacturers have been the most successful in increasing their service revenues, being followed by system OEMs, while aircraft manufacturers trail behind.

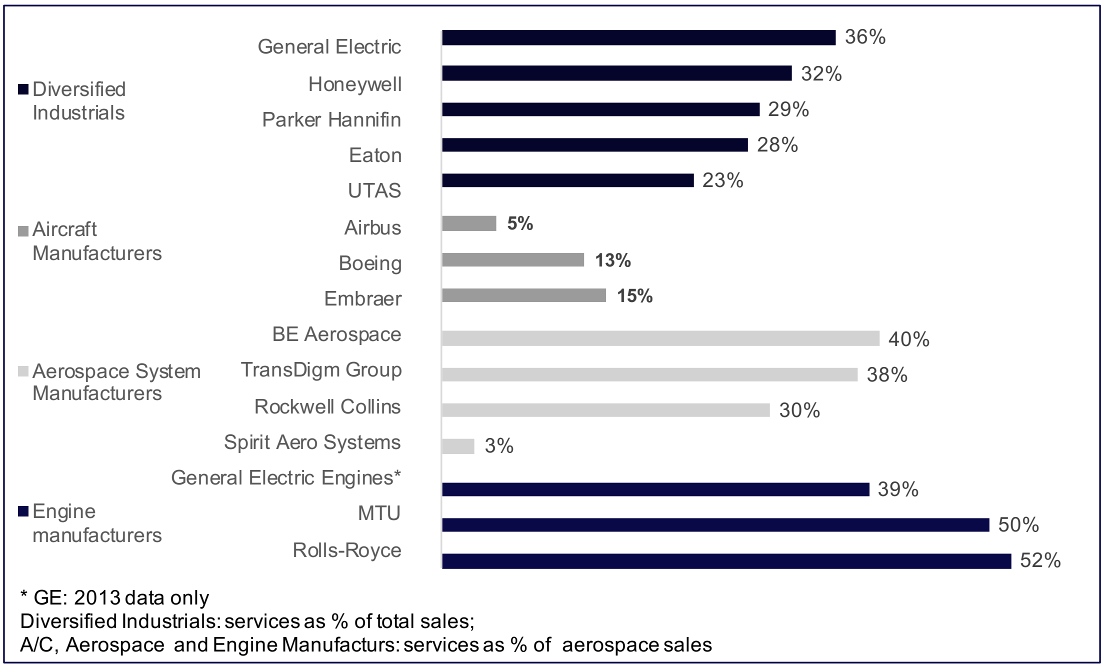


Figure 4.26: Share of Aftermarket Revenues of Aerospace and Diversified Industrial OEMs[63]

The entry of the manufacturers in the service market represents a dramatic environmental shift for incumbent MRO firms, that have been operating in the service market for many years. Usually, the MRO industry is characterized by low environmental dynamism — long product lifecycles, few market entries and exits, and high safety regulations, slowing down technological innovation. Now, MRO firms are attacked by the OEMs, equipped with unique resources and capabilities resulting from their manufacturing background (Ulaga & Reinartz, 2011), leading "merciless price wars" (Schneider et al., 2013, p. 297). While Airlines may profit in the short term through competitive pricing in some market segments, they have repeatedly addressed their concerns regarding possible monopolization of the MRO market, and the inflicted cost increase (Tanaka et al., 2003; Gubisch, 2011a; IATA, 2012). The following sections portray each type of manufacturer (aircraft-, system-, and engine), their employed business model and servitization practices individually.

[63]Illustrational selection. Year of company figures varies between 2013 to 2016. Aftermarket revenues include revenues from spare parts and service offerings. Source: N.N. (2014b); Herbert & Morales (2016); Pozzi (2016); Seidenman & Spanovich (2016a).

Engine Manufacturers Engine manufacturers were both the first and the most effective of the aerospace companies to capture the service market with their service offerings. While on legacy engines, manufacturers held around 30% of the service market, they are expected to gain between 65% and over 90% of all maintenance contracts on new engine types (see Figure 4.27) with Engine Solution offers.

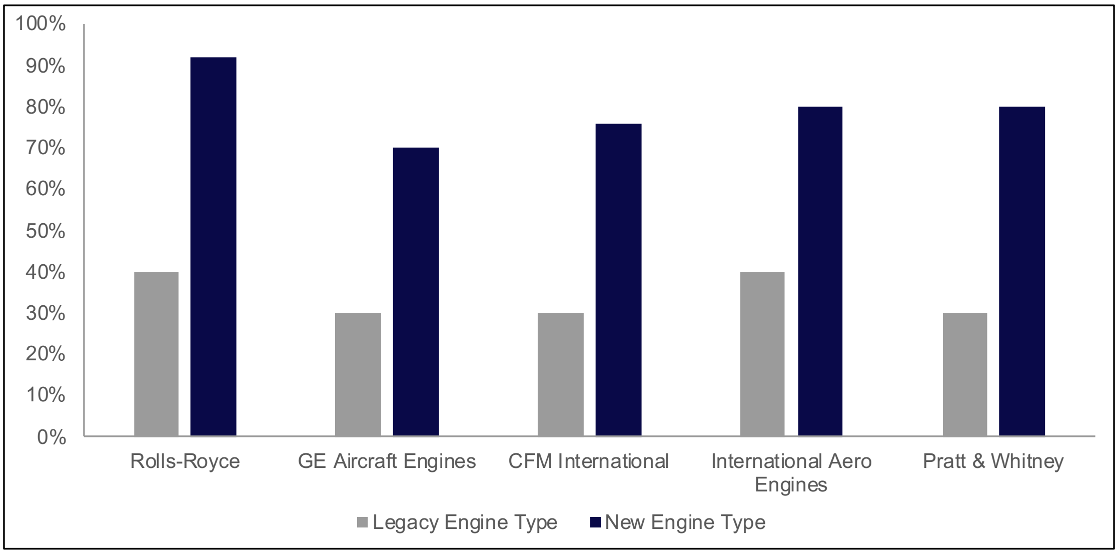


Figure 4.27: Market Share of Engine Manufacturers on Legacy and New Engine Types[64]

Additionally, servitization by the engine manufacturer Rolls-Royce has been well-documented in servitization literature (e.g., Scott et al., 2005; Baines et al., 2007; Johnstone et al., 2009; Ng et al., 2012). For these reasons, the engine manufacturers' servitization practices are introduced first and in most detail, followed by the airframers' and system suppliers' servitization practices.

The (even for the aerospace industry) high investment needs, long development cycles, and the high level of competition (Schneider et al., 2013) act as *antecedents* of the engine manufacturers' move towards hybrid value provisioning: the engine manufacturers require high investments for the development of an engine, which typically spans several years. This period of engine development takes place under high uncertainty of success of the developed engine type: first, engine manufacturers need to endure extreme competition to become the engine provider on a new aircraft type, as the battle between CFM and Pratt & Whitney overpowering the A320neo shows (Trimble, 2013). Second, the newly developed aircraft type needs to be commercially successful to ensure the amortization of the incurred investment. Third, the developed engine needs to be sufficiently competitive for operators to select this engine option, given the case that various engine options exist. In consequence, amortization periods for commercial

[64]Source: own illustration, based on Bourke (2018).

engine programs of 15 - 25 years are not uncommon (Lazonick & Prencipe, 2002; Derber et al., 2014).

These factors lead to a level of competition at the point of sale of the engine, that results in a sales price at or below production costs, while development costs need to be amortized through revenue in the aftermarket. To gain aftermarket revenues, the manufacturer has two main choices: (a) to increase sales margins on spare parts, or (b) to seek profitable growth through service revenues.

In the past, engine OEMs have chosen to limit their business model to manufacturing and providing spare parts. This choice seems reasonable since the engine OEM does not need to build a competitive offer, the required repair capabilities and take over risks inherent in the operation of the engine. However, MRO providers have made use of alternative sources such as PMA and surplus material and the development of alternative repair methods, in an attempt to lower the costs of engine overhauls for their customers. Consequently, the engine OEM needed to either take measures to increase their material-driven aftermarket profits or enter the service market themselves. Hence, the MRO's efforts to lower maintenance costs need to be considered as an antecedent to servitization of the engine manufacturers' business model, as these were deprived of a reliable source of income in the aftermarket.

To compete with services, engine manufacturers have implemented some changes to their previous, product-focused business model, illustrated in Figure 4.28. Through servitization, engine manufacturers can gain additional service *Revenue Streams* that complement the irregular revenues from initial sales of the engine. The "Power-by-the-hour" concept launched by Rolls-Royce in 1997 serves today as a boilerplate for the other engine manufacturers that sell engine maintenance services based on the flight-hours the engine is in operation. In this offering, the airline pays a fee per flight hour it is used, while Rolls-Royce is responsible for all maintenance tasks throughout the engine's lifecycle (Baines & Lightfoot, 2013). In practice, this offer is referred to as "flatrate", as no exceeding costs of the engine overhaul event need to be carried by the airline. For the manufacturer, this arrangement leads to a steady revenue flow when the engine is in operation, avoiding the previous cyclical revenue flows that were associated with the sales of an engine (Baines et al., 2007; Johnstone et al., 2009). Through servitization, service revenues have already increased to the considerable proportions of 40% or even over 50% of total revenues for all engine manufacturers.

In spite of the high level of competition between and the resulting price pressure for engine manufacturers, the relationship with airframers has evolved towards an increasingly integrated partnership. While historically engines were developed in isolation from the airframe, the development has become mostly incorporated into the development of the airframe. The main reason is that engines are the major driver of air-

[65] Source: own illustration. MTOW: maximum takeoff weight.

Key Partners	Key Activities	Value Proposition	Customer Relationship	Customer Segments
• Airframer: engine is main driver for aircraft performance and economics ▼ • *Worldwide maintenance network: MRO Joint Ventures and co-operations* • *Risk-and-Revenue-sharing Partners for engine development and manufacturing*	• Engine R&D • Production ▼ • Outsourcing of R&D and production to RRSPs • *Engine MRO throughout Lifecycle* • *Management of MRO Network*	Product-based: • Determines MTOW, distance, & fuel consumption of aircraft • Spare Parts, Manuals for Engine Maintenance • Limited time & material-based service contracts ▼ *Service-based:* • *Engine Availability on a pay-per-use basis* • *Tailored to individual demands of both airlines and lessors*	• Rather transactional throughout the life cycle of the engine ▼ • *More intense collaborative relationship (OEM's decisions affect airlines' operations)*	Engine: • Airframer: determines engine options for new aircraft program • Airlines & Leasing Companies: select between available engine options Spares: • Airlines • MROs ▼ *Services:* • *Airlines* • *Lessors*
	Key Resources		**Channels**	
	• Engine Development and Production Cap. • Technological expertise • Production facilities & staff ▼ • *Service Capability, -culture and -network* • *Risk Management Capability*		• Aircraft serves as sales channel to airlines • Direct negotiation with airlines at point of aircraft sales ▼ • *Direct channel to airline in service phase*	

Cost Structure	Revenue Streams
• Engine research & development costs • Engine manufacturing costs • Spare parts manufacturing costs ▼ • *Costs for service organization (mechanics, facilities, capital)*	• Engine Sales • Spare Parts Sales • Limited time & material-based services ▼ • *Usage-based engine services (40% to > 50% of total revenues)* • *License Fees*

Figure 4.28: Engine Manufacturers' Innovation towards a Service-led Business Model[65]

craft performance and economics. By integrating the power plant design into the airframe conceptualization, airframers can maximize the benefits of the new technology and increase the performance gap of the aircraft against its predecessors (Scott et al., 2005). Similar to the aircraft manufacturers' RRSPs, engine manufacturers increasingly outsource engine manufacturing to their suppliers. For example, Rolls-Royce has outsourced 70% of its value creation to its supply chain by 2011 in the programs "Advance 2" and "Advance 3"(Bandle, 2013).

Long-lasting service contracts, individually tailored solutions, and the increased responsibility for customers' processes allow the engine manufacturers to build deeper *Relationships* with the customer. For example, the removal of the engine is determined by the manufacturer, which has direct implications for operations and thus requires intensive coordination. One important aspect is the alignment of interests between engine OEM and customers in solution offers. In contrast to traditional time & material offers, both engine OEM and airlines are interested in achieving maximum availability of the engine, while minimizing maintenance costs (Johnstone et al., 2009).

To successfully build service-specific *Resources and Capabilities*, engine manufacturers have added global service networks to their manufacturing footprint that are operated partly internally, partly in cooperation with MROs and partly by MROs only. For example, Rolls-Royce has established an extensive international network of service stations, including 25 component repair stations, 140 engines repair stations and 11 pure service locations (Rolls-Royce, 2017). Also, developing a service culture, service-specific capabilities, and resources have been highlighted as a challenge not only for manufacturing companies in general but also for engine manufacturers specifically. Two examples are the establishment of a 24-hour available aircraft-on-ground (AOG) support center and the change of the engineering-/product-focused corporate culture towards services (Johnstone et al., 2009). *Key Activities* include the management of the production and service network, and additionally the conduction of engine overhauls via the internal MRO shops.

Engine manufacturers rely on traditional MRO firms as *Key Partners* to create their service network and complement their service capabilities. MROs become licensed service partners within the manufacturer's network and provide engine overhaul services on behalf of the OEM or directly to the end customer.

Aircraft Manufacturers For decades, the airframers' suppliers have reaped substantial benefits from the aftermarket, selling spare parts (and more recently services) at healthy margins to operators. Aircraft OEMs have, however, typically not participated in the aftermarket to the same degree, in part because they rely on suppliers to build the majority of parts that require replacement (Aaronson et al., 2016). Another contributing factor is the intense level of competition between Airbus and Boeing that have driven jet prices down, resulting in a level profitability that is significantly lower than the one of their RRSPs (Michaels, 2013).

Even with the introduction of RRSPs and the system integrator setup, aircraft OEMs require enormous financial resources, much higher than their partners, to develop new aircraft. As a BCG analysis shows, Boeing spent about $20bn for the development of the 787, while Spirit AeroSystems, who is responsible for fuselages, nacelles, and wing components, spent "only" about $30 to $40 million for the development of these systems (Aaronson et al., 2016). Since aircraft manufacturers require a steady flow of revenues to offset the initial investment but possess only limited possibilities to profit from the sale of proprietary spare parts due to the RRSP setup, offering services is a promising way to benefit from the aftermarket potential. In fact, by adding services to their aftermarket portfolio, aircraft manufacturers can tap into a revenue potential that is comparable to their narrow body and wide body manufacturing business (see Figure 4.29).

For these reasons, airframers follow the Engine OEMs' role model in shifting the focus of their business model towards services. The actors in the industry clearly perceive this shift in focus as Manager Procurement MRO 1 underpins: *"With Boeing, you see the tendency very clearly: they do sell aircraft, but rather to earn margins on the aftermarket. So,*

[66] Source: Herbert & Morales (2016), based on Boeing's estimations, aftermarket includes spare parts sales and services, which are both marketed in Boeing's Commercial Aviation Services division.

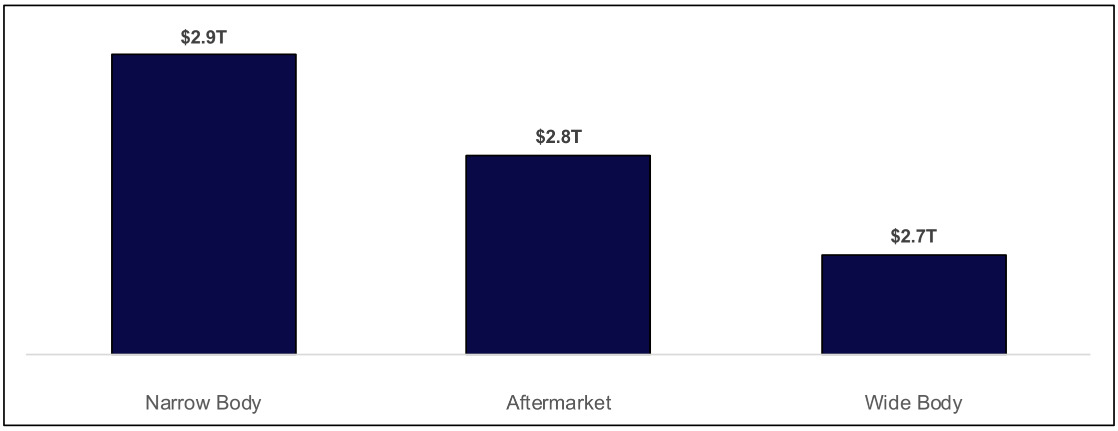


Figure 4.29: Airframers' 20 years Commercial Market Opportunities by Business Segment[66]

it almost seems that the idea with which Boeing is earning money, really gets a different focus and that the aircraft is a means to an end and not the other way around, as it has been for many years."

This process is clearly visible in both Airbus' and Boeing's target setting and organizational adaptions: Boeing founded the Commercial Aviation Services (CAS) business unit in 2010 to provide aftermarket services for Boeing aircraft. The company has formulated the ambitious growth target of increasing service revenues by 300% over the next five to ten years to $50bn, marking a substantial shift towards service provisioning. To achieve this goal, Boeing uses mergers and acquisitions to bolster its service capabilities and evens plans to introduce service offers for Airbus aircraft. Airbus employs a similar organizational configuration, having established the business unit Airbus Customer Services to bundle the responsibility of all commercial service activities. Airbus follows similar very ambitious growth targets for service revenue, aiming at achieving 25% of revenues with services while capturing 75% market share in the service market on the newest types of aircraft (Michaels, 2013; Herbert & Morales, 2016; Anselmo & Norris, 2017; Shay & Anselmo, 2017).

The aircraft manufacturers bundle their service offerings typically under the label of *Aircraft Solutions*. Boeing, for example, provides five main service segments under its CAS division: 24/7 customer support, Parts Solutions, Maintenance and Engineering Solutions, Flight Operations Solutions, and Comprehensive Solutions.[68] According to Boeing, the service capabilities have been extended to the full line of business and com-

[67]Source: own illustration, arrows depict added service-specific business model elements, which are printed in italics. Product-specific business model elements remain part of the business model. N.d.: not disclosed, AC: aircraft.

[68]Interestingly, both Airbus and Boeing have dissolved their initial service offerings Boeing Gold Care and Airbus Flight Hour Services and revamped their service business into Boeing Global Services and Airbus Support Services, respectively (Shay, 2017b).

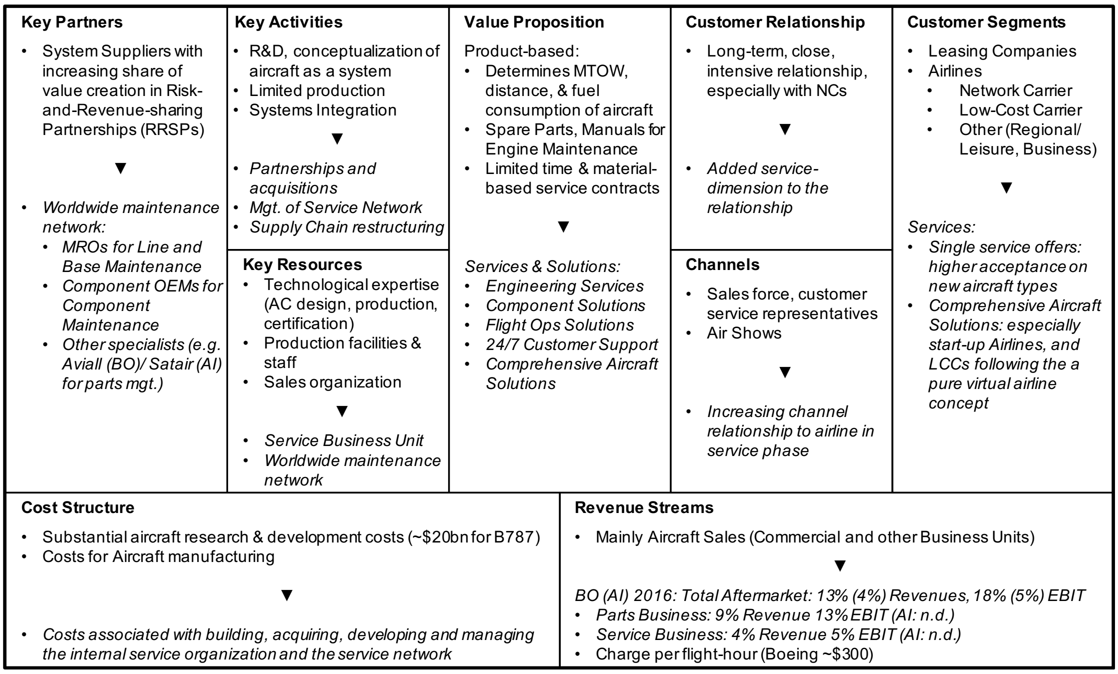


Figure 4.30: Airframers' Innovation towards a Service-led Business Model[67]

mercial jets; however, in practice comprehensive service offers are only contracted for the latest generations of jets (Herbert & Morales, 2016; Boeing, 2017b). Airbus promotes similar offerings under the name Airbus Support Services, encompassing 24/7 services, Maintenance & Engineering, Upgrades, Flight-Ops, Training, and Airport Operations and Technical Support Services (Airbus, 2017c).

The most comprehensive bundle of service offers are Aircraft Solutions. In these, the provider assumes the responsibility to ensure aircraft airworthiness through the definition of a maintenance schedule and maintenance processes that are tailored to the airline's individual needs and standards. Simultaneously, goals for aircraft reliability, availability, and a reduction of operating costs are jointly defined. Aircraft Solutions are typically priced per flight-hour. One example is Embraer's Total Support Package (TSP) that is being developed for the market entry of the regional E-Jet E2. The TSP is a comprehensive maintenance support program that includes material support, asset and repair management, logistics and engineering services, and maintenance activities on a pay-by-the-hour approach (Seidenman & Spanovich, 2016a).

For their commercial aviation business, aircraft manufacturers possess two main *Customer Segments*: Leasing Companies and Airlines. The former are of steadily rising importance, as in 2015, approximately 42% of all Western-built commercial aircraft were leased (FlightAscend Consultancy, 2016b). For lessors, the airplane is a financial asset that generates stable returns; hence their main concern is the residual asset value (Clark, 2007). Airlines can be distinguished into customer segments according to their business models, which determines the type of plane and requirements regarding the product. While traditional Network Carriers perceive aircraft as a vehicle of transporting their brand to the passenger, low-cost carriers instead see it as a commodity that delivers seat kilometers at the lowest possible costs. In general, a shift of airlines towards cost savings (notably fuel and direct operating costs, higher seat density), and less focus on speed and comfort is notable (Berrittella et al., 2007; Airbus, 2017b).

The main Customer Segments, including LCCs and network carriers, do not regularly purchase integrated Aircraft Solutions. Instead, most source single service offers to support their in-house capabilities individually. In contrast, only start-up airlines (Seidenman & Spanovich, 2016a) and a few low-cost carriers that either lack the in-house Engineering and Line Maintenance capabilities or choose a pure virtual airline approach (Doganis, 2010) rely on integrated Aircraft Solutions. Moreover, even for these airlines, relying on the comprehensive airframer solution offer is often a time-limited approach until they have built the required in-house capabilities.[69]

The *Relationship* between airframers and airlines can be characterized as long-term, and intensive with many ties on different hierarchical levels, even without the provisioning of services. The reason is that aircraft are the Key Resource for airlines, which is managed throughout the complete lifecycle: first, Airframers have always maintained close customer relationships, especially with Network Carriers that have been involved in the development of new aircraft types. For example, PanAm has intensely influenced the design of the B747 and Emirates has actively pushed the development of the A380 (Bieger & Agosti, 2005; van Hinte, 2015).

Second, aircraft are not delivered all at once but rather enter service at the airline at a predetermined yearly rate. Airline and manufacturer are in a regular exchange during delivery and the initial warranty period, as claims and concessions are made during the operation of the aircraft. Even after the warranty period, the manufacturer regularly offers upgrades (Service Bulletins and Airworthiness Directives) to increase the safety and performance of the plane. Third, airlines that have relied in the past on one aircraft supplier are likely to renew their fleet again with aircraft from the same supplier, as high switching costs occur between aircraft manufacturers. These switching costs arise through new technology that needs to be mastered, new certification requirements for flight crews and mechanics, and the cultural aspects of working with a different manufacturer and its idiosyncratic company culture and philosophy (Pompl, 2007).

[69]Examples are the Russian regional carrier Nordavia (Pozzi, 2017a), the Hungarian LCC WIZZ, and the Norwegian LCC Norwegian Air Shuttle (Broderick, 2013a; Wizz Air, 2015). WIZZ employs a pure virtual airline approach, relying long-term on the Aircraft Solution offer by Lufthansa Technik. In general, little has been written about which airlines rely long-term on solution offers; however, Krol (2011) states that especially small airlines concentrate on their core business and rely on external partners to deliver increasing parts of maintenance work.

Consequently, it is not untypical for airframers to maintain one or various customer service representatives at the base of larger customers. By adding services, this relationship is further extended, as the manufacturer assumes increasing responsibility for maintenance tasks. Whether this increase is significant is however questionable, as a very intense relationship between airframer and airline already exists even without a focus on the service business.

Ever since the introduction of RRSP and service offers, aircraft manufacturers follow a business model that has been described in literature as system integrator (Davies et al., 2007). In this business model, the airframer builds system integration as their central internal capability, while outsourcing significant parts of design, manufacturing and service provisioning to its partners. When choosing the system integrator approach for service provisioning, the manufacturer first builds and the service network through acquisitions and partnerships and then limits itself to the sales, management, and integration of the different service components.

Different *Key Partners* form part of the manufacturers' service network: Component Maintenance services are mostly provided by the system suppliers that manufacture the components, with whom the airframers have established cooperative agreements to support their solution offers (Seidenman & Spanovich, 2016a). Line and Base Maintenance are provided by a network of both airlines and independent MRO service firms, while aircraft manufacturers rely mostly on their internal engineering division for the provisioning of engineering services.

Boeing, for example, maintains a service network consisting of Magnetic MRO, Monarch Aircraft Engineering, British Airways Engineering, and Norwegian Air Shuttle as Line and Base Maintenance providers in Europe (Pozzi, 2017c), servicing customers such as Norwegian Air Shuttle and LOT Polish Airlines (Gubisch, 2012). Airbus follows a similar approach with the formation of its MRO network in 2005 (Frank et al., 2010), consisting of partners such as SIA Engineering Company Limited (SIAEC, Singapore Airlines' MRO provider), to provide training and Line Maintenance services for A320, A330, A380, and A350 aircraft.

To increase profits and support aftermarket revenues, Airbus and Boeing are currently restructuring their supply chain from the RRSP setup to what has been called a "Post-Tier 1 Setup" (see Figure 4.31). This program aims to increase profitability by insourcing design and intellectual property rights of major components, such as nacelles, pylons, flight controls, and landing gears, which can then be marketed in the aftermarket. These components are then produced in a build-to-print setup according to the airframer's specifications by smaller tier 2 suppliers (Michaels, 2017d).

Aircraft manufacturers possess an extensive set of valuable *Key Resources and Capabil-*

[70]Adapted from Michaels (2017d, p. 5).

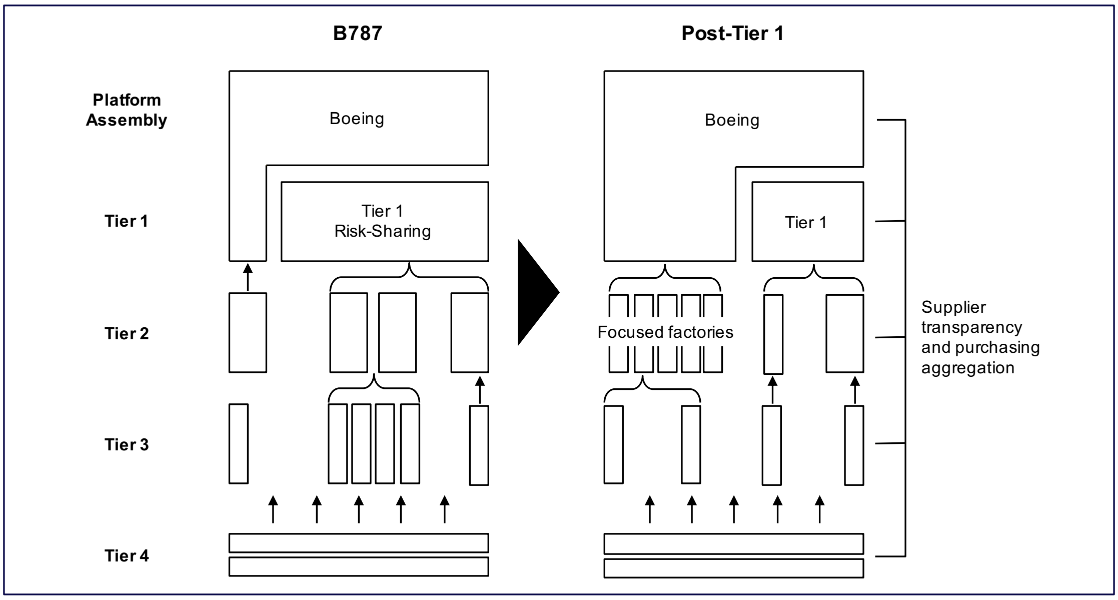


Figure 4.31: RRSPs to Post-Tier 1 Setup[70]

ities due to their size and various fields of activity. Airbus, for example, employed in 2016 approximately 134,000 employees, had 66bn € revenues (of which 50bn € for commercial aircraft), and 11bn € net cash (Airbus, 2017b). Similarly, Boeing has constructed a global presence of more than 160,000 employees in over 60 countries, allocated all over the world and major production facilities in Everett and Renton (both Washington, US) as well as North Charleston (South Carolina, US) (The Boeing Company, 2017).

Intellectual resources, such as aircraft design, production, and certification expertise are another Key Resource that enables aircraft manufacturers to build more competitive airplanes, and represents a significant entry barrier to firms such as COMAC and Mitsubishi that are just launching their first major aircraft programs (Goh & Hepher, 2017). By protecting their intellectual property rights, manufacturers hinder imitation and market this resource through, e.g. license agreements.

Another Key Resource with utmost importance especially for aircraft manufacturers is a large, professional, and effective sales force. The sales force requires very highly developed product sales capabilities, due to the single large volumes of aircraft deals, the high level of rivalry between the manufacturers, and the frequent involvement of governments. This is underlined by the legendary status that Airbus salesman John Leahy has achieved in his career, being nicknamed “Mr. Airbus” and the fact that Airbus’ rise from an underdog to a fierce Boeing competitor is often attributed to his contributions (Tovey, 2017).

Through servitization, additional service-specific sales resources and capabilities are required (Gebauer et al., 2005), which Airbus and Boeing gather under one roof in their dedicated service business units. To serve its approximately 9,300 aircraft under service agreements, operated by about 430 customers, Airbus has created a service network of more than 100 Maintenance and Repair Organizations and employs more than 5,000 internal staff (Airbus, 2017b), which is to be considered as a Key Resource. According to expert estimations, 2,500 staff work internally at Airbus in its service division, of which approximately 200 are dedicated to delivering the integrated solutions offering.

Two *Revenue Models* are defined in Aircraft Solutions: just as in Engine Solutions, a usage-based pricing model is established, in which the airline pays a certain, (hefty) fee per flight-hour the aircraft is used. Typically, additional performance-based pricing models are created, in which the solution provider benefits or is penalized depending on how performance parameters such as reliability and availability are met. In cases in which airlines do not rely on a comprehensive, integrated Aircraft Solution, single services, such as engineering are priced individually. In general, a steady shift of revenues towards China and India is notable, where the market for commercial aircraft is expected to grow 9% annually (Cooper, 2017). Here, especially Airbus is also most successful with its service offerings, as many Asian carriers decide to procure new Airbus aircraft such as the A320neo together with a service package.

To build service capabilities, airframers change their *Cost Structure* through the foundation of their service business units, staff, training, and the establishment of the service network. One common approach to limit the required investments while simultaneously moderate political costs is to form partnerships with local companies: for example, Boeing founded the JV BAPAS together with Singapore Airline's MRO division SIATEC to jointly service Singapore's recent order of 20 B787 in 2014 (Broderick et al., 2014). Simultaneously, acquisitions of aftermarket specialists do require considerable capital. For example, Boeing spent $1.7bn for the parts specialist Aviall, while Airbus acquired the aftermarket distributor Satair for $504m (Airbus, 2011; Holland & Davies, 2014).

While the airframers' move into the aftermarket through spare parts and single service business has been quite successful, the success of integrated solution offers shows mixed results. Boeing's Commercial Aircraft Services (CAS) division generated approximately $8.1bn revenues and approximately $1.1bn operating profit in 2016, representing 13% of Boeing's total sales but over 18% of the segment profits. Boeing is expected to extend the aftermarket business to approximately $10bn in 2020, with 16% margins, extending the total margin share of Boeing's service business to 40%. This places Boeing as the second biggest MRO provider on a revenue basis of the fragmented MRO market with a revenue share of 6.5% (Herbert & Morales, 2016).

However, a closer look is required, as Boeing's aftermarket success is mostly driven by sales of proprietary spare parts (approximately $5.4bn, representing 66% of aftermarket revenues), while the performance of Goldcare and other comprehensive services has been disappointing (approximately $0.5bn in 2016, (Broderick, 2013a; Herbert & Morales, 2016). Since the launch of the GoldCare program in 2005, Boeing was only able to convince Tui Travel for B787 support until the year 2012. It has even been suggested that Tui may have been put under pressure to contract Boeings GoldCare service in order to avoid contract penalties when it canceled ten 787 orders (Dpa-AFX & Ddp, 2009). In conclusion, Boeing is trying to market themselves as a successful service provider by labeling their manufacturing-based spare parts business as "services". Instead, their actual service business accounts for only 4% or revenues and 5% of profits.

Different sources argue that Boeing's limited success may be attributed to the fact that Boeing's solution was too overwhelming ("take-it-or-leave-it"), too expensive at $300 per flight-hour, and did not meet customer needs (N.N., 2012; Herbert & Morales, 2016). Additionally, the lack of the aircraft manufacturer's experience in aircraft operations did not help to increase GoldCare sales. In fact, Boeing's performance has been criticized after the repeated grounding of one the GoldCare customer Norwegian Air Shuttle's aircraft, which lead to the lease of two Airbus A340-300 which incurred costs of $17m (Broderick, 2013a). Problems like these may be the reason for Boeing to have renamed their aftermarket services program into Boeing Global Services as of July 2017 and concentrate on services based on digital analytics (Shay, 2017b).

Airbus trails behind Boeing in aftermarket penetration with only 5% aftermarket revenues in the commercial aircraft BU, accounting for its 13% profits. Just as Boeing, Airbus earns most revenues from its parts business. However, it is generally assumed that Airbus is more successful with its FHS program than Boeing, covering more than 150 aircraft[71] of various, mostly Asian airlines (Ballantyne, 2015; Herbert & Morales, 2016). An example of this is the A350, where Airbus has successfully established itself as one of only three Component Solution providers, competing against the Airline third-party MROs AFI KLM Engineering & Maintenance and Lufthansa Technik (Herbert & Morales, 2016).

In conclusion, it is not entirely clear, whether airframers already have reached complete legitimacy as capable MRO providers. However, it is only a matter of time until they will build the required capabilities to integrate and market their service successfully offers to a sufficiently large customer base, which will in turn further legitimize them as viable providers for aircraft-related services. This estimation is in line with the business analysts at CreditSuisse, that forecast further efficiency gains is an average low-double-digit profitability in 2020 of Airbus' and Boeing's service business (Michaels, 2017a).

For MRO providers, the entry of the manufacturers into the MRO market has various implications. First and foremost, competition is increased, especially in Component Solutions and engineering support. However, opportunities also present themselves for cooperation and competitive differentiation. MROs can gain additional revenues by participating in the airframers'

[71] As of Q1/2015.

service networks, providing MRO services for the airframers' customers. This collaborative option is a difficult choice, as it strengthens the competitor. On the other hand, not all MROs will resist this temptation; hence it is not a question of whether to cooperate but rather to which terms. Second, airline needs are driven by the OEMs offers towards more integrated solutions, encompassing various services, which are tailored to the individual customer needs. Here, established MRO providers can build on their expertise to develop unique value-added services and offerings that enable competitive differentiation versus other MROs and OEMs alike.

System Suppliers As previously described, system OEMs such as Honeywell, UTAS, and Rockwell Collins deliver entire aircraft systems that determine much of the functionality of the aircraft. The development of RRSP with aircraft manufacturers has implied significant changes in the structure of the supply chain, which allowed these formerly smaller suppliers to build their system integration capabilities and grow to become major players in the aerospace supply chain. Through the introduction of RRSPs, these tier 1 suppliers were able to reach a very high share of components on newer aircraft types. Examples are the A350 in which Honeywell provides approximately 40% of the systems or the B787 in which approximately 42% of the components are subcontracted to Hamilton Sundstrand (Gubisch, 2011a). This development represents a substantial change from the B777, where Boeing relied on ten primary tier 1 suppliers, which were reduced to five when developing the B787 (see Figure 4.32).

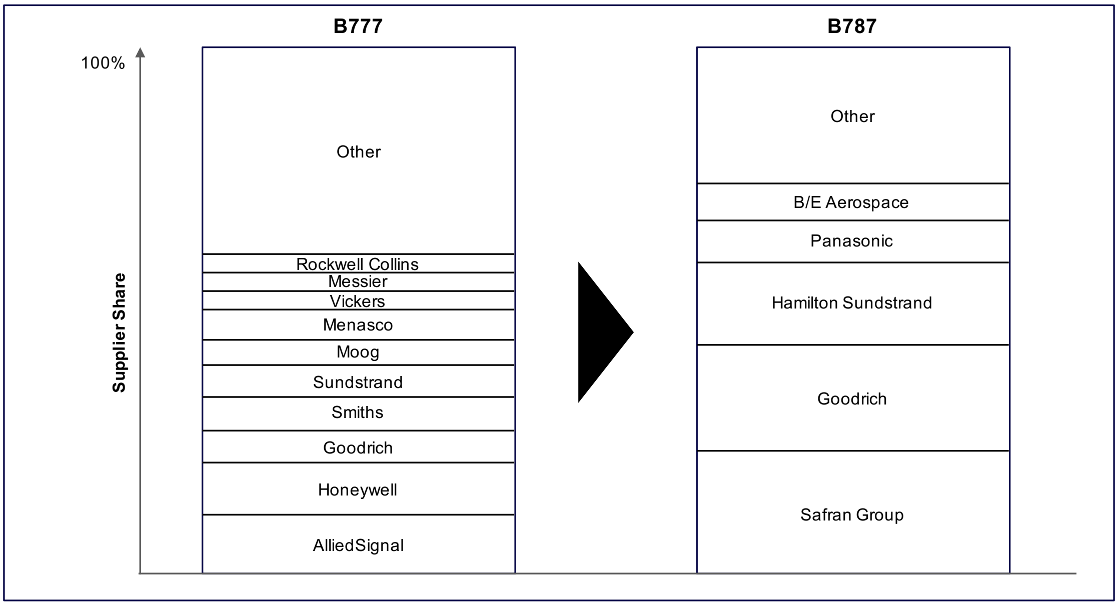


Figure 4.32: Tier 1 Supplier Share (adapted from Berger, 2014, p. 23)

Making use of their position in the supply chain, system suppliers have been able to earn healthy margins, well above their airframer counterparts, primarily through the sales of proprietary spare parts in the aftermarket. Airframers, in contrast, have gained shallow margins, due to the high level of competition in the Airbus-Boeing duopoly which resulted in jet prices little above marginal costs. To "rectify" the situation and achieve double-digit profitability, aircraft manufacturers started squeezing profits from their suppliers with contract re-negotiations, threatening to ban non-cooperative suppliers from future aircraft.[72]

On the newest aircraft types, such as the B777X, aircraft manufacturers have restructured their supply chain even further to the abovementioned Post-Tier 1 Setup (see Figure 4.31). In this new Supply Chain Structure, Boeing aims to increase its profitability through insourcing of design and intellectual property rights of major components, such as nacelles, pylons, flight controls, and landing gear, which can then be marketed in the aftermarket. These components are then produced in a build-to-print setup according to the airframer's specifications by smaller tier 2 suppliers.

However, even this source of revenues is increasingly threatened, as Boeing tries to squeeze profitability out of the supply chain by establishing alternative vendors for RRSPs' materials and insourcing of proprietary technology (Herbert & Morales, 2016).

Key Partners

- Airframer: aircraft systems developed in adherence to airframer's specification
- Tier 2 suppliers develop sub-systems and components

▼

- *Partnership with Airframers providing MRO for the AF's solution offer*
- *Partnerships with MROs that provide aftermarket solutions*
- M&As with other system suppliers and Tier 1 suppliers to extend capabilities and bargaining power in supply chain

Key Activities

- System R&D, Production and Integration

▼

- *Component maintenance*
- *Component pooling (to provide solutions)*
- Merger and Acquisitions of other System Suppliers and Tier 1 suppliers

Key Resources

- System Development and Production Cap.
- Technological expertise
- Financial resources for development of systems

▼

- *System Integration*
- *Service- and Value appropriation capabilities*

Value Proposition

Product-based:
- State-of-the-art aircraft systems
- Spare Parts

▼

Service-based:
- *Component Maintenance*
- *Limited Component Solutions (e.g. APU, Avionics)*

Customer Relationship

- Airframer: limited bargaining power

▼

- *Increased competition with MROs*
- *Establishment of more airline relationships*
- Increased bargaining power vs airframer

Channels

- Channel to airframer
- MROs: channel to aftermarket
- Regularly no channel to airlines

▼

- *Attempts to establish direct airline channels*

Customer Segments

Systems:
- Airframer: determines system supplier for new aircraft program

Spares:
- MROs
- Airframer

▼

Services:
- *MROs*
- *Airframer*
- *Attempt to establish Airlines as direct customer segment for service or pooling contracts*

Cost Structure

- System research, development, manufacturing costs
- Spare parts manufacturing costs

▼

- *Limited costs associated with local service organization*
- Costs for M&A

Revenue Streams

- System Sales to Airframer / Airlines (under price pressure)
- Spare Parts Sales

▼

- *Service Revenues make up to 30% of total revenues*
- *IP fees: licenses, test stands, repair manuals*

Figure 4.33: System Supplier's Innovation towards a Service-led Business Model[73]

[72] Ironically, Boeing named this supplier cost-cutting program "Partnering for Success" (Michaels, 2013, p. 2).

[73] Source: own illustration, arrows depict added service-specific business model elements, which are printed in italics. Product-specific business model elements remain part of the business model. AF: airframer.

The increasing relentless pricing pressure from airframers is antecedent to system suppliers adapting their business model through two main *Key Activities*: (a) increased M&As to bolster their bargaining power and (b) tapping into the lucrative aftermarket for revenues (Michaels, 2013, 2017d).

Some major M&A deals are a clear sign of the former activity, resulting in a consolidation of the aerospace supply chain: When Safran bought Zodiac Aerospace for 8.5bn €, two of Europe's largest Aerospace Suppliers merged into the second-largest component supplier (excluding Engines) in the world. As a result, Safran was able to extend its capabilities from Engine manufacturing and components (through the CFM International Joint Venture), landing gears, nacelles, to seats, cabin equipment, electrical power systems, airframe fuel, oxygen and water, and waste. Combined, the new European super supplier possesses a portfolio spanning the entire aircraft, with positioning similar to UTC Aerospace Systems following its 2012 acquisition of Goodrich (Michaels, 2017b). Another example of system supplier consolidation is the leading avionics specialist Rockwell Collins that acquired the aircraft interior supplier B/E Aerospace for $6.4bn (plus the assumption of $1.9bn of debt), resulting in a broad product portfolio spanning both aircraft systems and -interiors (Michaels, 2017e).

As a result of these mergers, only two or three suppliers are available on most equipment segments, which reduces cutthroat competition between a dispersed supplier base, increases the system suppliers' bargaining power against manufacturers, and bolsters their profits (Michaels, 2017b). Especially component suppliers as UTAS, Honeywell, or Rockwell Collins enjoy monopolies for particular systems, and their products cannot realistically be replaced by a competing product, due to the expensive, complex changes to the aircraft that would be required (Flottau et al., 2017).

System suppliers benefit from the increasing bargaining power, especially when they are selected as the single source for a particular aircraft type. In these situations, they possess monopoly-like bargaining power in the aftermarket, which they use to create healthy profits through the sale of spare parts, charging licensing fees to MROs for component overhaul, or completely insourcing component MRO services.

The resulting *Value Proposition* of this shift in business model entails not only enhanced product but also service components that are offered to both the airframer and increasingly airlines. Honeywell, for example, offers "Maintenance and Service Plans" for its Auxiliary Power Unit (APU)[74] for Boeing Business Jets directly to airline customers. This Solution offering includes maintenance, repair, material management, 24/7 support, and warranty at a fixed rate per flight hour and aims at providing a cost-efficient solution guaranteeing high dispatch reliability (Croft, 2016; Honeywell, 2017). Service-

[74]The APU ensures the aircrafts' supply with electricity and pressured air when the engines are not running, and the aircraft is not connected to ground power. It is one of the aircraft's components with the highest value.

based Value Propositions are also offered to the airframers, as system suppliers support their solution offers with spares and MRO services for their share of components (Seidenman & Spanovich, 2016a).

The System Suppliers' *Key Partners* are Aircraft Manufacturers, newly acquired aerospace suppliers, and in some cases also MRO providers to provide service capabilities for their growing aftermarket revenue. Airbus' and Boeing's aftermarket solutions are backed through collaborative agreements in which these system suppliers have committed themselves to support the airframer's service offers with spares and MRO offers of their own (Seidenman & Spanovich, 2016a).

To some extent, system suppliers also rely on MROs as partners to support them with their specific service capabilities to create successful aftermarket solutions. One particular partnership is the collaboration between Honeywell and Lufthansa Technik in which both providers jointly provide the global largest maintenance capacity for A350 component and APU maintenance (Brecken, 2017).

System suppliers have a vast amount of *Key Resources, and Capabilities* such as employees, technological expertise, and financial resources at their disposal that are required to develop and integrate state-of-the-art aerospace systems, pursue M&A tactics, and finance servitization. Intellectual Property (IP) and the capability to protect and appropriate the value inherent in IP is of critical importance to system suppliers. Using IP, OES pursue three primary tactics to successfully capture aftermarket profits that I call the (a) market dominance, (b) licensing, and (c) alliance tactic.

In the *market dominance tactic*, competition is eradicated by erecting market entry barriers through the required test equipment. Although the OES is legally obliged to provide the test-equipment to MROs due to the PSA stipulated between operator and OES, it can limit the access. To do so, the OES typically sets a prohibitive price that renders the business case for all competitors unprofitable. Additionally, re-engineering of the test-equipment is prevented by the installation of effective encryption technology. By employing this tactic, one avionics supplier on the B787 has achieved a 100% share of the repair service market on its own equipment.

The *licensing tactic* is the establishment of a network of licensed MRO repair stations. In this tactic, the OES erects market entry barriers through discounts on spares in a magnitude that renders all non-licensees uncompetitive. This aftermarket tactic has the advantage for the OES that it is unobjectionable from a legislative, anti-trust point of view and that it can rely on the resources and capabilities of various MROs to provide MRO services. In this setup, aftermarket revenues are generated through license fees, not service revenues.

In the *alliance tactic*, the OES relies on a single MRO to deliver MRO aftermarket support. This approach has the advantage that the system supplier can focus on its core competence manufacturing and still participate in aftermarket revenues. Additionally, it enables decoupling economic success from the consumption of spare parts, which in turn allows for the development of efficient repair methods and lower overall costs. Furthermore, the number of interfaces and complexity of channels to the customer can be reduced by relying on a single partner.

While OES can secure aftermarket revenues by the tactics just discussed, usually it is difficult for them to provide services or solutions directly to operators. The reason is that in a product-led business model, the airframer and MRO providers are the sales channel for equipment and spare parts to the airlines. To successfully provide MRO services to the end customer, OES need to establish direct *Channels* and *Relationships* with airlines (see Figure 4.13).

In general, this is however problematic, as aircraft OEMs and traditional MROs can offer integrated Component Solutions for the entire aircraft type and not only the system supplier's share. Consequently, most operators prefer contracting a Component Solution by one of these integrators rather than making individual repair contracts with a multitude of OES. However, some system suppliers that provide large proportions of the aircraft have been able to secure direct agreements with airlines that possess large fleets and hence have more capacity to manage the aftermarket support of individual spectra of components. For example, AirAsia concluded a maintenance contract directly with the avionics supplier Thales that also offers a pooling offering after placing an enormous order of 304 A320neos (Kjelgaard, 2017b).

System Suppliers incur additional costs especially through extensive M&A activities and to a more limited extent through building service capabilities. The reason is that only a few facilities are required on a global scale, as components are removed from the aircraft for service, easily packed and shipped to these workshops. Additional costs for the extension of service activities arise through establishing the required infrastructure as well as network, employee training, marketing, and mechanics to provide the repair services.

As a result of the increased price pressure and the airframers' attempts to shift the profitability in the supply chain to their favor, system suppliers attempt to earn profitable Revenue Streams with aftermarket spare parts and service offers. Some extraordinarily successful system suppliers are reported to already earn up to 30% of their total sales with services (Seidenman & Spanovich, 2016a). Like other types of aerospace manufacturers, system suppliers offer pricing models according to a usage-based logic per flight-hour as well.

4.5 Interim Conclusions

In the last sections, the commercial aviation industry was introduced with an emphasis on Aircraft Maintenance, Repair, and Overhaul. Aircraft MRO is $75 billion industry that is growing at approximately 3.8% annually on a global scale, with the most active development taking place in Asia. The MRO industry is highly competitive due to the high bargaining power of suppliers and intense rivalry among the existing firms caused by economies of scale inherent in technology- and asset-intensive industries.

Traditional MRO service firms compete in this industry with their traditional MRO business model that I have outlined, using the Business Model Canvas as an analytical tool. As cornerstones of their business model, MROs provide aircraft maintenance, repair, and overhaul services to airlines that can be disaggregated into Line, Base, Engine, and Component Maintenance. The cost-base for these services can be optimized by the use of alternative, non-OEM, parts and the development of alternative repair methods. MROs often engage in long-term trustful relationships that they can achieve through excellent service quality and taking the customer perspective.

As Key Resources and Capabilities, MROs can develop repair and engineering capabilities through learning curves on the serviced fleet, while increasing the span of their maintenance network to provide services on a larger geographical footprint. However, MROs rely on the manufacturers' spare parts and repair manuals which creates one-sided dependency on these players.

Business model innovation in the aerospace industry on both supplier and customer side exerts considerable pressure on the traditional MRO business model. Airlines are the central but least profitable actors of this industry, who operate a global fleet of more than 28,000 aircraft that require MRO services to remain in airworthy conditions. As MRO services constitute approximately 15% of airlines' operating costs and are easier to influence than fuel, salaries, or airport charges, price pressure is passed down to aircraft manufacturers and MRO firms. To cope with this price pressure, airlines increasingly outsource MRO services to professional MRO firms and manufacturers. Some airlines even dispense with the paradigm of keeping Engineering and Line Maintenance internally but rely instead on integrated MRO solutions, requiring guaranteed aircraft availability and reliability at a fixed rate per flight hour.

On the other side of the value chain, aircraft-, engine-, and component manufacturers have added services to their business model aiming to extend their position in the supply chain from being mere suppliers towards being suppliers and competitors at the same time. This phenomenon is caused by the high levels of competition and supply chain dynamics among the different actors in the commercial aerospace supply chain. Aircraft manufacturing has undergone some significant logic changes, supply chain structure and business models from the build-to-print setup in the 1990s, to an increase in outsourcing through risk-and-revenue-sharing-partnerships between airframers and their suppliers and the latest "post-tier 1" area in which significant consolida-

tions in the supply chain lead to the emergence of super system sellers.

Engine manufacturers have led the way in shifting from a goods-dominant to a service-focused logic in their business model, which enabled them to earn stable revenues at healthy margins throughout the life cycle of the engine. Servitization allowed them to escape cut-throat competition at the point of engine sales and finance new engine programs. Aircraft manufacturers and system suppliers have followed this blueprint, by adding services and solution offers to their business model. Servitization in the aerospace industry is on the rise, as increasing levels of service revenues at all types of manufacturers indicate. For the established Maintenance, Repair, and Overhaul Providers competition by the manufacturers constitutes a severe threat but at the same time an opportunity, as they often rely on competent partners for the fulfillment of their service offerings.

Due to the contemporary developments in the commercial aerospace manufacturing and airline industry, MROs are challenged to innovate their business model to cope with these changes and ensure long-term profitability. Two strategic options to innovate the business model are (a) developing solutions to fulfill the increasing demand of airlines and differentiate service offerings against OEMs and (b) forming different types of alliances with manufacturers to ensure competitive survival and jointly provide superior offerings to airlines.

Successfully developing solutions involves changing multiple elements of the MRO's business model, as providing guaranteed aircraft availability and reliability at a fixed rate per flight hour deviates considerably from traditional, input-based cost-plus MRO services. Alliancing with OEMs is no less of a challenge, as OEMs have been stigmatized by MROs as the industry's bogeyman for many years and are now emerging to their new super role of being simultaneously suppliers, competitors, and partners. In the next chapter, we will address what strategic options MROs have at their disposal, how they can implement these options, and in which case which business model innovation path is deemed the most promising.

5
The Cases

Contents

Following up the pilot study, the multiple case study consisting of the Engine, Components, and Aircraft Case was conducted, to explore the different strategic options that MROs can employ to cope with servitization in the aerospace industry.

5.1 The Engine Case

Traditionally, engine overhauls were conducted on a "time and material" basis, in which the customer paid for the time and material required for the refurbishment of the individual engine. This model resulted in high risk of exceeding maintenance costs for airlines, high mark-ups for spare parts and often long lead times (Johnstone et al., 2009).

Rolls-Royce has pioneered engine Solutions under the "Power-by-the-hour" concept that has been introduced in section 4.4.2. However, all engine manufacturers' servitization attempts can be characterized as very successful, as OEMs are expected to share approximately 80% of the service market on new engine types (see Figure 4.27). Also, interviewees report that virtually all customers of new aircraft rely on flatrate contracts, which was the case for only half of the legacy engine service contracts.

For MRO providers, this means that they are either forced to limit their service activities to mature engines or form alliances with the engine OEMs to form part of their service network. However, limiting the business to legacy engines is not considered an option that ensures competitive survival, even if direct market access should be possible in the future, as Manager Alliance Function MRO 1 vividly explains: *"I can't put my people in the garage for two or three years and tell them to go paint some fences, I believe we need to secure business volume that ensures our existence"*.

Thus, the OEMs' control of the service market marks a severe environmental shift for MRO service firms that were formerly competing against each other for airlines' business. Now, they need to innovate their business model, to provide value to engine OEMs as part of their servie networks. This represents a fundamental change in the underlying business logic, requiring new Value Propositions, Partnerships, and a change in corporate culture.

On new engine types, airlines rely almost exclusively on solution offers that are now provided by all of the engine manufacturers.[1] Due to the high success of the manufacturers' solutions and the limited capabilities to offer competitive alternatives, many airline third-party providers form alliances with an engine manufacturer. The focal company is a suitable example of this practice, as it has established various alliances of different configurations with the manufacturers to be able to provide repair services for

[1] For example, IAE provides Flight Hour Agreements that provide with coverage for maintenance events, based on flight hour basis (International Aero Engines, 2017).

the newest types of engines (see Figure 5.1). These alliances are of high importance for the focal company, as they are expected to reach a revenue share of approximately 50% in the next eight years in the engine segment.

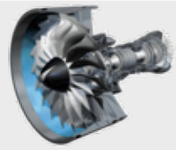
	Engine Type	Manufacturer	Aircraft Type
	GE-nx2B	General Electric	B747-800
	LEAP-1A	CFM International	A320neo
	PW1000g	Pratt & Whitney, MTU	A320neo, C-Series, MRJ, MC-21, E190-E2

Figure 5.1: Selected New Engines Served by the Focal Company[2]

Interviewees unanimously report that MROs need an affiliated airline with a sufficiently sized sourcing campaign as an "entry ticket" to enter alliance negotiations with an engine OEM. Using their bargaining power in the sourcing campaign, the airline demands the license required to build MRO capabilities for the respective engine type internally. Consequently, all independent MRO providers that are not able to convince an airline or investor to attain a license for them will need to focus on niches in legacy engine repair and thus most probably discontinue engine overhaul in the long term.

The OEM Workbench The focal company has formed a joint venture with one manufacturer that I label "The OEM workbench setup". In this setup, the manufacturer holds all customer solution contracts and subcontracts engine overhaul events to the joint venture that has been founded for this purpose. This arrangement implies some changes to the traditional business model of the focal company that includes the loss of channel access to the final customer for this type of technology. Also, the scope of the overhaul is reduced to mainly manual labor for engine disassembly, assembly, and testing that is compensated at a fixed rate per manhour[3]. Engineering tasks, such as determining the workscope of the engine overhaul are, in contrast, now performed by the manufacturer.

[2]Source: own illustration, based on illustrations from the manufacturers' homepages.

[3]Revenue Streams are determined based on a man-hour-rate (MHR), which lies at around $90 per hour at the time of writing. Despite its suggestive name, the rate includes all overhead costs, e.g., engineering and facilities. For each service, a working package including an estimation of the required man-hours is predefined by the manufacturer.

This setup results in a multifaceted relationship with the manufacturer in which the OEM has become simultaneously a supplier, customer, and partner for the respective engine type, while the two parties remain competitors for other engine types that are not covered by the agreement. The alliance itself can be defined as strategic since it is designed to span decades of aftermarket support. It is characterized by high idiosyncratic investments and mutual dependency. While the MRO depends on the OEM to receive parts, documentation, and support, the OEM is to some extent also dependent on the MRO, since the MRO is responsible for providing aftermarket services, with a direct influence on the OEM's performance and company image (Interviewee 19). The joint venture can even become critical to the system if it supplies a substantial amount of overhaul capacity.

Besides, the focal company needs to adapt its core business logic in two further aspects: One aspect is the importance of material and repair methods. While in the legacy business model alternative material sources and repair methods were used to minimize the consumption of expensive original material, the MRO provider is now granted access to spare parts at discounted rates. In return, the MRO commits itself to only develop and use PMA parts and alternative repair methods in consent and coordination through gain-sharing models with the manufacturer to not endanger the OEM's profitable spare parts business. Also, the repair of engine parts such as turbine blades is of less importance, since it is only valuable to the manufacturer if cost savings compared to production costs, not the catalog list price of spare parts are present.[4] However, for some complex and expensive components, the restoration of engine parts is still the most economical option. In terms of cost structure, the cost-reduction for access to materials are offset by higher initial investments required for acquiring a license to become OEM network partner.

The Coopetitive Solution The second type of alliance that the focal company has formed with an engine manufacturer is becoming a licensed partner of the manufacturer that competes with its own offerings against the manufacturer and other airline-affiliated third-party MRO shops. Due to the simultaneously competitive and collaborative aspects of this relationship, I call this arrangement "The Coopetitive Solution". Compared to the workbench setup, this arrangement is more beneficial because it allows the focal company to sell its traditional and solution offers directly to airline customers.

Another difference to the workbench setup is that in the coopetitive solution, the focal company aims to provide value to the manufacturer by providing advanced services such as mobile engine services and dynamic feedback loops aiming to increase the manufacturer's production- and service-related engineering capabilities. Mobile Engine Services are micro repairs that are conducted with the engine remaining mounted onto

[4] As production costs constitute only about 10% of the list price, the utility of repair of engine parts is significantly reduced compared to the traditional business model.

the aircraft (so-called on-wing), so they can be performed directly at the location of the airplane, wherever in the world. Conducting Mobile Engine Services can help to achieve higher engine availability and lower costs, e.g., through repair of damaged blades before consequential damage occurs, possibly mitigating a complete overhaul event. Mobile Engine Services are of rising importance due to the increased technical maturity and service life of engines, requiring fewer shop visits. In these repairs, information about the wear status of the engine that is not available digitally (e.g., of specific blades) can be gathered. This information allows for an informed decision of whether a repair can be performed on-wing, or whether a costly engine overhaul off-wing is required. Engine wear data is shared with the manufacturer, allowing him to determine design deficiencies and improvement measures.

5.2 The Components Case

Traditionally, airlines owned a stock of components at their major line stations to replace components in the aircraft upon failure. The repair of these components was either performed by the internal maintenance division, third-party MROs, or the manufacturers. This practice required stocking of all critical components and negotiating maintenance contracts with diverse parties. In contrast, Component Solutions allow the airline to gain access to a shared component pool that is managed by the service provider. Similar to Engine Solutions, the provider guarantees the availability of a set of components within a certain timeframe and is compensated on a flight-hour basis.[5]

Component Solutions have been pioneered by airline third-party MRO providers well before the manufacturers and were very successful due to the high cost-savings and reductions of risk and complexity that airlines could realize by relying on these contracts. Pooling enables cost reductions because components fail erratically according to a Poisson distribution. While the expected service life of each component is measured by the KPI "Mean Time Between Unscheduled Removal" (MTBUR), a component may fail well before this time limit is reached. Airlines that access a shared parts pool can economize this risk, as the service provider needs to stock components for the average risk of many customers and not the individual eventual risk that a component may fail earlier. Hence, Component Solutions are especially valuable on small to medium size fleets (less than approximately 250 aircraft), for new technology with uncertain MTBUR, or for critical parts that can cause an AOG (Canaday, 2016). Besides, airlines can partly forego the investment required for initial provisioning.

[5]Different options in pooling agreements exist, which differ in aspects as the spectrum of parts included, validity for all stations or outstations only, and whether the pool is shared with other airlines. Typically, airlines retain a certain spectrum of owned stock at their main stations.

Providing a Two-sided Solution The focal company has formed an alliance with a principal systems supplier on the A350 aircraft, in which the MRO was able to extend its solution capabilities upstream towards the manufacturing domain. In the alliance, the OES limits its activities to manufacturing, while the focal company has assumed the responsibility for conducting all aftermarket activities under the umbrella of a joint service offer. Since the focal company effectively provides an aftermarket solution to the manufacturer and Components Solutions to airline customers, I have labeled this setup, the "two-sided solution".

The OES' alliance decision was influenced mainly by two antecedents: First, the increased price pressure by aircraft manufacturers induced by RRSPs forced the system supplier to increasingly earn revenues and profits in the aftermarket either through licensing agreements or an internal service division. Second, the OES' previous service provisioning attempts on legacy aircraft types have had limited success in regards to customer satisfaction in the dimensions of costs, quality, and time. Also, previous attempts to improve service quality and profitability have not resulted in the aspired improvements. Third, and maybe most importantly, the system supplier cannot provide components solutions for the whole A350 but only for its own, albeit significant, share of components. Hence, all but the largest customers are more likely to sign a component support agreement with an integrator such as an airline third-party MRO or the airframer Airbus.

Consequently, the OES had two choices: the first option was to "get in line", becoming a second-tier repair provider for Airbus who acts as a solution integrator. This option would result in the previously discussed workbench setup, with the OES being the subcontractor of the airframer, leading to increasing dependency on Airbus in both manufacturing and service provisioning. The second option was to leverage the large component share on the A350 to create a Components Solution offer jointly with an independent MRO provider, capable of integrating various vendors' components into a seamless Component Solution. This option offers two major benefits: first, achieving a better position in the aftermarket with improved customer access, contract ownership, and less dependence on the airframer. Second, the OES can improve its service capabilities by relying on an external MRO specialist as an alliance partner.

The focal company faced a similar situation as the OES that made alliancing a favorable option: first, the very intense competition with Airbus that sells its components solution offer directly with the sales of the aircraft resulted in pressure on margins. Second, increasingly difficult access to intellectual property, less in-house repair capabilities, and increasing costs for licenses resulted in a less competitive cost structure. Thus, alliancing would create a win-win situation for both actors in which they could combine their resources and capabilities into an improved service offer. Hence, both firms decided to form an alliance, which involved some significant changes to the MRO's business model, which are discussed below.

In contrast to the Engine Case, the MRO does not provide single MRO services but a complete aftermarket solution for the OEM. The solution involves taking over the responsibility for all aftermarket activities, including MRO, integration of competitors' components, customer management, and logistics. In essence, the customer is provided with a seamless components solution directly from the focal company. This arrangement provides considerable value to the system supplier, as he can focus on his core business (development and manufacturing of aircraft systems), while the MRO is responsible for fulfilling contractual obligations of PSAs and solutions agreements.

The alignment of interests between system supplier and MRO, which involves sharing risks, costs, and revenues is an important underlying principle of the alliance, which is stipulated in a risk-and-revenue-sharing model. In this model, both companies share revenues and profits from the joint offering and participate in efficiency gains and other improvements. In essence, this enables the alignment of interests in which the OEM's profitability is not dependent on the sales of spare parts but the efficiency of the joint solution offer.

Similar to the Engine Case, the alliance results in a multifaceted relationship: while for the A350, both companies are partners with aligned interests, the OES is a large supplier and partly even competitor on other aircraft types. Also, the alliance has led to an increased mutual dependency between both parties. The MRO is dependent on the OES' performance in providing material and the required information for the repair of components overhaul. On the other hand, the OES is dependent on the MRO's performance in sales, repair, and the professional management of the pool. If the MRO fails to perform, the OES is held responsible by the airframer for not fulfilling parts of the PSA.

New Key Activities are required in regards to adding value to the OES and managing the alliance: To enable the OES an improved new product development process, customer and engineering feedback including sources of errors and improved repair methods are regularly shared in the form of an engineering council. Two-way communication ensures that the required information for both new product development process and MRO services is made available to both parties. A second activity is the commercial alliance management through regular commercial, business owner, and annual top management meetings. Additionally, a personal representative is placed at both the OES' and MRO's facilities to intertwine the operations and adaptions to the IT systems, which are required to enable both operational processes and contract structure.

5.3 The Aircraft Case

When choosing Aircraft Solutions, airlines rely on an external provider for most engineering, planning, and maintenance tasks, who assumes the responsibility to ensure airworthiness, reliability, and availability of the aircraft for a fixed fee per flight hour.[6] The solution provider performs most of the tasks that are usually conducted by the internal technical operations division of the airline, including aircraft engineering, planning of the maintenance schedule, reliability, and quality management. The provider also integrates the MRO services Line-, Base-, Engine-, and Component Maintenance from its internal service division and external providers.

Typical example of Aircraft Solutions are Embraer's Total Support Package (TSP), Boeing's GoldCare, and Airbus' Flight Hour Service offer that have been described in Section 4.4. The airframers' aggressive service market entry results in enormous price pressure on traditional MRO firms, and industry experts even report buying-the-deal behavior at prices below production costs.

Besides, the airframers' solution offerings have spawned increasing demand for integrated Aircraft Solutions, especially with start-up airlines such as Nordavia and partly also with LCCs such as Wizz Air. Aircraft Solutions are especially popular for start-up airlines as they usually lack the required in-house fleet management capabilities and rely on an external expert to kick-start their operations. Most airlines insource fleet management at a later point in time, once they have built the required capabilities (Arendt, 2015; Klooß, 2013; Wizz Air, 2015; Pozzi, 2017a). Interviewees report two main reasons, of why most airlines do not rely on Aircraft Solutions on a longer time frame: First and foremost, airlines suffer from a high dependency of the solution provider, as they lose their internal capabilities to steer their maintenance function directly and assess the competitiveness of their solution provider. SVP Fleet Management Airline 1 gives a vivid testimony:

"I think that the customers by now want less of a service package or because of the cost pressure, they want to know their MRO service costs much, much more directly. Now then, these high insurances within the total service packages, they want to have these less and more transparency and more decision-making power about what they buy at the end of the day."

Second, each MRO provider has strengths and weaknesses across the different service segments and fleets. Thus, it is reasonable to establish competition between the MRO providers through tenders and select the most competitive for each service category.

However, interviewees are divided with the assessment of whether Aircraft Solution will remain a niche product, due to the reasons mentioned above (Interviewees 5, 7, and 23) or of rising importance in the future (e.g., Interviewees 8 and 13). The argument

[6]Does not include ultimate accountability. For legal details, please refer to Section 4.3.1.

of the latter group is that fleet management and MRO services will increasingly become commoditized and thus not serve as a source of competitive differentiation, leading to increased provisioning of Aircraft Solutions offers. VP Purchasing MRO 1 summarizes his opinion: *"So generally speaking, this is my personal opinion, I believe that in the same extent to which the passenger says today: 'I don't give a shit what type of aircraft this is, bring me from A to B!', the airline goes into the direction to say: 'I don't care what type of tube this is, take away the risk so that I can sell tickets.'"* Also, Vice President Sales of MRO 1 already notes a trend towards solution offerings with one of the focal company's customers from the LCC segment: *"I can already imagine that we will migrate [towards solutions]. Now, we see this for example with customer A, for who we provide certain services and customer A is strongly driven by aircraft availability. They say: 'we need the aircraft for 18 hours per day, you can repair the other six or seven hours.'"*

In conclusion, whether or not Aircraft Solutions will remain a niche offering for start-ups and some LCCs or become a significant market segment, remains elusive as of today. However, airlines need to decide whether fleet management is one of their core competencies or a candidate for outsourcing. While the former path requires excellent fleet management and engineering skills, the latter will require the airline to excel at managing a principal supplier with strategic importance. However, MROs need to develop Aircraft Solutions to cater to all airlines that decide to outsource their Maintenance, Repair, and Overhaul function.

Developing Stand-alone Aircraft Solutions For traditional MRO firms, the airframers' entry into the service market constitutes an environmental shift, with possibly severe effects on MRO industry structure, the traditional MRO's business model, and consequently, profitability. The most imminent threat is that aircraft manufacturers may successfully establish themselves as the sole integrator of all products and services on their installed base. This move would allow them to reap much of the profitability of the MRO market through this platform-based integrator business model, in which MRO firms would be reduced to being mostly workbench partners, while airlines would be left with few choices for their maintenance decision.

At the focal company, two strategic options were discussed to cope with the manufacturers's aftermarket incursion: (a) developing Aircraft Solutions and (b) assessing whether an alliance would be a favorable option. The development of a stand-alone Aircraft Solutions offer was triggered by the change in customer demands that challenged the focal company, as Manager Product Management MRO 1 reports: *"our customers are asking for something that we don't have in the drawer. [...] They are asking for a full integration that I don't have."*

The service development process included various internal and external development and review stages, including the internal development of a minimum viable service offering, a challenging session with top management, and further co-creation cycles with customers. One of the major challenges for the focal company was the development of a fully integrated offering that included extensive aircraft performance guarantees and could be tailored to the individual needs of each airline.

Another critical part of Aircraft Solution offerings is the co-development of mechanisms to offset the one-sided dependency of the airline on the provider. The focal company and one major customer have established significant bonus/malus regulations in the contract that effectively moderates the buyer-supplier relationship, as Team Lead Aircraft Engineering Services MRO 1 reports: *"[performance-based pricing] increases the pressure on us to find solutions for the customer. It also increases the collaborative approach, so that you have a joint interest in solving problems and not block each other while finding the solutions."* In essence, Aircraft Solutions go well beyond traditional MRO service offers and require substantial adaptions of the service offerings.

One of the strategic questions that needed to be answered was, whether the MRO should partner with the airframer, becoming a subcontractor in the airframer's solution network. On the one hand, this collaborative option would present the focal company with some benefits, such as increased revenues by servicing the airframer's customer base, or improved access to IP that is otherwise increasingly restricted (Seidenman & Spanovich, 2016b). On the other hand, the collaboration would further strengthen the airframer's offer and possibly weaken the long-term position of the focal company in the industry.

In contrast to the Engine and Component Case, the focal company deliberately decided not to pursue a strategic alliance with the airframer but rather to seek punctual collaborations, where beneficial for both parties. For example, the focal company plans to participate in tenders in which the airframer subcontracts Line and Base Maintenance services to service partners, who then deliver these services on behalf of the airframer to the end customer. This arrangement allows the focal company to serve the customer directly and not enter a relationship that closely resembles the workbench setup. As a result, a multilateral relationship with the airframer emerged, in which the airframer is simultaneously supplier, competitor, and partly even customer.

6

A Strategic Approach for MRO Business Model Innovation

Contents

"Aviation's Maintenance, Repair and Overhaul (MRO) sector is undergoing a seismic shift as original equipment manufacturers (OEMs) win more and more long-term after care contracts from airlines. The aggressive strategy is a threat to the bottom lines of global maintenance providers." (– Ballantyne, 2015, p. 1).

As this opening quote from the introduction indicates, the entry of the Aerospace manufacturers into the service market represents a dramatic increase in competition for established MRO firms that has not gone unnoticed, neither in the press nor in the MRO's balance sheets. MRO firms need to compete against this new type of competitor with a different business model including unique resources and capabilities resulting from their manufacturing background (Ulaga & Reinartz, 2011). While increased competition is generally welcomed by customers, as it improves their bargaining position (Porter, 1979), airlines have addressed their concerns regarding possible monopolization of the MRO market because manufacturers erect increasing if not insurmountable barriers to hinder MROs from competing (IATA, 2012; Arendt, 2015).

Simultaneously, many airlines focus on their core business and require guaranteed aircraft availability, maintenance costs, and cost models based on aircraft utilization (Ward & Graves, 2005; Rieple & Helm, 2008; Schneider et al., 2013). Developing and competitively offering these new Value Propositions poses additional challenges to MRO firms.

Nonetheless, MRO firms sustain competition against manufacturers to varying degrees of success. While engine manufacturers are expected to gain between 65% and 90% of all maintenance contracts on new engine types (Hygate, 2013b), aircraft manufacturers have not successfully established themselves as providers of base maintenance services, at least yet (Shay, 2017a). In component services, both aircraft manufacturers successfully offer components solutions with a focus on new aircraft types such as the A350 and B787, while MRO firms are expected to remain very competitive in this market (Herbert & Morales, 2016).

In this chapter, I develop a portfolio approach for business model innovation of Aerospace Maintenance, Repair, and Overhaul firms to cope with challenges and realize opportunities resulting from servitization. As discussed in the conceptual background chapter (Chapter 2), the different configurations presented in the portfolio allow MRO firms to achieve a fit between strategy, the business model and internal and external conditions. Using a portfolio approach enables MROs to deal with strategic uncertainty and make resource commitments to the chosen plan, which allows them to gain a competitive edge.

The chapter is structured as follows: in the first section, the MRO Business Model Portfolio is conceptualized based on the generic BMI paths that MROs can employ to cope with servitization, resulting in a total of five viable business models for MRO service firms.

The second part of this chapter is dedicated to generating an understanding of competitive strategies in the Aerospace MRO industry, which is an essential building block for the development of a portfolio approach to MRO business model innovation. The second part starts with the exploration of the viability of Porter's (1980) generic competitive strategies cost leadership, differentiation and focus in the MRO industry. Then, I extend the existing literature by establishing a two-sided approach to explain business model-based competitive advantage between firms that come from the increasingly blurring manufacturing and service industries (Zott & Amit, 2010; Ulaga & Reinartz, 2011; Wise & Baumgartner, 1999).

Based on this understanding, I build a contingency approach to support the choice of the appropriate configuration in the MRO Business Model Portfolio. This approach extends today's limited and anecdotal knowledge of alliance and stand-alone Business Models of pure service firms in the context of servitization (Jaakkola & Hakanen, 2013).

Finally, I will explore the four configurations of the MRO business model (Section 6.3) as well as the specific dynamic capabilities that MROs require for transforming the business model along the two continua of developing solutions and alliancing with manufacturers (Section 6.4). In conclusion, this chapter allows us to understand MRO business model innovation in the context of servitization in terms of *what* is being innovated, *why* it is being innovated, and *how* innovation can be achieved.

6.1 Strategic Options for MRO Service Firms to Cope with Servitization

Against the backdrop of the manufacturers' incursion into the MRO service market and the changing customer needs of airlines, MRO service firms are challenged to innovate their business model into configurations that can cope with both, the manufacturers' downstream movement into the service market, and the airlines requirements for maintenance cost guarantees and pricing models based on aircraft usage.

The portfolio is constructed along the two dimensions of promising generic types of strategic options that allow MROs to innovate their business model to remain competitive in the face of these two trends. One option is to develop outcome-based solution offerings themselves to be able to compete with manufacturers in serving airlines that increasingly focus on their core business. The second strategic option is to ally with the manufacturer to become part of the manufacturer's solution network.

6.1.1 Developing Solutions

The first strategic option is for MROs to develop outcome-based solution offerings themselves to be able to compete with manufacturers in serving airlines that increasingly focus on their core business (Schneider et al., 2013).

A Definition of Aerospace MRO Solutions To determine why and how aerospace maintenance, repair, and overhaul firms can develop solutions, we require a definition of what MRO solutions are and their common characteristics. So far, literature has mostly focused on Rolls-Royce' engine solutions offering, while only a few studies are available that investigate the servitization efforts of aircraft manufacturers and other types of solution offers (e.g., Johnstone et al., 2009; Ferreira et al., 2013, 2016). I have derived the following definition by identifying the common characteristics of MRO solution offers through a comparison of Engine, Components, and Aircraft Solutions, which are the three most common types of solution offerings in the Aerospace industry.

MRO Solutions are service offers in which the provider assumes the responsibility for planning and performing maintenance, repair, and overhaul services targeting the aircraft, its engines, or components that are compensated on a usage- and performance-basis.

The first common characteristic of MRO solutions is that they comprise mostly services in which the provider assumes the responsibility for the customer's maintenance planning processes which were previously performed by the internal technical operations function. In addition to traditional maintenance services, solutions, therefore, involve subcontracting continuous airworthiness management tasks such as engineering and maintenance planning. Against a common misconception, the ownership of the asset is typically not included in the solution fee (Baines & Lightfoot, 2014). Hence MRO solutions are to be placed on the right side of the product-service continuum (Vandermerwe & Rada, 1988) (see Figure 6.1). Components Solutions are somewhat an exception, as here the solution provider is the owner of the components pool. However, a large part of the value of Component Solutions lies in the service content, as components from different manufacturers need to be repaired, stocked, and transported from and to the airline. Due to this high service content, not only manufacturers but also MRO service firms can potentially provide competitive MRO solutions, based on their unique resources and capabilities from a base in service provisioning.

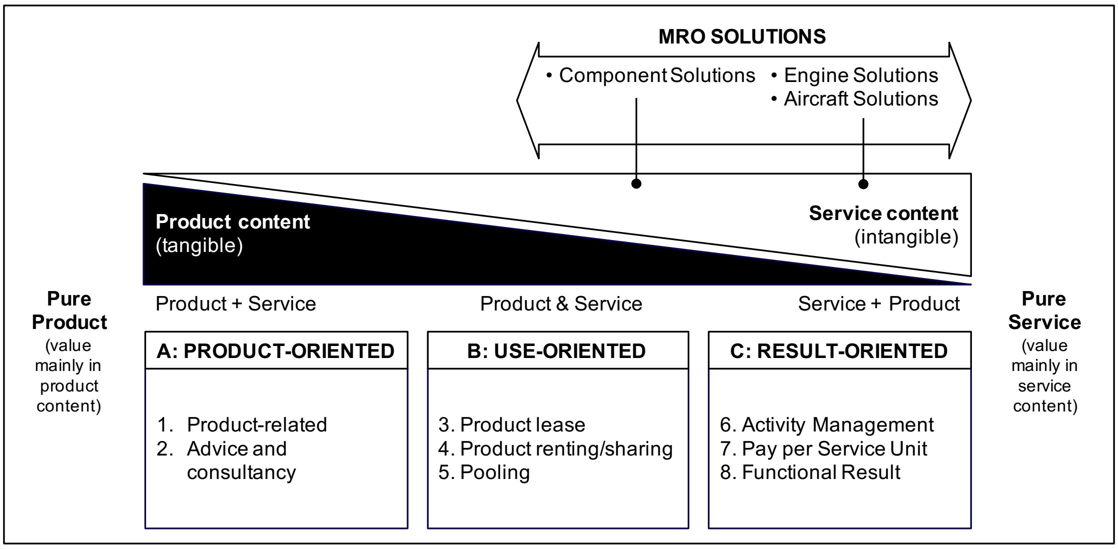


Figure 6.1: Aerospace MRO Solutions in Tukker's Product-Service Continuum

Second, MRO solutions typically encompass services for systems of a multitude of different vendors. The reason is that aircraft and its components are the archetypes of a complex product-system (Hobday et al., 2005). COPS include a variety of sub-systems and adjacent systems which interact with each other. Hence, MRO solution providers need to manage the interdependencies and involved supply chains to guarantee overall system availability and performance. Providing a component pool is the most prominent example of this characteristic; however, also engine and aircraft solutions entail the management of a multitude of vendors and their subsystems.

The third common characteristic of MRO solutions is that they typically employ usage- and performance-based payment models simultaneously. Engine Solutions are compensated based on flight-hours and flight-cycle ration, while Components Solutions and Aircraft Solutions are billed on a flight-hour basis. In addition, performance-based pricing mechanisms are used to ensure the performance of the solution provider and enable the customer to perform effective supplier performance management. Additional service elements that are not core to the solution offer can either be included in the flight-hour rate or billed separately.

Drivers of MRO Solutions Development Developing solutions is commonly perceived as being one of the most important BMI paths for MRO providers to remain competitive in the face of servitization in both industry-specific as well as to a limited extent in academic literature. For example, Tegtmeier (2009) notes that integrated support packages continue to grow in popularity, as an increasing number of operators aim to shift their risks of maintenance expenses to the MRO providers. In consequence, Tegtmeier argues that MROs should provide integrated services at budgeted, known quality, becoming so-called one-stop-shops. This phenomenon is part of a wider adaption of the business models of many major airlines that go through a process of de-integration, contracting-out large portions of their business model in pursuit of greater efficiency and effectiveness (Rieple & Helm, 2008). This practice also affects the previously internal Maintenance, Repair and Overhaul function that is increasingly outsourced to external providers (Brown, 2015).

As a result, solution development is regarded as a necessary business model innovation to address changing customer needs of airlines that increasingly focus on their core business (Schneider et al., 2013). In contrast, focusing on airlines that rely on traditional service offers would result in a reducing market share for MROs, especially in the light that many growing start-up airlines and low-cost carriers contract solutions over various stages of their development. Even if an airline contracts solutions for a limited time-frame, providing them allows MROs to establish Channels and Relationships with customers early on, and gain an in-depth understanding of their operation and needs. Two examples of airlines that have contracted solution offers are the Hungarian low-cost carrier Wizz Air that relies on Lufthansa Technik (Wizz Air, 2015) and Norwegian Airlines that have contracted Boeing's Gold Care offer (Pozzi, 2017c).

Solutions as an Enabler of Differentiation Advantage Porter's (1980) three generic competitive strategies cost leadership, differentiation, and focus, which were outlined in Chapter 2.1.2 build the theoretical framework of this chapter. Here, I seek to answer the question of whether MROs should rather choose a cost leadership or differentiation strategy to compete against their peers and manufacturers. First and foremost, airlines are under an enormous price pressure due to the strong competitive forces in the industry and the entry of operators with low-cost business models, which has in sum led to poor profitability and many cost-reduction efforts (see Chapter 4).

While the airline's cost pressure is a prejudice for following a cost leadership strategy, traditional service offers provide few opportunities for competitive differentiation, which makes charging high price premiums unlikely. The reasons for this mostly cost-based competition lie in the properties of MRO services: Due to their relevance for safety, most MRO services are strictly regulated and to a high extent standardized in manuals. Thus, traditional MRO services are in general perceived as a commodity, as Manager Product Management of MRO 1 illustrates: *"it's not like we would have the big label [...] 'Quality Leader' ... AFI, MTU, SRT, they can do that, too. They are all regarded as equal and deliver proper results"*. In consequence, airlines treat maintenance often as a necessary expense that belongs to the operating budget and is a common item on the hit list of cost-reduction programs (Tsang, 2002).

Second, input-based MRO services result is maintaining a part, system, or entire aircraft in airworthy condition. Airworthiness, good workmanship, and safety are typical must-be-quality requirements in the Kano Model (see Figure 6.2) that do not allow for competitive differentiation (Kano, 1984; Matzler et al., 1996).

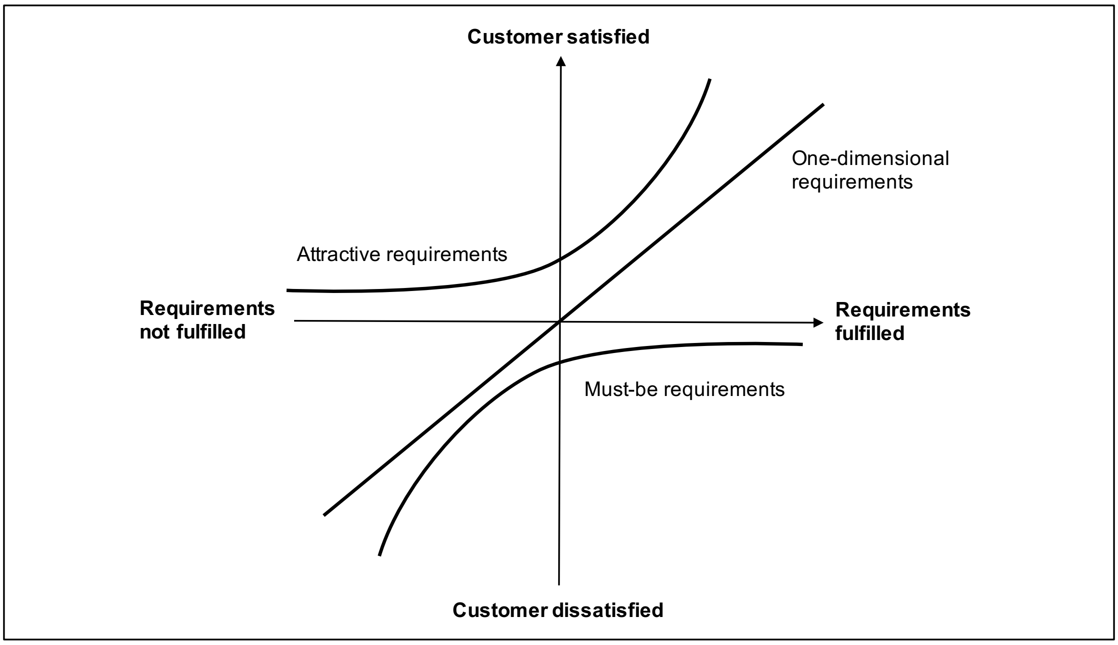


Figure 6.2: The Kano Model (Kano, 1984)

The Kano Model differentiates between three types of quality requirements: must-be, one-dimensional, and attractive requirements. Must-be quality requirements are the ones that need to be fulfilled to ensure customer satisfaction but do not allow for competitive differentiation by increasing customer satisfaction. In contrast, only the absence of these hygiene factors leads to dissatisfaction. One-dimensional requirements are requirements that lead to customer satisfaction in proportion to their level of fulfillment. Attractive requirements have the most significant influence on customer satisfaction, if met, are however typically not expressed by the customer (Kano, 1984; Matzler et al., 1996).[1] Having to fulfill must-be-quality requirements, not the MRO services are visible to the passenger, but just a lack quality timely repair.

Third, bar some exceptions such as cabin modifications, airlines do not want to but have to buy the service (*"it's not like the customer would want his engines to be overhauled, rather there is no real alternative. So, the decisive factor at the end of the negotiation is always the price"*, Manager Product Management of MRO 1, emphasis added by author). These effects are stronger for established technology, where few risks of uncertainties exist, and a stable market has developed.

While these characteristics hold for traditional service offers, developing solutions allows firms to escape harmful price-based competition and further differentiate their offers (Matthyssens et al., 2006). The reason is that solutions are typically priced according to output or performance (Tukker, 2004), which allows decoupling pricing from the consumption of resources (Baines et al., 2007). This pricing model enables MROs to earn premiums over through pain-gain-sharing models if they can achieve performance gains for airline customers and mitigate possible cost disadvantages on material versus manufacturers. As VP Purchasing MRO 1 explains: *"The customer does not perceive the things that we do [to mitigate] the cost disadvantages that we may have in value creation. Well now, if they are not included crystal-clear in the pricing."*

Besides, solutions entail the integration of various product and service components into a seamless offer that provides more value than the individual parts alone. The provider is integrated into the customer's business, which allows them to optimize the total costs for the customer (Brax & Jonsson, 2009). The two aspects of adding value through integration and being able to optimize the customer's costs by forming part of his business system offer additional differentiation potential that providers of traditional service offers do not possess. VP Purchasing MRO 1 reflects upon the value of reduced complexity especially for small customers: *"I have the advantage to reduce the complexity of [my customer's] system by providing additional services. [...] There are many advantages for small or very small airlines to say: 'I will go to one [provider], where I indeed have to pay a premium but the complexity [is reduced] and I don't have a negotiation lever anyway and am bamboozled by everybody.'"* The typical price premiums for Aircraft Solutions are visible in the hefty rates that are charged by aircraft manufacturers, which are reported to reach up to $300 per flight hour for offerings like FHS or Gold Care.[2]

The Engine, Component, and Aircraft case support the general assumption that offering solutions does not only address changing customer needs but also enables competi-

[1] Either an aircraft is airworthy, or it is not, no "very airworthy" exists. Of course, some basic performance parameters such as turn-around-time also exist in traditional service offers. Usually, these are however expected to be met as stipulated in the contract, while non-compliance with these performance parameters leads customer dissatisfaction and penalty charges.

[2] Pricing for engineering, planning and integration services only, MRO and other services (e.g., logistics) not included.

tive differentiation and escaping purely price-based competition (Gebauer et al., 2010a; Nordin & Kowalkowski, 2010). Also in the Aerospace Industry, MRO firms have the opportunity to pursue competitive differentiation by providing solutions. In contrast to traditional service offers, solutions allow MROs to make Value Propositions that fulfill one-dimensional quality requirements such as increased aircraft reliability and availability. Hence, these Value Propositions are likely to have a positive effect on customer satisfaction (Kano, 1984; Matzler et al., 1996) and thus allow for competitive differentiation.

In summary, providing MRO solutions is a promising way to assume additional responsibilities along the supply chain and extend the scope of their service offers. By taking over the airlines technical operations management processes, solution providers can reduce their customers' complexity involved in aircraft maintenance and enable airlines to focus on their core business.

Additionally, solutions allow MROs to employ a differentiation strategy as economic success is decoupled from material consumption and value-added services that reduce complexity and have a direct impact on airline performance can be provided. This mechanism allows MROs to depart from the cost leadership strategy that they typically employ for traditional service offers, where little room for competitive differentiation is present. This finding is in line with previous literature that suggests that for this type of product lifecycle services[3] only little opportunities for non-price-based differentiation exists (Ulaga & Reinartz, 2011). This approach requires building solution-specific resources that allow for competitive differentiation (e.g., specialized and skilled aircraft engineering or customer service representatives supporting the individual customer) while organizing the remaining resource base according to the overarching low-cost strategy.

In contrast, not developing solutions and hence focusing on customers that prefer traditional service offers, needs to be considered counterproductive to cost leadership, due to the high significance of economies of scale in the Aerospace industry that I have outlined in Section 4.3.4. As cost leadership is the most promising strategy for offering traditional MRO services on a large scale, firms that do not develop solutions are threatened to be reduced niches. This, in turn, dramatically hampers their ability to stem the necessary investments to build capabilities for new generations of equipment and thus ultimately threatens competitive survival. Hence, developing solutions needs to be considered as a promising generic strategy to tap into lucrative customer segments, enable competitive differentiation, earn additional revenues, and increase profits. Hence, MROs should seek opportunities for developing solutions within and across all types of service segments.

[3]Services that facilitate the access to the supplier's good and ensure its proper functioning during all stages of the life cycle, see Ulaga & Reinartz', 2011 Typology of Industrial Services for Hybrid Offerings, Figure 2.7.

6.1.2 Alliancing with Manufacturers

The alliancing BMI path of MROs stems from the phenomenon that servitization does not occur in an isolated way at manufacturers, but instead in the form of solution networks in which traditional service firms play a vital role. As a general agreement, manufacturers face limitations in performing all tasks associated with solution-provisioning themselves (Baines et al., 2007; Gao et al., 2011), and this is often economically less viable to do so (Gebauer et al., 2013). Therefore, manufacturers tend to outsource non-core services to third-party service providers (Cohen et al., 2006; Helander & Möller, 2007), who possess more experience in service provisioning (Beuren et al., 2013). As a result, manufacturers form networks with these third-party service providers as "solution integrators", which are usually referred to as service or solution network (e.g., Windahl & Lakemond, 2006; Gebauer et al., 2013; Eloranta & Turunen, 2016). In the service networks, each actor contributes to the offering (Lusch et al., 2010), focusing on their core competence and cooperation with other network actors (Basole & Rouse, 2008). In this context, service firms need to reconfigure their business model to become network partners of these manufacturer-led solution networks, changing the existing relationships with manufacturers that enter the service market.

In the Aerospace MRO market, alliancing with the manufacturer has been suggested as the second viable option to cope with servitization. Three main reasons exist why an alliance is a promising BMI path for MROs to deal with servitization. The first major reason is the manufacturer's ability to limit the MRO's access to repair manuals, licenses, and the required tooling (Schneider et al., 2013). This practice allows them to create entry barriers or a cost advantage against MROs that make competing an unviable alternative. The quote *"if you can't compete you better cooperate"* (–Vice President Sales MRO 1) illustrates the common perception among many MROs for these cases.

Second, the manufacturer's strategy to incur revenues in the aftermarket has resulted in the threat of rising maintenance costs for airlines. As a reaction, airlines are increasingly trying to increase this threat by pinning one manufacturer against another in negotiating the asset purchase and maintenance contract simultaneously (see Figure 6.4). However, this typically excludes the MRO from directly competing for a service contract with the airline and leads therefore to fewer opportunities for revenue generation directly with airlines (Spafford & Rose, 2013). As a result, MROs are increasingly confined to participate in service tenders for the diminishing proportion of legacy and sunset aircraft types (see Figure 4.22). Needless to say, that focusing purely on a diminishing portion of the market leads to shrinking revenues and endangers growing a sustainable business. Third, participating in manufacturer-led solution networks also offers opportunities to realize benefits such as access to new customer segments and extension of the own service offerings (see Table 2.5).

However, alliancing has not remained free of critique as an unsustainable approach to innovate the MRO's business model. Firstly, it has been criticized as a short-term approach as some types of relationships place MROs in an inferior, dependent position on the OEM. For example, license agreements allow manufacturers to shift profit margins to their own benefit away from MROs (Spafford & Rose, 2013). Some industry experts fear that an alliance represents a time-limited approach for MROs that works until OEMs have built sufficient service-specific capabilities to insource the entire service business (Schneider et al., 2013).

However, MRO-OEM alliances are common practice to cope with the environmental changes induced by servitization. For example, 82% of respondents of Oliver Wyman's MRO survey stated that they had closed an alliance agreement with one or more OEMs (Spafford & Rose, 2014). Examples of these alliance include BAPAS (Boeing and SIA Engineering and Maintenance), N3 (Rolls-Royce and Lufthansa Technik), or Pratt & Whitney's MRO network comprising of MTU Maintenance, IHI, and Lufthansa Technik (Derber, 2013; Broderick et al., 2014; Kjelgaard, 2017a). Even though the topic has been on the agenda for some time, it has remained one of the most critical trends in the MRO industry. For example, the MRO Europe 2018 featured various sessions and panel discussions on the OEM aftermarket incursion and MRO-OEM alliances (Informa USA, 2018) in its program.

In conclusion, alliancing with the OEM is a promising business model innovation path for pure service firms to sustain competitive survival and potentially realize benefits in general and in the aviation industry in particular. This is further underlined by the number of collaborations, especially between MROs, airframers and engine manufacturers that have and are currently taking place in the industry. Hence, the question is not whether or not MROs need to form alliances with manufacturers. Instead, the question is how they can perform this deed in the most sustainable and value-creating manner. To guide MROs in this challenge, I outline a portfolio of different strategic options of alliance configurations in Chapter 6.1.4.

6.1.3 Alliancing with other MROs

While Schneider et al. (2013) suggest partnering with other MROs as viable BMI path to cope with the manufacturers' servitization efforts, this type of alliances is rather an exception within the MRO industry. If alliances between MROs are formed, then predominantly to cover jointly small fleets such as the A380 or E-Jet in which providing competing service offers would leave each competitor with an insufficient market share.

Besides relational rents though complementary resources, cost and differentiation advantages could be gained if a similar resource and capability base is reaped more synergistically: for example, economies of scope could be reached by allocating complementary engineering capacities and capabilities into centers of competence to gain a differentiation advantage. Alternatively, joining the two maintenance networks could increase the flexibility of utilization (e.g., slot allocation in base maintenance facilities) and build economies of scope (e.g., by founding a dedicated A320 Base Maintenance facility for the joint serviced fleet). This endeavor would, however, require the establishment of common standards (i.a., processes, qualifications, manuals, IT tools, pricing), which represent a significant intervention in the business model of the individual MROs. Also, financial resources could be joined to split the investment required to re-engineer repair manuals or develop new repair methods, which may somewhat limit manufacturer-dependence.

A second mechanism by which an alliance between two MROs might result in an improved competitive position is by combining the serviced fleet. The larger maintained fleet makes it more viable to co-develop PMA parts, reaching a cost advantage because investments for PMA developments can amortize across more aircraft. Also, substantial economies of scale can be achieved by sharing assets such as spare engines, landing gears, airframe-related components (e.g., inlet cowls or nacelles) if commonalities exist between the fleets and the MROs establish a contractual basis that enables them to loan or exchange these assets swiftly at better than market conditions. Besides, joining the serviced fleet data pools would give MROs a head-start in developing the data processing and interpretation capabilities required for predictive maintenance methods. The reason is that the development of the algorithms underlying the predictive maintenance methods require large amounts of data. Once MROs have developed these algorithms, they can be applied to a single aircraft to improve its maintenance schedule, reliability, and cost position.

Finally, alliancing could be used to increase the MROs' bargaining position. In procurement, combined bargaining power may result in an improved position against distributors, service providers, or other non-monopolistic vendors, which could result in improved material or service conditions. Against manufacturers, an improved bargaining position is, however, more challenging to achieve as the affiliated airlines would need to coordinate their aircraft procurement campaigns. Achieving this coordination is, however, very unlikely if no alliance agreement or even merger between the airlines exist.[4]

Although MRO alliances may enable both partners to create relational rents, they do not solve the MROs' main problem induced by servitization, which is gaining access to the manufacturer's resources. While a joint approach towards the manufacturer may somewhat increase the bargaining power of each MRO, overall, dependence on the

[4]The reason is that airlines are typically not willing to make the required compromised regarding timing and specification of aircraft and the manufacturers' unwillingness to let such practices erode their pricing politics. Due to these reasons, the joint procurement of aircraft outside of financially affiliated airline groups remain an exception (Clark, 2007). Known examples are the purchase of an A330 by Swissair and Sabena, as well as the purchase of 187 aircraft outside of a formal alliance by LanChile, TACA, and TAM (Delfmann et al., 2005).

manufacturer will be complicated to decrease. For independent MROs that experience even more difficulties in acquiring access to IP and licenses, partnering with an airline-affiliated MRO may be considered a promising option. However, it is unclear whether the airline-affiliated MRO is allowed to share these resources and why it should do so. As independent MROs do not possess any structural advantage versus airline-affiliated MROs that they may use, these firm would need to formulate an attractive Value Propositions based on their own unique resources and capabilities. Since alliances between MROs do mitigate threats or capture opportunities that result from servitization, I have not included them in the MRO Business Model Portfolio.

In conclusion, alliances between MROs provide many opportunities to pursue cost and differentiation leadership strategies, especially if broad fleet commonalities exist. On the other hand, partnerships between MROs with low fleet commonalities can be used to amplify the service portfolio of each alliance partner. Reaping these benefits would however require a large extent of harmonization of processes and data structure; moreover a many responsibilities would have to be shifted between partners. This makes an acquisition of one MRO by another a more likely option than a cooperation between equal partners. For MROs that are not affiliated to an airline, alliancing with an airline-affiliated MRO is an attractive opportunity to increase its bargaining position considerably. The independent MRO, however, needs to make considerable Value Propositions to its potential partner to be sufficiently attractive to warrant alliance negotiations. As partnerships between MROs are not a specific strategic option to cope with servitization, they are omitted however in the MRO Business Model Portfolio.

Practice resonates well with the proposed two BMI paths, especially in the engine segment: cooperations and joint ventures with manufacturers are seen of even increasing importance in the future compared to current levels, as OEMs need to provide sufficient overhaul capacity on new engine models. Besides, MROs can achieve competitive differentiation against other MROs and OEMs by developing highly customized integrated solutions (Horwitz, 2019). Moreover, additional advanced alliances between independent MROs and airline third-party MROs or even with OEM-MRO JV come into existence.[5]

6.1.4 The MRO Business Model Portfolio

The MRO Business Model Portfolio (see Figure 6.3) is constructed along the two just discussed business model innovation paths: the first dimension (x-axis) of the portfolio distinguishes between business models that provide either traditional services or solution offers, whereas the second dimension (y-axis) distinguishes between business models that entail an alliance with a manufacturer.

The two-by-two field matrix results in principle in four different configurations of MROs

[5]One example of the latter partnership is the cooperation between MTU, an independent engine MRO provider with EME AERO, a joint venture between engine manufacturer Pratt & Whitney and LHT.

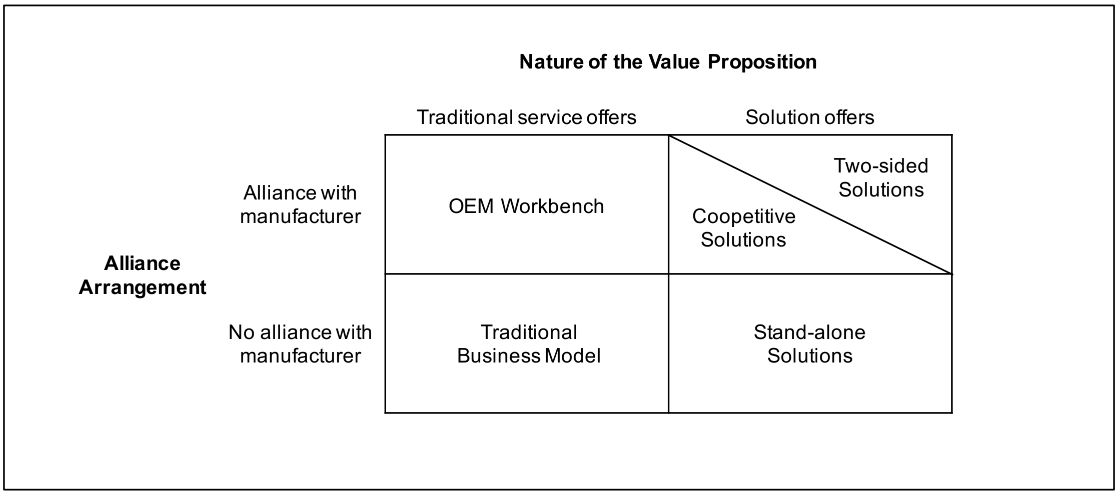


Figure 6.3: MRO Business Model Portfolio

business models, providing traditional service offers either to the airline or the OEM alliance partner, and providing solutions, either without an OEM-alliance (stand-alone solutions) or together with an OEM. Providing solutions in an alliance with the OEM can, however, take two different sub-configurations, which results in a total of five configurations that are described further below.

Traditional Business Model In the traditional business model, MROs provide aircraft maintenance, repair, and overhaul services that are billed typically on a time- and material-based revenue structure to airlines. In this business model, the MRO assumes only a limited amount of risks for its customers and typically does not take over responsibility for the customer's services.

As manufacturers increasingly limit the MROs access to intellectual property rights and many airlines focus on their core business, MROs need to develop approaches to innovate into another configuration of their business model (Schneider et al., 2013). MROs that fail to do so run into the danger of being reduced to niche markets which may leave them unable to ensure competitive survival in the long term.

Stand-alone Solutions In the stand-alone solutions configuration, the maintenance firm provides service offers in which it assumes the responsibility for planning and performing maintenance, repair, and overhaul services targeting the aircraft, its engines, or components that are compensated on a usage- and performance-base. The second important characteristic of stand-alone solutions is that MROs provide solutions in competition with the OEM. One example would be the aircraft case in which the focal firms provides its customers with aircraft solutions, competing with the airframer's offers.

Developing stand-alone solutions allows MROs to tap into the lucrative market of start-up carriers in the aircraft segment, for components and engines, solution offers need to be considered as being important market segments. Also, developing stand-alone solutions lets MROs provide output-based offers and unlock mechanisms of competitive differentiation against other OEMs and manufacturers.

The OEM Workbench In the OEM workbench setup, MROs form an alliance with the OEM in which they provide time- and material-based maintenance services to the manufacturer as a sub-contractor. Although this setup allows to continue providing service offers, it possesses some disadvantages compared to other, more advanced, OEM alliances. First and foremost, the MRO suffers from a significant dependency of the OEM that is at the same time the supplier of all material, intellectual property, and the only customer. Second, the MRO loses access to the market, as the OEM holds all customer contracts and only subcontracts services to the MRO. Hence, MROs can choose this configuration to ensure competitive survival, should however aim to develop more advanced solution capabilities that will allow them to execute the next two, more advanced configurations.

The Coopetitive Solution In the coopetitive solution configuration, the MRO becomes a partner in a network of typically independent and OEM-owned repair shops, which compete for customer business. The cooperative aspect of this arrangement is that the MRO becomes a license partner with access to repair manuals, spare parts, and tooling. This arrangement is advantageous for the MRO compared to the OEM workbench setup since the MRO has direct market access, can retain the customer channel, is less dependent on the OEM, and can pursue reaching a competitive edge with its solution offers — at least if the OEM assures a level playing field between all network partners.

The Two-sided Solution The two-sided solution is the most advanced configuration of MRO business models and requires both excellent solution-specific and relational dynamic capabilities to be established. In this setup, the MRO simultaneously provides a solution for both, the airline customer and the OEM by assuming responsibility for the outcome of the solution offer and processes that would traditionally be performed by either party.

While for the customer, a solution offer is provided (e.g., availability of components for a fixed rate per flight hour), the MRO takes over the responsibility for the manufacturer's aftermarket business for the joint offering. This task typically includes the administration of customer contracts, managing the customer channel and relationship, repairing equipment, planning of inventory and logistics, as well as risk management,. This arrangement allows the manufacturer to de-servitize and focus on the core manufacturing business (Kowalkowski et al., 2017). It can typically be characterized as a risk-and-revenue-sharing partnership that includes performance-based compensation mechanisms. The advantage for the MRO compared to other setups is the lower level of one-sided dependency; instead, both OEM and MRO are highly interdependent.

Interim Conclusions *In this section, a portfolio containing five different configurations of MRO business models entailing both solution and alliance arrangements has been developed. By innovating their business model towards the configurations described in this portfolio, MRO can achieve a better fit with the environment and are thus likely increase their firm performance compared to remaining in their traditional business model. The next section discusses which business model innovation is appropriate in which circumstances by the development of a contingency approach.*

6.2 Choosing the Appropriate Business Model Configuration

In this section, I develop an approach for MRO service firms that allows them to choose the appropriate BMI path. The choice is based on the analysis of sources of competitive advantage inherent in manufacturing and MRO service-based business models, as well as the contingency factors that influence the alliance decision.

6.2.1 Competitive Advantage of Manufacturers and MRO Service Firms

This section explores the competitive advantage between servitizing manufacturers that enter the service market with product-based business models and MROs that come from a base in services. This contribution extends the current knowledge-base that has been mostly one-sided, focusing on the advantage that manufacturers can gain through service infusion. The research question *"How can competitive advantage between MROs and manufacturers be explained based on their respective business models?"* reflects the holistic business model approach to explain competitive advantage (see Section 2.1) that is employed here. Choosing this approach allows us to broaden our scope beyond purely resource-based competition, and instead take the whole business model as the unit of analysis (Osterwalder et al., 2005).

In the chapter covering business models (Section 2.1.2), we have outlined how business models can explain competitive advantage on a generic level, i.e., either by its elements or their hard to imitate combination. Here, we apply the Business Model Canvas to explain how the respective business model of MROs as pure service firms and manufacturers can explain competitive advantage in pure service and solution offers. As this represents a shift from the generic business model concept to the concrete manifestation delineated in the form of the Business Model Canvas, we need to define which elements are eligible in explaining competitive advantage. Previously, we have already outlined that Key Resources and Key Capabilities are potential sources of competitive advantage, explained by the resource-based view (Barney, 1991) and its extension, the resource advantage theory (Hunt & Morgan, 1995). Also, Key Partners were identified as a possible source of competitive advantage, explained by strategic network theory (Jarillo, 1988) and the relational view (Dyer & Singh, 1998). Now, we need to clarify the role of the remaining business model elements in the creation of competitive advantage.

Value Propositions are the result of using Key Activities to transform Key Resources through Key Capabilities to marketable offers to the customer (Amit & Schoemaker, 1993; Osterwalder et al., 2005). Hence, Value Propositions are not a source but a mediator of competitive advantage and discussed as such as part of the analysis.

By controlling customer *Channels*, firms may gain a positional advantage over other firms that would like to make Value Propositions to the same customers. Through the control of customer channels, customers can be locked-in, while other competitors may be locked-out (Heide & John, 1988). Hence, channel control may indeed be a source of positional advantage, inhibiting other competitors from competing through switching barriers that are created for the customer (Porter, 1979).

A firm's *Cost Structure* results from the Key Activities a firm performs and the required Resources, Capabilities and Partners used (Osterwalder et al., 2005). Only firms with a lower cost structure than their peers can employ a sustainable cost leadership strategy (Porter, 1998). A firm's Cost Structure is then a mediator between the firms base of resources, capabilities, and partners towards achieving a competitive advantage and treated as such in the analysis. On a similar note, Revenue Streams result from the successfully marketed products and services of a company. Hence, they are the result, not an antecedent of competitive advantage.[6]

Customers are the recipient of the Value Proposition and firms compete if they aim to serve similar *Customer Segments* with comparable offers. Companies can reach competitive advantage when they can serve a specific Customer Segment with lower costs or better Value Propositions than its competitors (Porter, 1998). Hence, I have excluded Customer Segments from the analysis.

[6]Nonetheless, financial resources result to a considerable part from Revenue Streams and are included. This segregation aims to mitigate the threat of tautological reasoning that may result from considering Revenue Streams as an antecedent of competitive advantage.

Table 6.1 summarizes and compares the manifestation of the six business model elements relevant to the competitive advantage of MROs and manufacturers, as well as their proposed effect on this advantage. The MRO's items are based on the traditional MRO business model and selected by the inclusion criteria stipulated in the methodology section. The manufacturer's items are based on the literature review on the role of pure service firms, the Aircraft, Engine, and System manufacturers' business models, and the case studies.

Business Model Element	Relevant Items MROs	Relevant Items Manufacturers	Proposed Effect on Competitive Advantage
Key Partners	• Affiliated airline	• Risk-and-revenue-sharing partnerships with other tiers in the manufacturing supply chain	• MRO: limited positional advantage and unique resources and capabilities result from the affiliated airline
Key Activities	• Operational services • Development of alternative parts- and repairs	• R&D, manufacturing of products	• MRO: differentiation advantage by providing a broader set of operational services than OEMs • MRO: cost and differentiation advantage through lack of product-business and development of alternative parts- and repairs • OEM: R&D and production of products are antecedents to unique manufacturing-specific resources and capabilities
Key Resources	• Maintenance network • Operator experience	• Maintenance network • Product development and manufacturing assets • Product Sales Force and Distribution Network	• MRO: cost and differentiation advantage through operators experience, serviced fleet, and maintenance network • OEM: cost- and positional advantage through protection of intellectual property and access to assets
Key Capabilities	• Repair & engineering capability • Multi-vendor capability	• Bundling capability • Risk management capability • Hybrid offering deployment capability	• MRO: cost and differentiation advantage through repair and engineering capability • MRO: cost and differentiation advantage through multi-vendor capability • Data-based comparative advantage depends on data access and ability to link data to service in operations • OEM: differentiation advantage through risk management capability in offerings that involve high risks • OEM: no sustainable competitive advantage through hybrid offering deployment capability
Customer Relationship	• Long-term trustful relationships with airlines	• Intensity of airline relationships depend on type of manufacturer	• MRO: positional advantage through long-term, service-focused relationships
Channels			• OEM: positional advantage through preferred customer channel access

Table 6.1: Unique Business Model Elements of MROs and Manufacturers, Proposed Effect on Competitive Advantage

Key Partners

In the Key Partners segment, MROs and OEMs possess different elements in their business model that they can potentially leverage into an advantage. While airline third-party MROs possess an affiliated airline, manufacturers have formed far-reaching risk-and-revenue-sharing partnerships with other manufacturers from different tiers of the supply chain.

Affiliated Airline MROs that possess an affiliated airline are part of the organization of the OEM's customer. Exploiting this position in the supply chain, MROs can intend to use the purchasing power of their parent company to raise entry barriers to OEMs that wish to enter the market. Well-known examples of this practice are flight training schools that have thwarted the market entry of the flight simulator manufacturer Thales, who tried to add pilot training and the management of simulator training facilities to his product portfolio (Davies et al., 2006).

Another promising tactic may be to increase the resilience of airlines against the OEMs' service offerings by means of the affiliate. This tactic may work since manufacturers who wish to enter service markets with firmly established service providers first need to change the current industry culture to reach legitimization (Turunen & Finne, 2014). In Aerospace, the value of the affiliated airline to erect market barriers is however limited, as aircraft, engine, and component manufacturers have already successfully entered the service market to a large extent.

Another third way in which an affiliated airline may be valuable for MROs is to provide them with unique resources or capabilities. Affiliated airlines that place an early, substantial order of a new aircraft types and contract all maintenance business to the affiliated MRO, provides it with the Key Resource of a serviced fleet. A sufficiently-sized serviced fleet allows the MRO to capture a considerable early share of the growing aftermarket that justifies initial investments and enables the MRO to gain operator experience and economies of scale. In contrast, manufacturers need to win early customers for their service offers on their aircraft types, which can initially be a burden, as Boeing's initial limited aftermarket success demonstrates (Herbert & Morales, 2016).

Another important point that sets affiliated MROs apart from manufacturers is that they are typically highly integrated with their airline (Al-kaabi et al., 2007a) by providing Line Maintenance which is closely intertwined with the airline's operation. This allows them to achieve a unique, in-depth understanding of "how an airline works", benefiting their operator experience (a Key Resource) and the airline perspective Value Proposition. A last, albeit softer argument is that affiliated MROs can use ties of the affiliated airline to their peers to enter discussions with other airlines on equal footing, instead of being a mere supplier.

In conclusion, an affiliated airline and the benefits gained from the relationship definitely constitute a potent source of competitive advantage that MROs need to consider in their BMI decisions. Independent MROs that do not form part of an airline group do not enjoy the associated benefits, which makes it harder for them to both endure competition with their peers and manufacturers, as well as to form alliances with the latter. This lack of benefits places independent MROs in an awkward position, in which they have to aim to thrive in niche markets or markets that require less ICA.

Risk-and-Revenue-Sharing Partnerships Today, Aircraft and Engine Manufacturers have formed extensive Risk-and-Revenue-Sharing Partnerships (RRSPs, see Section 4.4), outsourcing up to 80% of the aircraft and its parts to suppliers (Krol, 2011; Wallin, 2013a). By integrating the different systems that are provided by their suppliers, both engine and aircraft manufacturers have become system integrators, which can potentially leverage the associated benefits of a central network position and complementary resources into competitive advantage (Jaakkola & Hakanen, 2013).

In the Aerospace industry, the central supply chain position does however only result in limited potential for competitive advantage regarding aftermarket and service offerings, for a variety of reasons: First, the considerable amount of outsourcing of both R&D and production limits the internal knowledge about the respective components and thus hampers knowledge-based advantage. Second, the intellectual property rights from the system development are granted by the aircraft OEM to remain with the suppliers and hence are of minimal use in the aftermarket (Horng, 2007). Third, integrators can only exert limited pressure on their RRSPs in the aftermarket, as the suppliers have already been squeezed for initial production pricing and need to reach amortization of their initial investment via the service business (the revenue-sharing part of the alliance agreement). Hence, these players are barely inclined to grant more favorable aftermarket conditions for e.g., spare parts or services to the integrators. Also, it is likely that many large suppliers possess considerable bargaining power once they have become RRSP on a particular aircraft platform, as they are positioned as a single equipment source on a specific aircraft type and almost not interchangeable due to the enormous switching costs that would result from such a move (Krol, 2011). This is underlined by the components case, in which an alliance strengthens the competitive position of both OES and MRO against the airframer. The alliance shows that partners for manufacturing are not necessarily partners for service provisioning if their margins are further put under pressure by the integrator. Hence, a coopetitive relationship between airframer and its RRSPs develops that spans manufacturing and service sides of their business model.

Key Activities

Key Activities can principally affect competitive advantage either directly or indirectly. To reach a direct advantage vis-a-vis their competitors, firms should either deliberately choose to perform different Key Activities or perform the selected Key Activities in a different manner (Porter, 1996). Key Activities also have an indirect effect on competitive advantage, as they strengthen the firm's Key Capabilities. The reason is that Key Capabilities are developed over time through interaction with the firm's resources (Amit & Schoemaker, 1993), i.e., through performing Key Activities to transform resources into Value Propositions.

Comparing the business models of MROs and OEMs, differences in Key Activities become apparent (see Table 6.1). “Operational Services” and “Development of alternative parts and repairs” are Key Activities that are predominantly performed by MROs, whereas research, development, and the production of goods, is predominantly performed by OEMs.

Operational Services While MRO providers can principally perform all major types of operational services (Line, Base, Engine, and Component Maintenance) on equipment of multiple manufacturers, OEMs limit themselves much more on the operational services of their own equipment. Engine and component OEMs provide repair services only for their equipment, while airframers typically possess little internal operational services but integrate these from a network of service partners. The broad service portfolio principally enables MROs to achieve competitive advantage directly or indirectly via their resource and capability base.

A direct effect on competitive advantage can result from performing a broader set of operational services internally. One option is that customers may prefer a one-stop-shop that offers all types of services. Here, the internally available broad service portfolio acts as a differentiator (Tegtmeier, 2009). This effect is expected to be especially pronounced in solution offerings, as these are more encompassing as traditional offers, which are typically contracted separately. The quote of one interviewee underlines this claim: *“take alone the fact that Airbus is doing [Aircraft Solutions] with many partners. They know that they can't do it themselves, but they also need to integrate, but not their own shop but many many others and that is a lot more cumbersome. And we are sure that our product fits much better with the demand of a one-stop-shop.”* (–Team Lead Aircraft Engineering Services MRO 1). However, it is unlikely that customers have any preference to whether services are provided internally at the provider or integrated from external sources. Hence, competitive advantage can only result if MROs integrate internal services more seamlessly than external services, or if the services themselves enable cost leadership or differentiation advantage.

Competitive advantage should also result if unique synergies can be leveraged across the different service segments that are more difficult to reap across firm boundaries. This mechanism should be especially pronounced in solution offers, where providers integrate an increasing amount of internal or external service modules into a seamless offering (Jaakkola & Hakanen, 2013). Manager Product Management MRO 1 gives testimony regarding the existence of such synergies:*“unfortunately, we still have the phenomenon that our divisions focus on their performance and [service] portfolio and we do not reap the suspected — and what we are currently seeing — really exciting potential of our holistic setup. And this is something that we consider as absolutely necessary, especially on new aircraft types, to reap this potential and to understand what potentials we can realize for the customer that other competitors can't”*.

One facet is the fact that MROs, unlike their manufacturing counterparts, perform Line Maintenance. Line Maintenance is closely connected to all other maintenance services and may thus enable a broad set of potential synergies: for example, unserviceable components are removed from the aircraft during Line Maintenance, Engine Maintenance tasks are performed during Line Maintenance checks, and work packages are frequently shifted between Line and Base Maintenance events to optimize aircraft availability. Performing Line Maintenance allows the MRO to "connect the dots" between operation and the different maintenance services, which enables him to identify more areas of improvement than an OEM could, which is especially vital in integrated Aircraft Solutions. In contrast, the aircraft OEM as solution integrator is limited by firm boundaries and would need to ensure the flow of this tacit information between its network partners to be able to achieve these synergies.

Performing operational services also has an indirect effect on competitive advantage, i.e., by delivering services and thus interacting with the resource-base of the firm. For example, operator experience is built which strengthens the MRO's repair and engineering capabilities. The reason is that a firm that repeatedly performs a specific activity can realize learning curves (Darr et al., 1995), which enables MROs to establish higher levels of efficiency and cost-effectiveness compared to their counterparts that are newer to service provisioning. This indirect effect in which operator experience acts as a mediator is discussed in the operator experience section.

R&D and Manufacturing of Products Manufacturers perform *"R&D and manufacturing of products"* as one of their Key Activities, with pronounced implications for competitive advantage. For manufacturers, these activities primarily have an indirect effect on competitive advantage, as they result in unique manufacturing-specific resources and capabilities such as product development assets and capabilities and intellectual property (Ulaga & Reinartz, 2011). The impact on the competitive advantage through these resources and capabilities is explained in the respective section.

In contrast to manufacturers, MROs do not possess a relevant amount of manufacturing business, which counter-intuitively may give them an advantage against manufacturers. The reason is that the lack of manufacturing business places them in a neutral position between airlines and OEMs, who are, in turn, inclined to increase the profitability of their spare parts business (Fischer et al., 2010). This unique, neutral position is valuable for a variety of reasons:

First, some airlines formulate a deliberate sourcing strategy favoring MRO over OEM offerings for two reasons: First, airlines are concerned of an OEM hegemony in the MRO market and the inflicted long-term price increase. The resilience of these airlines against OEM offerings increased as the servitization of the engine MRO market has left them with little or no choice in their maintenance decision and thus dependent on the

OEMs' aftermarket strategies. A second factor is that a single sourcing strategy, sourcing both equipment and maintenance services from a single supplier, leaves the airline exposed to greater risk (Treleven & Schweikhart, 1988). One interviewee cited an airline owner: *"I want to oblige the OEM to build only the aircraft, I don't want to do anything else with them, he should please only deliver the aircraft."* (–Director Finance, Product Sales and Key Account Management MRO 2) However, not all airlines share this view, especially Asian carriers are reported to be more OEM-minded, even preferring OEM over independent service offers.

Besides these direct effects on the airline sourcing decision, the MRO benefits from an absence of manufacturing business and thus the OEM's constraints. This absence allows the MRO to develop alternative parts and repairs, develop the multi-vendor capability, and develop an "airline perspective". Five interviewees assessed that MROs can differentiate themselves from OEMs through this airline perspective, which is best summarized by Team Lead Aircraft Engineering Services MRO 1: *"we think and act like an airline, not like the OEM"*.

The airline perspective is valuable for airlines, as MROs can deliver a credible OEM-independent consultancy approach that is in the airline's best interest. For example, the MRO can independently assess the economic viability of service bulletins recommended by the OEM, while the OEM is naturally inclined to sell his upgrade. Another topic is performing warranty claims against manufacturers. MROs can make these claims, having only the airline's interest in mind, while the manufacturer's service division is limited in credibly supporting warranty claims against its parent company. A third example is the initial provisioning[7] in a Component Solution offer: while MROs are inclined to determine the optimal pool stock level for airlines, OEMs have fewer incentives to do so, since this would decrease their initial spare parts sales. In conclusion, airlines have many reasons to keep the responsibility for manufacturing and maintenance separated and not rely on a single partner.

In conclusion, this airline perspective is difficult to imitate for OEMs even in the long term, as it rests on both tacit operator experience and the affiliated airline that both permit gaining the in-depth understanding of an operator. The second factor is that MROs have close to no in-house parts manufacturing business and thus do not need to balance the interests of both business units (Gebauer et al., 2011; Kindström et al., 2013).

Development of Alternative Parts and Repairs The usage of alternative spare parts and alternative repair methods (DER repairs) may be one source for both cost and differentiation advantage against manufacturers. As outlined in the traditional MRO business model, PMA parts are known to enable savings of regularly 30% to 50% compared

[7] Initial provisioning is the process of determining and supplying the Line Stations with the required components that are replenished from the pool upon usage.

to the OEMs' spare part price. Similarly, surplus material can enable savings of commonly 50% compared to new parts, depending on supply, demand, and the remaining service life of the part. With an average share of 46% material costs in the MRO's cost structure, these types of parts have a considerable potential to lower MRO costs.

In contrast to manufacturers, the MRO is inclined to use alternative sources because for him they are transitory items: as a pure service provider, MROs do not rely on parts to generate profits; instead, they are billed to the purchasing price plus handling charge to the customer. OEMs, on the other hand, rely on the sales of spare parts as a revenue stream in their business model and is hence not inclined to lower the price or make use of alternative parts (Fischer et al., 2010). In similar terms, alternative repair methods that prolong the service life and reliability of parts are of limited interest for the OEM, as they limit the sales of spare parts. While these arguments hold for input-based offerings, they lose relevance in pure output-based offerings, as here manufacturers can decouple economic success from material consumption (Baines et al., 2007).

However, the value of these parts for cost reduction purposes is limited by some factors: First, PMAs are not available on all parts and lack acceptance with some airlines and most lessors (IATA, 2012). The steadily increasing share of leased aircraft (42% in 2015 (FlightAscend Consultancy, 2016a) further limits usability. Second, manufacturers fiercely oppose the usage of alternative materials and repair methods, raising concerns of decreased safety and reliability. These concerns are however regularly dispelled by aviation authorities (Avia Solutions Group, 2017). Also, OEMs such as Rockwell Collins are actively shaping the surplus market by the foundation of affiliated surplus companies such as Intertrade (Rockwell Collins, 2013). In doing so, OEMs (a) participate from the revenue potential of the surplus market and (b) actively limit the supply of surplus material for MROs and airlines. At the time of writing, many OEMs even have established so-called "buy-back" agreements that ensure them privileged access to surplus parts after removal from the aircraft, further decreasing the availability of surplus material. One important last point is that MROs usually are required to agree to cease the usage of alternatives to OEM material when entering an alliance with an OEM.

Thus, it is to be predicted that the usage of alternative materials and repair methods will decrease on new aircraft types, limiting competitive options for MRO providers and airlines, while the market for surplus and PMAs will thrive mainly on legacy aircraft types (Cooper, 2017). Once today's new aircraft types enter the second and third lifecycle, it is to be estimated that increasing surplus material will be available. Whether PMAs and DERs can be developed and warrant the required efforts, remains subject to speculation.

Key Resources

Resource- and capability-based competitive advantage between OEMs and pure service firms has so far received most academic attention. The seminal work of Ulaga & Reinartz (2011) requires special mentioning, as it is to my knowledge the only academic work explicitly concerned with this topic. The authors uncover resources and capabilities not available to traditional service providers that manufacturers can use to build a competitive cost or differentiation advantage in hybrid offerings. In this section, I aim at making a contribution to the understanding of this phenomenon by (a) adding unique resources only available to pure service firms and (b) examining the proposed effects of manufacturer-specific resources in a different empirical setting.

Maintenance Network In the MRO industry, a maintenance network is required on a local level for Line Maintenance, regional level for Base and Engine Maintenance, and global level for Component Maintenance (Arendt, 2015). Having an internal maintenance network at one's disposal allows a firm to gather operator experience and develop its repair and engineering capabilities. Firms that possess a superior maintenance network, operator experience, repair, and engineering capabilities can aim to leverage the combination of these unique resources and capabilities to provide superior services and hybrid offers.

Servitization literature acknowledges that a maintenance network is a Key Resource resource for providing after-sales services that is difficult for manufacturers to construct (Ulaga & Reinartz, 2011). In Aerospace, traditional MRO providers possess a maintenance network rooted in their base in services, that they can leverage to their advantage against manufacturers that first have to either build an internal maintenance network or rely on external partners. Hence, in Aerospace, a maintenance or service network is not a unique resource of manufacturers, as has been previously assumed but rather a source of competitive advantage for established service firms.

Manufactures may encounter difficulties to construct mature and efficient networks themselves, as they require mechanics and engineers with the suitable capabilities (Santamaría et al., 2012). Hiring this workforce constitutes a barrier for manufacturers that encounter difficulties due to a shortage of skilled workforce available on the market as of today (Spafford & Rose, 2014). The shortage of skilled labor is not likely to decrease soon, as Boeing predicts that the industry will need 679,000 new maintenance technicians over the next 20 years (Shay, 2017e). Hence, manufacturers need to use aggressive and thus costly hiring techniques to achieve a sufficient number of qualified applicants, especially in Western Europe (Spafford & Rose, 2014).

The manufacturers' relative disadvantage of hiring and training such a workforce is however limited by the fact that they can form alliances with airlines to access staff of their maintenance division. Another option to mitigate this barrier is to rely on external partners that provide MRO services. Manufacturers that employ the system integrator business model commonly choose this external approach to capability building. Boeing, for example, relies on a network of MRO providers of Magnetic MRO, Monarch Aircraft Engineering, British Airways Engineering, and Norwegian Air Shuttle that form their Gold Care network in Europe (Pozzi, 2017c). This approach allows airframers to overcome workforce shortage for their service business but leaves them with the challenge to integrate external providers into a network that is capable of delivering services to a consistent quality and performance standard.

While the reliance on partners is not a disadvantage per se, MROs possess opportunities to leverage the fact that they possess an internal maintenance network to achieve competitive advantage. Interviewees stated three main direct underlying mechanisms: (a) cost advantage through leveraging economies of scale, (b) differentiation and cost advantage through shortened repair TATs, and (c) consistent quality standards throughout the network. Additionally, superior repair and engineering capabilities can be achieved by gathering operator experience through the internal maintenance network, while integrators have to rely on knowledge spillovers from external partners to gain these resources and capabilities.

Economies of scale on tangible and intangible resources are the first mechanism by which large maintenance networks can be leveraged to gain an advantage against manufacturers that enter the service market. In MRO, tangible resources such as maintenance facilities or test benches require high investments and are thus subject to economies of scale through utilization. Firms with a broad established customer based are better able to exploit these resources than firms who first need to invest to credibly build the repair capability and then earn a sufficient customer base to ensure a high asset utilization. Also, intangible resources such as engineering orders for cabin modifications are subject to economies of scale. One example is the assessment of a Service Bulletin[8]: The total amount of engineering hours required to assess an SB and write the needed engineering orders for its implementation incur only once per aircraft type (e.g., the A320). Once an assessment and working order has been designed for the particular aircraft type, just minor adjustments for the idiosyncrasies of each customer need to be made.

Component Solutions represents one example where a *shortened repair TAT* and *quick fixes to problems* lead to a cost and differentiation advantage. Cost savings are reached, as components that are repaired internally require less shipping to dispersed repair stations around the world and are thus returned quicker to the serviceable pool. In effect, less shipping and capital costs accrue for the pool's upkeep. A short repair TAT is espe-

[8]Service Bulletins (SBs) are non-mandatory recommendations issued by manufacturers. Typically, they are not safety-relevant but include modifications that aim to improve optimizing operations or passenger comfort (Hinsch, 2012).

cially relevant for time-critical parts, e.g., in case of an AOG. While Airbus and Boeing subcontract most component maintenance to their tier 1 component suppliers, the MRO possesses workshops that repair most of the components in-house. Manager Product Management at MRO 1 explains that *"in 80% of the cases we can act faster as someone who is doing [the repairs] externally. Let it be Air France or even Airbus."* This is especially valuable in case of AOG, as the Head of Business Development Strategy Component Maintenance at MRO 1 resumes: *"Dear customer, please consider what happens, when you have an AOG [...]? Then, I walk over into the workshops and tell the boys: 'drop everything and finish this unit first, no one goes home before it's finished!' But if I subcontract it, like Airbus, then I don't have it in my direct control, but I have to call my suppliers and beg him to expedite that damn part somehow."* These quick fixes allow to lower the substantial costs that airlines incur in case of an AOG.

Pure service firms that rely on an internal maintenance network may also differentiate themselves through the establishment of *constant service quality standards* throughout the network. For system integrators, this may be more difficult, as the education and work ethics of the workforce, processes, IT, quality assurance systems, and other factors are more challenging to influence across firm-boundaries. Consequently, manufacturers that want to successfully follow this path first need to develop distinctive capabilities (Paiola et al., 2013). In fact, Boeing's service quality has been criticized after the repeated grounding of one the GoldCare customer Norwegian Air Shuttle's aircraft, which lead to the lease of two Airbus A340-300 which incurred costs of 100 million kroner (USD 17 million) (Broderick, 2013a). However, an equal service quality does not come for free but requires considerable investment. MROs need active efforts to establish global standards across the individual units to actively increase their cost efficiency and service quality (Haubensak et al., 2010).

If, in contrast, manufacturers choose to build their maintenance network internally, traditional MROs initially have an advantage through their established operator experience and associated learning curves, leading to superior Repair and Engineering Capabilities.

Operator Experience The MRO's Operator experience is the resource that enables competitive differentiation against OEMs which received the most robust empirical support, being named by 16 interviewees. Operator experience is considered vital as it (a) is valuable for competing through both cost leadership and differentiation, (b) is tacit and thus difficult to imitate for OEMs, and (c) allows the MRO to address the airline's needs better. Operator experience enables MROs to gain competitive advantage through cost leadership and differentiation in both traditional services and solution offers.

In traditional service offers such as Engine Maintenance, operator experience allows the MRO to improve its repair and engineering capability through learning-by-doing. These learning curves present in both manufacturing and services industries (Darr et al., 1995) enable to lower the unit costs and increase efficiency for service provisioning. As operator experience is accumulated over the years by servicing aircraft, manufacturers cannot easily imitate it but need to walk down the learning curve themselves.

The effect of operator experience on cost and differentiation advantage is even more pronounced in solution offerings. This is because solutions involve taking over the responsibility for the customer's processes (Matthyssens & Vandenbempt, 2008) and thus require explicit and tacit knowledge components that are related to taking over airline-specific processes. Manufacturers that lack some of those knowledge components or underestimate the complexity of solution-provisioning may experience servitization failure (Valtakoski, 2017).

The Vice President Sales of MRO 1 nicely illustrates the manufacturers' difficulties in understanding customer operations: *"The OEMs are very good in developing, designing and approval of new equipment. But actually, they have no idea what it means to operate the equipment. They only receive rudimentary information about what problems are associated with that, and there we are much closer."*

The lack of operator experience becomes especially crucial in Aircraft Solutions, where MROs can make use of its operator experience to optimize the maintenance schedule because it can *"think and act like an airline and not the OEM"* (Team Lead Aircraft Engineering Services MRO 1). Thinking like an airline allows the MRO to achieve improved levels of aircraft availability, reliability, and cost-efficiency. This understanding of the airline is also limited in the engine segment as, as a Manager Engine Repair Services explains: *"do they [the OEMs] also have the experience of the operations? The proximity to the airline, the proximity to the customer through operations? Do the OEMs have that per se? In my opinion, you surely cannot accredit that to everybody [...]. That they actually know now how an airline works. And that they can also handle the complexity of the airline business, I would say, to the expectation of the customer. In my opinion, many OEMs cannot perform that."*

Operator experience is tacit knowledge, which is gained by servicing the aircraft and customers' operation directly. Being tacit, it is difficult to replicate for manufacturers, since they do not operate the aircraft themselves and often use third parties to provide Line Maintenance to airlines. Thus, airlines and MRO providers have a better knowledge of the airplane and components in operation, which can influence customers in their maintenance decision (Valtakoski, 2017).

The gap in operator experience is estimated to narrow in the future, as OEMs make use of increasing levels of sensor technology, data transmission, and data analysis in their products (digitization), which I explore further in the next section. Another factor that has to be taken into account is that manufacturers will gain more experience by providing services in the future and thus narrow today's knowledge gap.

Serviced Fleet (Incl. Data) Two main mechanisms have been identified by which a serviced fleet acts a Key Resource that can be leveraged into a competitive advantage: First, firms can build the just discussed operator experience and the associated service capabilities by performing services on the fleet. Second, servitization literature argues that manufacturers should aim to provide services on the installed base (i.e., fleet of serviced aircraft in the aerospace industry) of their products (Wise & Baumgartner, 1999) to build data processing and interpretation capabilities that they can leverage to cost and differentiation advantage against pure service providers (Ulaga & Reinartz, 2011). According to servitization literature, installed base data is a unique resource for those manufacturers that systematically construct their equipment in a manner that neither competitors, third parties or pure service firms can properly provide service on their equipment (Ulaga & Reinartz, 2011).

In the Aerospace Industry, MROs are however generally the established providers servicing this installed base. In contrast, manufacturers first need to increase their market share to gain a comparable amount of serviced aircraft, which they have now achieved to a varying degree. Besides, data is broadly available on legacy aircraft types while on new types of equipment manufacturers establish barriers to third-party data access. This serviced fleet is valuable, as increasing data-availability has the potential to lower maintenance costs (Baines et al., 2007), which may result in a competitive advantage for whoever has access to the data, be it OEM, airline, or MRO. To successfully leverage data, firms then require data processing and -interpretation capabilities, which are elaborated in the Key Capabilities section.

Hence, the three questions that need to be answered are: (a) *"how much value and thus potential for competitive advantage can be derived from the data?"*, (b) *"who has preferential access to operational data of the serviced fleet?"*, and (c) *"do MROs or OEMs possess superior data processing and interpretation capabilities?"*.[9]

In Aerospace, digitization has raised the debate about the utility and ownership of the exploding amount of available data in aerospace, as well as who is best poised to profit from these developments (Spafford et al., 2015; Valeika, 2015; Hoyland et al., 2016; Shay, 2016; Canaday, 2017b). While some authors (e.g., Spafford et al., 2015) argue that big data will be disruptive, other authors (e.g., Anselmo, 2017) and interviewees (2, 7, 11, 16, 20) predict only incremental improvements in cost efficiency and aircraft performance. This is because aircraft already have very high reliability (typically above 95%) and provide ample data that is used for maintenance optimization.

[9] Questions (a) and (b) are elaborated in this section, question (c) in the Key Capabilities section.

However, a consensus exists that increasing availability of big data and analyzing capabilities will enable reduced costs and improved aircraft performance through methods as predictive maintenance (Brown, 2014a; Spafford et al., 2015). Another consensus is that digitization will enable new, platform-based business models such as asset-free component pooling or data consolidation and provisioning.[10] These new business models will however not replace maintenance, repair, and overhaul activities, as the CEO of MRO 1 notes: *"One thing is for sure, there will be no revolution. We will continue having workshops that repair parts; engines need to be repaired, and also Base Maintenance will continue existing in the future. Digitization doesn't help here at all."*

So, does data generated by the serviced fleet enable competitive advantage? While it is still too early to predict the exact amount of cost-reductions that can be reached by digitalization (Shay, 2017b), interviewees estimate single digit up to 15% of MRO cost-reduction through increased efficiency and reliability gains. Much of the efficiency gains are enabled by predictive maintenance, i.e., the performance of maintenance tasks, when required by a predictor and not by a fixed interval. For example, a maintenance technician will inspect and change a tire, once indicated by a sensor and not depending on a maintenance schedule that cannot take operational effects into account. Also, indirect effects on aircraft operating costs exist. One example is reduced fuel burn of engines when maintained in optimal condition, or fewer disruptions in operations if parts are changed at the hub before failure on outstations.

Increased data also raises opportunities for competitive differentiation. For example, MRO providers can tailor offers more individually to the customer's needs as improved data improves their customer knowledge. Additional data may also enable MROs to make further consulting offers to the customers that could increase their aircraft performance or cost-efficiency. In conclusion, many opportunities exist to leverage the fleet's data into cost leadership and differentiation advantage, while the specifics still need to be determined.

The second question is, whether MROs or OEMs are better poised to access and interpret the data generated by the serviced fleet. Three distinct types of data exist that can be combined and leveraged for competitive advantage: (a) sensor-generated data, (b) operations-generated data (e.g., flight routes that inform about hot and sandy conditions), and (c) data generated through maintenance events.

Sensor- and operations-generated data is per default property of the airline and thus can, in theory, be accessed by both MROs and OEMs alike. Here, MROs can gain an advantage against OEMs, as many airlines prefer to share data with a neutral intermediator and not directly with the OEM (Spafford et al., 2015), to limit their OEM-dependency. MROs are better poised to take this intermediator role, as CEO MRO 1

[10] First signs of these new business models are already visible as of today, e.g., Lufthansa Technik's AVIATAR Platform that collects and provides MRO-relevant data from different airlines (Shay, 2017b).

confirms: *"we are underway with the concept of an open platform, while the manufacturers offer a closed system, in which I [the airline] have to even pay for the findings of my own data! [. . .] And of course, you don't want that. Plus, there are many airlines — not all, but many — that do not want to let the dependency on the manufacturer grow even further."* This dependency is especially critical as OEMs encounter a conflict of interest as they determine the timing of parts removal while they are inclined to sell more spare parts (Spafford et al., 2015). However, it is common practice for manufacturers to gather certain proprietary portions of data in encrypted channels that is not shared with the customer.

The third type of data is generated through maintenance events. This includes for example findings of the mechanics during removal that are documented in maintenance records. As Line Maintenance is regularly not provided by the manufacturer but by the airline or the MRO provider, MROs have an advantage in accessing this type of data. Manager Product Management MRO 1 illustrates with an example: *"The OEM has the advantage that he can in principle have access to data from all airlines [...] and the MRO has the advantage to have access to in-depth data. That means knowing really everything from the contracted airlines. It means knowing not only that a component has broken, Airbus knows that as well [. . .], but we also know exactly which washer has broken."* One challenge is to combine and interpret these different types of data, which requires a capacity that is discussed as the data processing and interpretation capability in the Key Capabilities section.

Product Sales Force, Distribution Network, Customer Relationships, and Channels [11]

The product sales force and distribution network that underlies the hybrid offer sales capability provides the manufacturer with close ties and privileged channel access to the customer (Ulaga & Reinartz, 2011). Interviewees have asserted this claim, stating that Engine and Aircraft manufacturers enjoy earlier access to the customer on a higher organizational level (usually the CEO instead of the Technical Director), which allows them to pre-shape the maintenance provider decision. This claim is confirmed by a recent survey conducted by Oliver Wyman that shows an increasing willingness of airlines to procure maintenance services at the time of aircraft purchase to pit one OEM against another and secure beneficial long-term aftermarket contracts, often leaving independent MROs out of the equation (Spafford & Rose, 2013). In many cases, this enables the OEM to "bag the deal", before MRO providers even know of it, as Manager Product Management MRO 1 puts it: *"They have the big advantage that they have the first point of contact that you can have, every airline has to speak to them, that's not the case for us. And for sure they have the advantage that they can partly already put the pig in the poke before we even knew that there was a pig."*

[11] This section all three business model elements as they are closely tied to one another and are difficult to disaggregate.

[12] Source: Spafford & Rose (2013, p. 4). Sourcing of MRO services during the aircraft selection process does not necessarily exclude MROs. For airlines, this timing decision is the most sensible to be able to reap full bargaining power and transparently compare the full lifecycle costs.

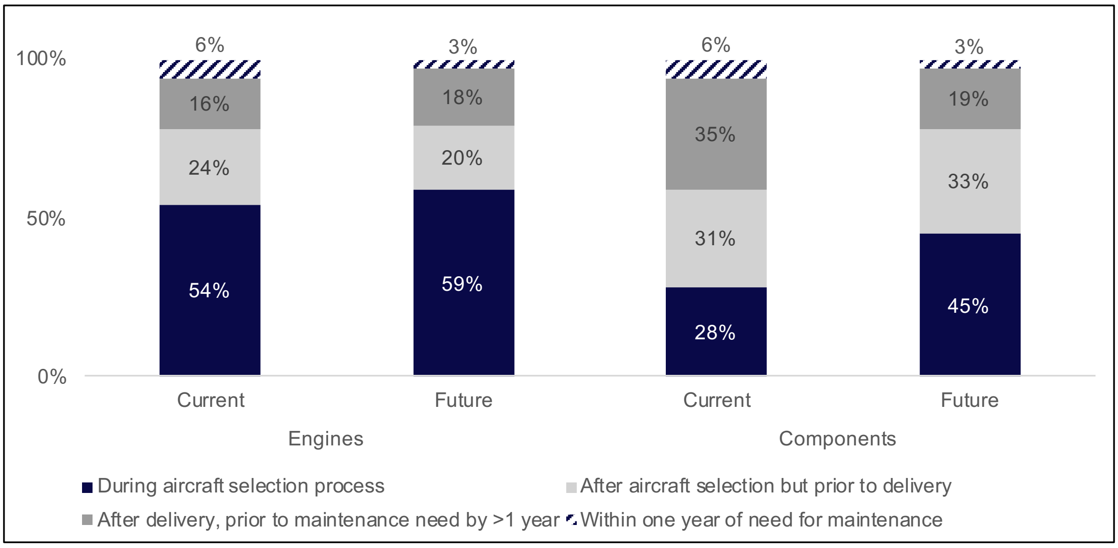


Figure 6.4: Timing of Airline's MRO Sourcing Decision[12]

The manufacturers' superior channel access through their sales force is however partly offset by the MROs' long-term trustful relationships with airlines regarding MRO services. Additionally, the MRO's sales force may initially be more effective, since a product sales force needs to acquire additional knowledge and capabilities. The reason is that sales managers have to transform from a passive recipient of a predefined offer into more active participants in a value creation relationship typical for services (Kowalkowski et al., 2015). It has even been argued that a separate service organization with a dedicated sales force should be created and a service culture needs to be built to provide services successfully (Gebauer & Friedli, 2005). In practice, both Airbus and Boeing have followed this logic by establishing separate service business units including a dedicated service sales force.

In conclusion, unlike previously assumed, the manufacturer's sales force is a unique resource that provides manufacturers with a definite sustained competitive advantage. Instead, the source of competitive advantage rather lies in preferential channel access. For MROs, long-term relationships that have created trust in the MRO's service quality may provide a differentiation advantage, at least until manufacturers have been able to gain legitimization and earn their customers' trust in the provisioning of services (Sirdeshmukh et al., 2002).

Product Development and Manufacturing Assets Manufacturers hold unique tangible and intangible resources relevant for R&D and production of goods, such as tools, patents, and licenses that pure service firms do not possess. Unlike service firms, manufacturers can thus exploit spillover effects between production and service provisioning to gain a differentiation advantage against pure service firms (Ulaga & Reinartz, 2011).

However, this proposed mechanism of unique service innovation has received only little empirical support in the study, where interviewees did not report any mentionable unique Value Propositions to airlines. One reason that was repeatedly mentioned by interviewees was the high level subcontracting in the aerospace supply chain and the associated limitation to systems integration on behalf of the airframer (Krol, 2011), as the CEO of MRO 1 explains: *"What is the actual added value that Boeing provides via Gold-Care? Boeing is doing nothing besides system integration; Landing Gears are not overhauled internally, engines are not overhauled, have a look at Boeing partnumbers: on a 737 or 787, of these 600 partnumbers, Boeing can repair maybe only 200 - 250, the so-called Boeing partnumbers. The rest are all suppliers, so what Boeing is doing today in aftersales is nothing but a huge integration service."*

The perception of the interviewees may, however, be somewhat biased, as manufacturers are the only ones legally entitled to approve certain repairs and modifications. Also, Engine Solutions on new engine types in which the manufacturer is capable of providing more maintenance cost guarantees than pure service firms.[13] In conclusion, some evidence of spillover effects between production and service provisioning exist. The question, whether MROs or OEMs can differentiate their service offers thus depends on the OEMs' capability to better leverage those spillover effects in the future and the MROs' capacity to build offers that are based on their unique operator experience.

However, a different predominant mechanism of gaining competitive advantage by manufacturing-related assets became salient in the study. By protecting access to intellectual property rights and testing equipment, manufacturers systematically erect entry barriers to servicing their equipment. These entry barriers constitute a positional or cost advantage as they increase the MRO's cost of competing or inhibit competition altogether. Therefore, product development and manufacturing asset enable competitive advantage, however not by differentiation but instead by the creation of barriers to competition.[14]

Other MRO Key Resources The two remaining Key Resources of the MRO business model, i.e., financial strength and manufacturing-specific resources have not received empirical support as a source of competitive advantage for MRO firms against manufacturers. In contrast, dependence on manufacturing-specific resources is discussed as one main contingency factor determining the MRO-OEM alliance formation (see section 6.2.2). While financial strength is required to make necessary investments in new generations of technology, the funds available to MROS as pure service firms are

[13]See the discussion of the Risk Management Capability in this section.
[14]See discussion in the section 6.2.2.

dwarfed by the budgets regularly available for the research and development of aircraft manufacturing programs. Hence, financial strength is instead a prerequisite for competitive survival and many small MRO shops are not expected to be able to stem the investments that are required for servicing new generations of aircraft.

Key Capabilities

Repair and Engineering Capability Manufacturers and pure service firms differ considerably in both their repair and engineering capability due to their base in either products or services. While for manufacturers, performing repairs was traditionally seen as a "necessary evil" (Lele, 1997, p. 141), maintenance, repair, and overhaul is at the heart of the traditional business model of MRO firms. Manufacturers do however possess an in-depth knowledge of the product as they have designed and manufactured it, possibly under the considerations of easy maintainability (Lele, 1997).

Engineering capabilities, on the other hand, are rooted in the manufacturers' R&D departments, which are at the core of their business model. Recent research suggests that product and service innovation follow similar underlying mechanisms (Nijssen et al., 2006) and that manufacturers can transfer their product-based engineering capabilities for service innovation (Ulaga & Reinartz, 2011). However, other studies find that in service innovation, increased interaction with the customer is required to make the front-end of service innovation less "fuzzy" and positively affect innovation performance (Alam, 2006). Hence, it is not apparent why one party or the other should possess superior service-specific engineering capabilities.

However, interviewees perceived the MROs' engineering and repair capabilities as superior to the OEMs' throughout the different segments, as they have been honed through years of operator experience and the fact that MROs repair the equipment of multiple OEMs. While the former allows MROs to accumulate tacit repair knowledge and realize learning curves, the latter will enable them to fix errors that are outside the scope of a specific OEM and benefit from knowledge spillovers between technologies.

One quote illustrates exceptionally well how tacit repair and engineering knowledge is created through interaction with the technology: *"The OEMs [...] only receive rudimentary information about what problems are associated with [the operation of the equipment], and there we are much closer, so we see the unserviceable units in our shop, we repair them and our engineers think about: 'what could you do different, so that they are not these are not as susceptible here or there'?"* (–VP sales of MRO 1). This quote shows that MROs possess service-specific repair and engineering capabilities that are closely linked to the product in operation and that these specific capabilities are challenging to imitate through development and production of equipment. Also, the Aeronautical Repair Station Association (2013) reports that airlines prefer providers that can differentiate themselves through repair capabilities that are based on operator experience and entail the ability to find quick solutions to non-routine errors.

A second advantage arises as MROs possess repair capabilities across the equipment of multiple OEMs (i.e., the multi-vendor capability). By servicing the equipment of various manufacturers, MROs can participate on knowledge spillovers across products and services, which is illustrated by the following quote: *"we can learn across different models of equipment: the new engine technologies are similar, first comes one manufacturer, then the second, then the third. We can gather experience on all models."* (–CEO MRO 1).

In summary, a complex interplay of repair and service-specific engineering capabilities across OEM platforms, operator experience, and the integration capability allows MROs to gain superior repair and engineering capabilities that they can leverage to gain a competitive advantage against OEMs who do not possess these capabilities.

Multi-vendor Capability The capability to provide services on multiple types of OEM equipment is unique to MRO service firms and allows MROs to provide repairs across the boundaries of a single OEM. This capacity furnishes MROs with a differentiation advantage that spans from finding solutions to problems that are outside the scope of a specific manufacturer up to becoming a one-stop-shop for all of customers service needs. The latter solution offer can reduce costs and complexity of operators that wish to concentrate on their core business and rely on Aircraft Solutions to outsource their maintenance needs (Schneider et al., 2013).

One quotation illustrates how the multi-vendor capability allows MROs to find and repair errors outside of the scope of a specific OEM on a particular aircraft type: *"We have the view on the whole aircraft: if, for example, Pratt needs to perform a repair and the failure does not concern the engine directly, then they are K.O. We, on the other hand, are a full integrator that can exchange all parts. This is our Value Proposition on the one hand towards the OEMs who themselves are giving performance guarantees, and on the other hand also towards the airlines."* (–CEO MRO 1). Here, more value is created for the customer, especially in solution offers, where the provider is responsible for the outcome and integrating the repair of the equipment of multiple manufacturers.

The multi-vendor capability is of some, albeit more limited, value across different aircraft types. The reason is that most MRO services are sourced individually per fleet, e.g., a landing gear overhaul for a carrier's A320 and B777 fleet would typically not be procured within the same tender. Here, added customer value lies mostly in reduced complexity by having to deal with only one instead of two suppliers. Furthermore, all-encompassing Aircraft Solutions are mostly purchased by start-up carriers that usually operate a single aircraft type and hence do not benefit from the multi-vendor capability.

Some room for differentiation exists, however, as this example shows: A network carrier operating a diversified fleet of both Airbus and Boeing aircraft that wishes to install a connectivity system for its fleet. If the operator prefers to deal with a single supplier that is able to design one solution for its entire fleet, it cannot rely on the airframer but requires an independent provider.

The manufacturers have realized the importance of this capability and the advantage it gives to independent MROs. Hence, they are actively pursuing to build multi-OEM capabilities, as David Longridge, Vice President of Sales of Boeings Commercial Aviation Services stated at a panel at MRO Americas on 27 April 2017: *"Airlines don't want an Airbus solution, an Embraer solution, and a Boeing solution. They want a service solution. [...] The rise of independent of MROs is proof of that."* (Trimble, 2017, p. 2). However, it is highly questionable if manufacturers will be able to build multi-OEM capability, as their competitors will try to inhibit all attempts to service their installed base and additionally gain information about technical properties of their aircraft.

Data Processing and Interpretation Capability As discussed in the Key Resource section, digitization and the inherent increase of available data can lead to competitive advantage through increasing cost-efficiency of MRO services as well as increasing aircraft availability and performance. Also, we clarified that both OEMs and MROs can access serviced fleet data, however with a different scope: While the OEM can potentially access equipment-related data for its entire installed base, the MRO has potentially more access to operations- and maintenance-related data.

Competitive advantage then arises if either party possesses the required capabilities to transform the available data to superior service or solution offerings. To build these service-related data processing and interpretation capabilities, manufacturers can make use of their product development and manufacturing assets that provide them with an in-depth understanding of their system to create unique customer benefits such as cost reductions and productivity enhancements (Ulaga & Reinartz, 2011).

Pure service firms lack this in-depth product-related knowledge, especially on new types of equipment, which puts them at a disadvantage against manufacturers in this field. However, they possess unique other resources and capabilities that they can leverage in the process of building service-related data processing and interpretation capabilities. First, their multi-vendor capability allows MROs to gather and analyze a broader set of data than their manufacturing counterparts, making use of spillover effects between equipment. Second, MROs can build independent platforms, such as Lufthansa Technik's AVIATAR that allow customers to perform health monitoring of all their aircraft, engines, and essential components, irrespective of the manufacturer. This creates unique value for customers that can access one single platform for all their assets instead of multiple OEM platforms, with the associated usage costs and complexity. This one-stop approach, in turn, may enable them to gather even more data than their manufacturing counterparts and further elaborate their data interpretation capabilities. Third, by utilizing their unique access to maintenance- and operations-relevant data, MROs are better able to link operating conditions, data generated by the equipment, and its physical condition, which may allow them to make superior predictive models than their OEM counterparts that have only limited access to operating and maintenance data.

In conclusion, it is questionable whether OEMs can create superior service-related data processing and interpretation capabilities than independent service firms. The result is likely to be contingent on the MROs' data access and the manufacturers' ability to link data to operations, and superior service or solution offers. Alternatively, also new business models in which manufacturers provide their data-driven solutions on independent platforms may evolve in the future, combining the strengths of both competitors.

Bundling Capability As manufacturers possess a product and service portfolio, they possess the unique capability to bundle the pricing of both product and service components in a seamless hybrid offer. MROs, on the other hand, are somewhat limited in their bundling options, as they would first need to procure the product to then bundle it with their service offers. In the Aerospace Industry, this is only regular practice in Component Solutions, while the airline itself typically purchases or leases aircraft and engines.

Bundling asset and service sales inseparably is a strategy that can be employed by manufacturers to achieve complete channel control, effectively inhibiting other firms from competing (Stremersch & Tellis, 2002; Nalebuff, 2004). However, customers generally prefer debundled pricing, due to the higher transparency in the procurement process. Although debundled pricing results in more customer value and a higher willingness to pay (Steiner et al., 2016), it has been shown to drive servitization failure (Forkmann et al., 2017a).

Unlike MROs, manufacturers can bundle and hence to some extend cross-subsidize product and service sales, by granting conventional discounts on equipment only in case that service packages are selected: *"the OEMs want to make money off [the MRO market], so they will sometimes even sell the airplane at a lower cost, and they won't make any money on the airplane, but they will make money in the aftermarket."* (–Technical Operations and Maintenance Instructor, Airline 6). If detected, manufacturers, however, refrain from this practice, since its legality is rather doubtful if employed to a great extent. For example, Rolls-Royce has successfully performed an inseparable bundling strategy on its Trent engine, holding over 90% of all maintenance contracts in the past. Today, however, Rolls and other engine manufacturers have abolished this strategy to dispel anti-competitive concerns and to establish more competitive engine service networks

(Shay, 2015b). Hence, bundling is nowadays less relevant in the aerospace industry to create entry barriers.

Also, airlines usually demand debundled pricing of the asset (e.g., the aircraft or the engine) and related service offers to (a) ensure a more transparent asset and service buying decision, (b) reduce dependence on the OEM, and (c) establish competition between providers of service offers. A more subtle bundling option of manufacturers is to offer more cash flow flexibility to airlines, discounting the initial purchasing price of the aircraft, which is offset through higher MRO rates at a later point. This way, airlines can shift their capital expenditure in favor of future operative expense, which is an attractive option for airlines under financial pressure.

Risk Management Capability My study confirms previous findings, according to which manufacturers can gain differentiation advantage through their ability to assess and manage risks associated with performance-based contracts, as they are better able to assume their customers' risks (Ulaga & Reinartz, 2011). Engine Product Manager vividly sums up his perception of the situation: *"we can't assess the risk, we don't know the engine from a technical standpoint, we don't know the prices, we only have an idea how they can develop, so [pause] making a Flatrate offer is threatening our business. [...] Well, the OEM is actually the only one who can really do that."* (emphasis added by author).

Three mechanisms were identified on which manufacturers base their superior risk management capability. First, they possess superior product design data and abilities which allow them to better assess the service life of the product from a technical standpoint and lower the level of risk before the product starts its operational phase. Second, manufacturers are less exposed to risks as their ample profit margin on spare parts[15] acts as a risk buffer. In cases in which the product does not meet the performance requirements, the profitability of the combined spare parts and service business will decrease, however much less than for the MRO who has to carry the list price not production costs of the replaced parts. A third advantage is the manufacturers' ability to influence the profitability of the aftermarket business through material price increases, which shift the risk back to the customer and third-party service providers. In aerospace, manufacturers are typically able to increase the prices on spare parts, as often little or no alternative to OEM spare parts exist. In conclusion, manufacturers have superior risk assessment and -mitigation capabilities that are especially valuable for offerings that involve assuming high levels of risk, such as engine maintenance. Here, MROs are limited in their ability to offer solutions and hence suffer from a differentiation disadvantage.

[15]Interviewees report unanimously between 500% to 1,000% profit margins on spare parts.

Hybrid Offering Deployment Capability Manufacturers possess the unique hybrid offer deployment capability, which is the capacity to "rely on flexible platforms that allow for standardizing production and delivery processes while safeguarding its ability to adapt to individual customers' needs" (Ulaga & Reinartz, 2011, p. 16). Recent research has found that manufacturers indeed transfer manufacturing concepts to service provisioning, "industrializing" services, in order to increase their repeatability, scalability, and profitability (Kowalkowski et al., 2015). In the process, OEMs are confronted with barriers of transferability of manufacturing-based models, as the underlying assumptions do not hold in service industries (Grönroos & Ojasalo, 2004).

Hence, it is questionable whether the industrialization of services is a unique capability of manufacturers, especially as unlike much of manufacturing it requires the standardization of back-end processes while maintaining a customized front end (Miller et al., 2002). In fact, interviewees reported the usage of lean methods to improve a variety of services, partly with considerable results. One example is the reduction of component repair TAT to about 30% of its initial value, allowing the company to return customers components faster and reducing capital costs in their components solution offer.

Hence, the hybrid offering deployment capability is not unique to manufacturers. Instead, both manufacturers and pure service providers have taken efforts to adopt efficiency concepts such as lean methods from manufacturing to a service context. The difference between both parties is that manufacturers typically adapt their product-based platforms to fit for service-provisioning, while pure service firms directly apply similar concepts on their service business. Therefore, it is unlikely that either party can achieve a sustainable competitive advantage through this capability, as the efficiency gained depends on how well the related activities are executed.

Conclusions: both manufacturers and pure service firms possess unique elements in their business model that they can leverage into a competitive advantage. Not surprisingly, the manufacturers' foundation of competitive advantage lies in their base in products, whereas MRO firms can compete based on their service-based business model. Stating that one party possesses a total competitive advantage over the other would be a simplification. Instead, different contingency factors exist that favor either manufacturers or pure service firms in attaining competitive advantage. These and other contingency factors that influence the MRO BMI path to form alliances with manufacturers are explored in the next section.

6.2.2 Alliancing with Manufacturers: a Contingency Approach

In this section, an empirically-founded contingency approach towards alliancing with manufacturers from a service provider's view is established. According to contingency theory, a fit between a firm's business model, strategic intentions, and the firm's environment needs to be achieved (Osterwalder, 2004; Zott & Amit, 2008; Demil & Lecocq, 2010). Contingency factors are then those internal (e.g., firm- and offering-specific) and external (i.e., market-specific) factors that determine which type of business model innovation is best suited to fit these particular circumstances (Davies & Brady, 2000).

This contingency approach contributes to our understanding of antecedents of alliances between OEMs and service firms from the currently under-developed service firm side. Considering the size and diversity of the sample relative to the size of the Aerospace industry, it needs to be assumed that a practically relevant approach has been identified that reflects the perception of managers in the industry.

Pure service firms that become partners in manufacturer-led solution networks are a common theme in solution literature (e.g., Gebauer et al., 2013; Paiola et al., 2013), which has due to its manufacturing-focus created very little knowledge regarding this BMI path and the different types of network partner business models. Partnerships between pure service firms and OEMs also occur in the aerospace industry but have come under critique regarding a lack of added customer value and sustainability for service firms Schneider et al. (2013).

The pilot study showed however that MROs do not need to form alliances with manufacturers in every case to offer solutions. Consequently, forming a partnership is not necessarily the best way to innovate the MRO's business model in any given situation, especially considering the aforementioned adverse side effects. Instead, contingency factors exist that determine whether allying is the best response and may have an impact on the type of alliance that will be formed (Mintzberg, 1979). Additionally, MROs can pursue various configurations of partnerships with manufacturers, which differ in many facets such as the Key Activities performed and the roles of each actor in the alliance. The contingency approach is limited to the alliance decision, i.e., whether or not to form a partnership. The subsequent choice of which type of collaboration is most beneficial is discussed in Section 6.3.

The contingency factors were identified through a cross-case analysis of theoretically sampled cases including different outcomes of competitive advantage and the subsequent alliance decision (Miles & Huberman, 1984). The result of this analysis is illustrated in Table 6.2 and the factors that shape the alliance decision of pure service firms are explored in the next sections.

For readers, it may come as a surprise that the main contingency factors that determine whether MROs enter alliances with OEMs stem from resource dependence theory, which is a stark contrast to the alliance approaches that have been identified from the manufacturer's side (see Chapter 2.3). The reason for the difference in approach by pure service firms lies in the fact that manufacturers are not only competitors and possible partners but also the most important suppliers of MRO firms. Hence, a buyer-supplier relationship between these pure service firms and manufacturers with considerable levels of bargaining power of one party over the other exists. When manufacturers evolve

Case characteristics		Engine	Components	Aircraft
Description	Solution offer	Engine Solution	Component Solution	Aircraft Solution
	Main OEM Competitor	Engine OEM	Aircraft OEM	Aircraft OEM
	Main OEM Supplier	Engine OEM	Component OES	Various different sources
Outcome	Alliance / Competition Decision	Alliance w/ Engine OEM	• Alliance w/ OES • Competition w/ A/C OEM	Competition w/ A/C OEM
Dimension	**Contingency factors**	**Engine**	**Components**	**Aircraft**
DRIVERS OF OEM BARGAINING POWER	**Material dependence**	**H**	**M**	**L**
	Material share	~ 60-70%	~ 30%	~ 10-15%
	Availability of alternative sources	L	M	H
	IP / tool dependence	**H**	**M**	**L**
	IP necessity	H	M	L
	Tool necessity	M	H	L
	IP / Tool Imitability	L	M	M
DRIVERS OF MRO BARGAINING POWER	**Airlines Sourcing Practices**			
	Fostering competition	present	present	present
	Short-term focus	present	present	present
	Industry Position & Environment			
	Affiliated Airline with sourcing campaign	present	present	present
	Legal Norms	H	H	H

Table 6.2: Cross Case Analysis: Contingency Factors per Case

their role from suppliers to competitors through servitization, MRO-OEM interdependence serves as the main factor driving the MROs alliance decision. In the next sections, the drivers of OEM and MRO bargaining power are analyzed in greater detail.

Drivers of OEM Bargaining Power

In the study, I identified five drivers of bargaining power of manufacturers against pure service firms. These drivers are outlined in Table 6.3.

Material Dependence describes the MRO's dependence on the OEM's materials for service provisioning. The magnitude of material dependence depends on the two drivers (a) the material share, i.e., the percentage of material costs in total costs required to provide the service offering and (b) the availability of alternative material sources besides the manufacturer.

The value created by returning a part of an aircraft or the aircraft itself into a serviceable condition is created through services such as the performance of maintenance tasks and

Dimension	Contingency Factor	Item	Proof Quotas
DRIVERS OF OEM BARGAINING POWER	Material Dependence	OEM material share	*The market entry of the component OEM has another facet, as it is not only our competitor but also our most important supplier. [...] And then [...] we have in many places a dependency, [as] we buy much of the material [...] from the manufacturer. When the OEM says at the same time 'I would like to enter the market' then he does not have an interest in providing us with incredibly good material conditions."* – Head of Business Development Strategy Component Maintenance MRO 1
		Availability of alternative material sources	*„We know of Honeywell that they buy all the Honeywell material directly after an aircraft is scrapped, they are very active. [...] and we know of others that buy the surplus material to scrap it to shorten the supply."* – Manager Procurement MRO 1
	IP / Tool Dependence	IP necessity	*"what is a massive determinant in the engine market is that I need the access to IP. I need the access to manuals and repair data. And if I am not a member of the club I don't get it. And then I lack the basis for even performing repairs"* – Manager Alliance Function MRO 1
		Tool necessity	*"The essential entry barrier [for component maintenance] is the test equipment for avionics. And because of data scrambling I can't re-engineer it, I can't access it. And when I say: ‚I have a authorization in the supply support conditions that you have to make an offer", then the usual approach is that the test bench costs twelve million. And then the business case is not worth it. [There is] for example a manufacturer on the B787 that has 100% market share of repairs. We don't have repair capability"* – VP Purchasing MRO 1
		IP / Tool Imitability	*"We [can] build an alternative test bench. The re-engineering is becoming increasingly difficult, the closer it is to avionics and the more electric is included. But everything that is mechanic, I think we are confident [to build]."* – Manager Alliance Function MRO 1

Table 6.3: Drivers of OEM Bargaining Power

the exchange of material or spare parts. The MRO's dependence on manufacturers to provide the service depends on the magnitude of material required to perform the services. For services such as Base Maintenance that require only a small percentage of parts, a low dependence on the manufacturer results, while services like engine maintenance with a high material share result in a much higher dependence. This effect is magnified if the concentration of the supplier base is high, i.e., when most of the material is provided by few, or even worse, only one supplier (Pfeffer & Salancik, 1978). In these cases, the bargaining power of the OEM is further increased, which is underpinned by contrasting the three cases:

In the Aircraft case, the overall material share for service provisioning is low with approximately 15% material share in the Line Maintenance and 20% in the Base Maintenance segment. Additionally, most of the materials are provided by the airframer's suppliers, distributors and third-party vendors which results in a low estimated material share of 10-15% provided directly by the airframer.

In the Engine case, the material share is generally high, approximately 68%. In contrast to the Aircraft case, the material is almost exclusively provided by the OEM, except for some surplus and PMA material. On new engine types, alternative sources are scarce, and engine OEMs are actively working on "drying out" (Manager Procurement MRO 1) the material market, which further increases dependence. In summary, a single OEMs material share is estimated to reach 60-70% of total overhaul costs.

The component case is the best indicator for this factor: the dependence on the Original Equipment Supplier can be characterized as medium for two reasons. First, the overall cost-share of material is approximately 60% of the offering and second, a medium to a large share of the components on the aircraft are provided by the respective OES, resulting in a total material share of the OES' parts of approximately 30% of the Components Solution offer. In contrast, the dependence on the airframer (the main competitor) is considerably lower because the airframer supplies fewer components than its tier 1 OES.

Intellectual Property / Tool Dependence The second type of OEM-dependence results from the requirement of the OEM's intellectual property (e.g., instructions for continuous airworthiness) and tools (e.g., test stands) that are required to perform maintenance. The manufacturer has the possibility to decrease the MRO's competitiveness or prevent it from competing altogether by either restricting access to IP and tools or charging prohibitive prices, which renders building MRO capabilities uncompetitive.

The OEM's ability to protect the IP from re-engineering depends on the technology used in the component: While repair manuals and testers for mechanical and hydraulic units are comparably simple to re-engineer, while doing so on testers of electronic units is less feasible and economical due to data encryption technology. Also, the technological gap of new technology versus previous versions of equipment influence the imitability intellectual property. The reason is that MROs can more easily re-engineer new technology, which is similar to legacy technology, on which MROs still possess manuals. The effectivity of restricting IP access is widely accepted in market periodicals, e.g., Derber (2017, p. 2) states: *"The acid test for whether CFM is serious about retaining an open maintenance market will be the access it grants to LEAP technical documentation. By restricting this access widebody engine OEMs have made it near impossible for third-party providers to offer competing aftermarket services on certain powerplants."* This assessment is shared by one manager of the alliance function of MRO 1: *"So, today you are not able anymore — at least in some areas — or it requires massive investments, to be able to overhaul parts yourself if you don't have access to the documentation. And the CMM's that are available regularly have partly become thinner [...]. The MROs actually need to create the ICA themselves, verify themselves, test themselves."*[16]

Licenses OEMs use licenses to (a) moderate access to the aftermarket and (b) create revenue streams from their service network. As licenses are theoretically not required

[16] CMM: Component Maintenance Manual; ICA: Instructions for Continuous Airworthiness.

to perform MRO services but intellectual property, tools, and material discounts are only granted to licensees, licenses are a rather mediators than moderators of OEM dependence.

Manufacturers can limit themselves to either earning revenues only from license fees or competing with their own service offers against their licensees (as e.g., in open engine networks). In the latter case, the conditions stipulated in the license agreements directly determine the competitiveness of the MRO provider, as is illustrated by one alliance manager of MRO 1: *"you have to trust that the license conditions are good enough that [you can] still be competitive."* As licenses are a mediator, not driver of OEM dependence they are not included into the list of contingency factors.

Drivers of MRO Bargaining Power

Just as for manufacturers, a set of conditional factors exists that increases the bargaining power of MRO service firms, including airline's strategic sourcing practices and environmental (i.e., legal) factors. The business model innovation of becoming an OEM alliance partner is contingent on these factors, as it enables MROs to enter negotiations with OEMs to become partners in their service networks.

Airlines' Sourcing Practices Airline's strategic approach to the sourcing of MRO services (or the lack thereof) affects the competitive prospects of MRO service firms. Interviewees reported an interesting duality of procedures, on one side, increased awareness of increasing OEM hegemony in the MRO market but similarly a short-term focus on fixing the best available price for MRO services, even if this leads to increased market concentration in the long term. I have labeled these two aspects "fostering competition" and "short-term cost focus".

Airlines have been sensitized of the risk of increased monopolization of the MRO market and associated price increases since Rolls-Royce established complete market control with its Power-by-the-hour offering for the Trent engine (see proof quotas in Table 6.4). As a consequence, operators increasingly foster competition by enforcing their right to delegate their entitlements of the aircraft manufacturer's product support agreement to their MRO provider of choice (see Figure 4.13). These entitlements then allow MROs to access repair manuals and spare parts on behalf of the airline. This limits the MRO's dependence on the manufacturer, as the MRO can, in principle, access all relevant information.

OEMs counter this source of MRO bargaining power by providing maintenance manuals that contain only sufficient information to ensure airworthiness, indicating whether a component needs to be replaced. Information about repair methods and the required

Dimension	Contingency Factor	Item	Proof Quotas
DRIVERS OF MRO BARGAINING POWER	Airlines' Sourcing Practices	Fostering competition	*"I believe that it is the biggest risk for the MRO if everything runs via the airframer. Because monopolization increases even further and because of that less competition is taking place. And at the same time this is also the biggest risk for the airline. The awareness has already increased strongly due to [the development in the engine market]. Because everybody needed to sign with the OEM although they did not want to."* – CEO MRO 1 *"The airlines have no interest in a shut-off market and I would say that the airlines would need to try to inhibit with tooth and nails that today something like Rolls-Royce happens again. Where there's no competition, you know what happens with the prices. The airlines have the huge problem that they can secure [maintenance] conditions during the sales of the asset in the best case for 10-15 years but the aircraft flies for 20-30 years. That is the worst-case scenario in a negotiation because you only have two options: either you are at the OEM's mercy or you can negotiate with him on equal footing because you have another aircraft campaign. Otherwise you are de facto quite screwed."* – Manager Alliance Function MRO 1
		Short-term cost focus	*They just want to get their assets fixed, but in the long term this is going to hurt them, the pricing will be higher and higher because they are not doing the due diligence necessary to avoid monopolization in the market."* – Technical Operations and Maintenance Instructor, Airline 6 *"if an airline like easy Jet or Ryanair gets a good price with the OEM because they have high volumes and also constantly buy new aircraft, why should they be concerned regarding the rest of the world?"* – Commercial Director Business Unit 1, MRO 1.
	Industry Position and Environment	Affiliated airline	*"I think absolutely that [the affiliated airline] is the entry ticket. Without this lever, we soon would not exist anymore in many fields. I am firmly convinced of this."* – Manager Engine Repair Services, MRO 1
		Legal norms	*"[UTAS] said from the beginning: ‚we have probed from an antitrust perspective that it is enough to have three providers worldwide. So, in every country it needs to be possible to say: ‚There are three different sources for the same product, the same service. That's why we will issue three licenses.' And then they have not started to officially auction the licenses but they issued them only to someone with a certain footprint."* – VP Purchasing MRO 1

Table 6.4: Drivers of MRO Bargaining Power

tools is however increasingly restricted. Thus, airlines that foster competition between manufacturers and MROs can increase the MRO's bargaining power only to a certain extent.

Another facet of airlines fostering competition is that some airlines even employ a deliberate sourcing strategy of sourcing products from the manufacturers while providing services either internally or buying them from MRO service firms, as Director Finance, Product Sales and Key Account Management of MRO 2 explains: *"There are very few [airlines] that want to put all eggs into one basket, I know of one airline that is Asiana, where Tony Fernandes himself as owner said that he wants to oblige the OEMs to only deliver aircraft, he doesn't want anything else to do with them, they should please only deliver the aircraft, and he is playing Airbus and Boeing out against each other."* These types of airlines are actively shaping the market, obliging OEMs to pass the relevant information to MRO service firms, which is often conducted via some form of collaborative agreement. A third mechanism that has increased the manufacturers' openness of allowing competition was the severe reduction of engine value on the second-hand market, where airlines refrained from employing this engine due to the lack of MRO options (Schofield, 2018).

However, also a short-term sourcing approach could be identified that are instead focused on “fixing a deal” with short-term competitive maintenance costs than establishing a competitive cost position over the entire service life of the asset. Interviewees perceived the reasons for this rather short-sighted approach as being (a) financial sacrifices required for establishing an independent service provider, (b) initially favorable pricing for large airlines with sufficient bargaining power, and (c) focus on short-term operating costs.

A Product Manager at MRO 1 explains the aggressive buy-in behavior of manufacturers and the resulting financial sacrifices required for establishing a traditional MRO service firm against a manufacturer: *“and then again, the airlines say: 'okay, Airbus is entering [this market], it now becomes more difficult to get a good price, because once a monopolist has established itself, he can virtually set the price.' But none of the airlines wants to be the 'golden rider' in the phase before that. So to say: '[...] I chose the underdog, to not let this happen' because they are all somehow cost-driven and are looking for the best price. And that is what is happening on the new aircraft types, there is a fierce price war.”*

As shown in Table 6.4, large airlines with sufficient bargaining power are little concerned with OEM monopolization of the service market, as they possess recurring aircraft sourcing campaigns that they can use to re-negotiate MRO pricing with manufacturers. Consequently, these airlines can secure competitive pricing in the long term and suffer limited sacrifices of a market consolidation.

A third point is that smaller airlines simply lack the strategic sourcing capabilities and bargaining power to influence the MRO market in the long term actively. Hence, they rather focus on achieving favorable maintenance conditions for the initial contract period, as anything beyond this period lies outside of their scope or area of influence.

Industry Position and Environment This category refers to contingency factors that result from the MRO’s position in the industry (i.e., whether it forms part of an aviation group and thus has an affiliated airline) and legal environmental factors that positively influence MRO bargaining power. Due to the factors mentioned above, having an *affiliated airline* is regarded as a necessary condition for competitive survival in fields of high OEM dependency. The reason is that an affiliated airline is more likely to bear the costs and sacrifices for keeping the market open as these can be compensated through benefits of the MRO business. CEO of MRO 1 remarks: *“When the group buys aircraft [...] that is the only time that you have them [the OEMs] by the neck. Otherwise never. So, it is in our own interest to stay part of the [aviation] group, [...] only then we can enter the new technology.”* However, the affiliated airline is only an “entry ticket” to open negotiations, as the bargaining power is limited to the aircraft operated by the affiliated airline. When OEM dependence is high, MROs need to conduct further negotiations to attain a license to service third-party customers. Industry experts are unison in the opinion that an affiliated airline is a prerequisite for continuing to provide services on a broad scale. Consequently, independent MROs will have to focus on niches if they cannot seek alliances with OEMs (Gubisch, 2011a,b; Brown, 2015).

In conclusion, airlines that foster competition by ensuring the MROs' access to intellectual property and material generally increase the MRO's competitiveness. In areas where high OEM dependence is present, an affiliated airline or investor is a necessary condition for not being forced to limit the service portfolio to legacy equipment and service niches. Consequently, it is very questionable, whether providers without this support will be able to attain the required financial resources and economies of scale to ensure competitive survival in the long term. VP and General Manager MRO 5 gives a vivid testimony: *"The days of the independent MROs are numbered. The reason for that are the new airframes introduced by the manufacturers. These are game changers. They are produced differently from traditional airframes and those airframes produced in the next 2-3 decades will continue to be different. The entire approach towards airframe maintenance will be different if they continue down the road of building composite aircraft. Airframes from the manufacturers have made it impossible to access this knowledge. The barriers are insurmountable."*

Legal norms or legal interventions may reduce OEM dependence by ensuring third-party maintenance providers with access to intellectual property, testing equipment, and spare parts. An example of this type of intervention is present in the automotive industry where car manufacturers have utilized similar tactics as in aerospace to limit competition on the service market. The European Commission has intervened various times to ensure fair competition, arguing that the independent repair shops generate consumer benefits by exerting competitive pressure on OEM-affiliated repair shops, which exhibit price levels between 16% and 120% above their independent counterparts (European Commission, 2003).[17]

[17] In the automotive industry, the first antitrust act was passed by the European Commission in In 2003, aiming to provide all independent repair shops with access to all necessary technical information, tools, equipment, including diagnostic equipment, and training (European Commission, 2003). Clauses that inhibited OEM-affiliated repair shops from using alternative spare parts of matching quality were declared as illegal as well (European Commission, 2007). Apparently, these efforts were not sufficient to impede manufacturers from competition-limiting practices, which led to another intervention in 2007. In that year, the European Commission declared it mandatory to provide all independent repair shops in the EU with standardized access to all technical repair information at a price allowing competition, since without the required information independent repair shops would lose their ability to compete and be driven from the market (European Commission, 2010; Preiss, 2012). Following this regulation, car manufacturers employed tactics to ensure customer retention and revenue creation by declaring the loss of warranties on new cars if independent repair shops have performed maintenance tasks. However, this tactic has been declared illegal as well by the European Commission in 2010 (Boston Consulting Group, 2012). The currently final step was taken in 2011, in which the European Commission obliged manufacturers to release electronic data enabling the exact identification of replacement parts for vehicles, further fostering competition (Wall, 2015).

While direct legal intervention in the MRO market is not present at the time of writing, the European Commission has started a preliminary inquiry in 2015, aiming to assess whether airlines are forced into anti-competitive long-term contracts for engine maintenance (Hollinger et al., 2015). It was launched after an IATA complaint about restrictive practices of manufacturers preventing competition in the aftermarket resulting in excessive profit margins for manufacturers and high costs for airlines. Currently, the inquiry is limited to the CFM56 engine, the single option for the B737 and one of two options for the A320 as well as the Trent XWB, the only option for powering the A350 (Hollinger et al., 2015). At the time of writing, CFM and GE have signed an agreement with the IATA to adopt MRO conduct policies that enhances the opportunities for non-OEM MRO providers to conduct Engine Maintenance on the CFM56 and LEAP powerplants (Walker, 2018). While manufacturers can design different aftermarket configurations to comply with possibly increasing anti-trust regulations, the strategy to license a few MRO providers seems to become the dominant approach.

Two main reasons exist, why coopetitive solution configurations are more beneficial even for manufacturers than the workbench setup. First, allowing customers to choose from different licensed providers is less legally questionable, as it enables the customer to retain a choice in its maintenance decision and perform tenders between different vendors. However, the license conditions are the main factor determining whether traditional MRO shops can, in fact, be competitive contestants to the manufacturer or not. Second, the residual value of the asset is decreased dramatically at a point when the OEM remains as the only service provider and airlines are left without negotiation levers for maintenance. In essence, who would buy a second-hand engine if maintenance costs cannot be secured long-term? These considerations do however mostly hold only on larger assets as the engine or APU, where airlines hold direct maintenance contracts with the manufacturer or MRO firms. For smaller assets that are typically included in a Component Solution, manufacturers face less opposition if they shut-off the aftermarket as airlines are only indirectly affected. Here, it is up to the aircraft manufacturers to formulate proper PSAs with multiple vendors to ensure sustainable competition both in manufacturing and services, as well as the efforts of airlines to enforce these PSAs to keep their maintenance costs under control.

Integrative Framework

The multiple case study suggests that interdependence in the supply chain between OEMs and MROs are the main drivers for the formation of alliances in the aerospace industry. This finding is illustrated in the integrative framework displayed in Figure 6.5 that demonstrates the relationship between the different factors.

In summary, MROs need to form alliances with manufacturers in cases in which they are dependent to a critical degree from the manufacturer's material, repair manuals, or

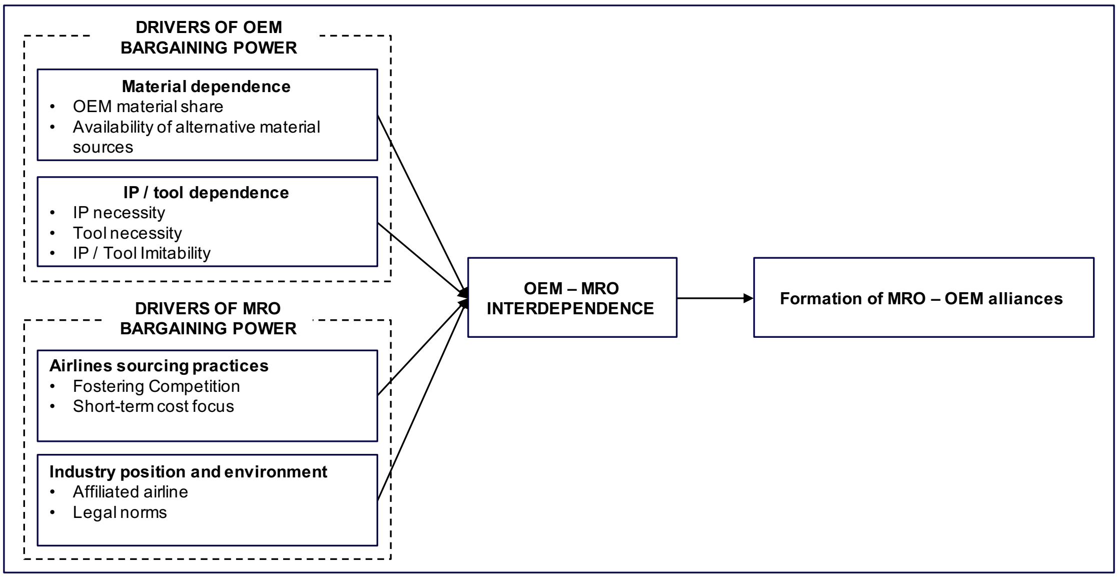


Figure 6.5: A Contingency Model for OEM-alliance-oriented MRO Business Model Innovation

tools that are required for the maintenance, repair, and overhaul of the manufacturer's equipment. OEMs on the other hand, are dependent on MROs if these possess an affiliated airline with an aircraft sourcing campaign that can negotiate access to the required resources. As a result, alliances between both parties are formed. Other factors that moderate the formation of partnerships are legal norms, requiring manufacturers to a certain extent to allow competition in the aftermarket, as well as airline strategic sourcing practices that aim at establishing a competitive market. These practices are however often limited and instead characterized of a rather short-term cost-driven approach.

These findings suggest that the formation of MRO-OEM alliances are mostly driven to cope with interdependence, at least according to the perception of the interviewees. This is an exciting finding since MROs can create considerable value to the OEM through the alliance. Possibly, a shift away from a dependence focus towards a focus on the benefits that can jointly be generated would allow MROs to create more and better configurations in term of sustainability and added customer value.

6.2.3 Contingency Factors per Alliance Configuration

Even though only one case per configuration is available, propositions regarding the factors that influence the type of setup could be identified. In general, the two-sided configuration is the most advanced and beneficial type of alliance for the MRO, which is followed by the coopetitive solution. The reason is that the two-sided solution allows the MRO to take responsibility for the manufacturer's service business and places the service firm at the interface between the manufacturer and the customer. The workbench setup is the least beneficial configuration due to the high dependence on the manufacturer that acts both as the single vendor of parts and the single customer. Coopetitive solutions are placed in between these two configurations. Here, the MRO can compete with other independent and OEM-owned service providers for customer contracts. Hence, MROs should aim at establishing two-sided solutions, if the circumstances allow and otherwise opt for a coopetitive solution network. In contrast, the workbench setup should only be pursued as a last resort to ensure competitive survival.

By comparing the cases, three main factors that influence the MRO-OEM alliance configuration could be identified. The first factor is the existence of *legal norms*. While in the Automotive Industry, the European Commission has intervened multiple times to ensure a level playing field between manufacturer-owned and independent car mechanics, this intervention has not taken place (yet) in the aerospace industry. However, manufacturers design solution networks with antitrust aspects in mind (see for example the respective proof quota in Table 6.4). This fosters the formation of coopetitive solutions over the workbench setup or the two-sided solution. The main reason is that the manufacturer can ensure the legality of their aftermarket approach from an antitrust perspective.

Second, the requirement of a *multi-vendor capability* to provide solutions was identified as an influencing factor favoring the two-sided solution offer. In the Components Case, the tier 1 supplier of the airframe manufacturer can provide Components Solutions directly to airlines. This solution offer encompasses availability of aircraft components that are offered by competitors. By alliancing with the MRO service firm, the OEM was able to build the multi-vendor capability and provide integrated solutions successfully. Without this alliance agreement, the manufacturer would have been confined to the workbench setup with another integrator such as the airframer.

Third, the *lack of success with the previous service offers* was identified as an antecedent of the manufacturer's decision to deservitize and rely on the two-sided solution. The Components Case was an example of the service paradox that has ultimately led to the decision to outsource service provisioning to the focal firm. As further discussed in the limitations section, these three contingency factors are only a first approach in explaining the fit between situational factors and the three MRO alliance business model configurations.

6.3 Configurations of the MRO Business Model

This section explores the four configurations into which MROs can develop their traditional business model. For a concise presentation, the focus is set on describing only the differences between the types.

6.3.1 Stand-alone Solutions

Here, I discuss the innovations that MRO firms need to make to the nine elements of their traditional business model to offer stand-alone solutions. It is important to note that the solution business model does not replace the traditional MRO business model. Instead, it is a different configuration in which new items are added, while items of the traditional MRO business model may not be needed. For real firms, business model elements of the traditional business model are likely to remain in place, as these continue to offer traditional services, as well. The resulting stand-alone solutions business model is depicted in Figure 6.6.

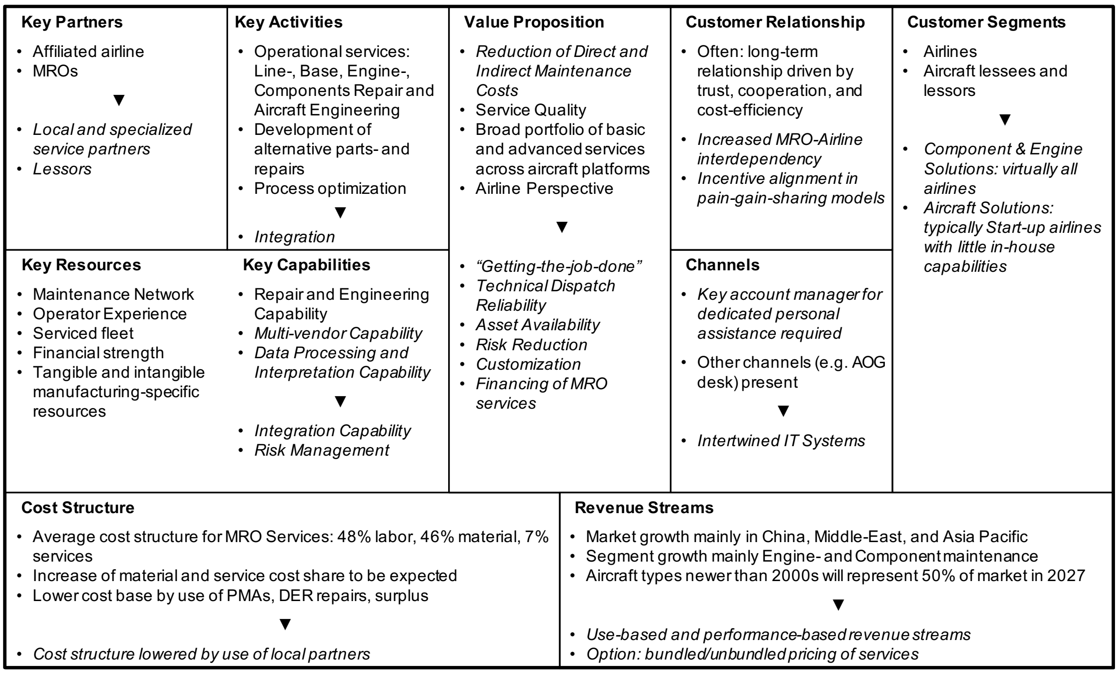


Figure 6.6: Stand-alone MRO Solutions[18]

[18] The figure shows the stand-alone solutions configuration of the MRO business model with the specific items in *italics*. Elements of the traditional MRO business model that need to be further developed due to increasing importance for the solution offers are displayed above, and new items are shown below the arrow.

Value Proposition

Getting-the-job-Done In stand-alone MRO solutions, the provider promises to *"get-the-job-done"*, which involves assuming the responsibility for planning and performing maintenance tasks and guaranteeing availability and reliability of either the aircraft, its components or engines. This Value Proposition enables the airline trouble-free operations and focusing on the core business (Johnstone et al., 2008; Schneider et al., 2013; Smith, 2013), which is the transport of passengers and cargo.

Just as in other industries, MRO solutions typically include the final service provisioning stage, which is performing the operational MRO services (Line, Base, Component, and Engine Maintenance). A major limitation compared to other industries is that the MRO cannot take full responsibility for the services performed on behalf of the customer towards the aviation authorities. Instead, the responsibility for the airworthiness of a fleet remains with the airline, impersonated through the function of the Postholder Maintenance, who has to prove direct involvement and control regarding all maintenance tasks towards the authority (Hinsch, 2012).

All three types of solution offers have in common that the MRO reduces the capabilities, complexity, and manpower needed at the operator. This allows the customer to focus on its core competence, however without delegating the responsibility vis-à-vis the authorities.

Technical Dispatch Reliability Aircraft reliability is the first important performance indicator of MRO solutions and represents one of an airline's most important performance metrics (Ross et al., 2006). Aircraft Reliability is measured through the performance indicator technical dispatch reliability (TDR). This indicator is calculated as the percentage of flights that have taken off with less than 15 minutes delay (Niehues et al., 2001). Delays that do not occur due to technical reasons are excluded from the figure (Bineid & Fielding, 2003). While for today's mature aircraft, a TDR above 99% can theoretically be achieved, figures between 95% and 99% are more realistic.[19] For airlines, achieving a high TDR of their fleet is of utmost importance, as a reliable fleet is a precondition for high punctuality, which in turn, drives airline profitability (Niehues et al., 2001). Unreliable aircraft, In contrast, reduce the available capacity, which leads to flight cancellations and the inherent adverse side-effects for passengers and airlines. While Line Maintenance procedures have a direct impact on TDR, it is also directly influenced by components and engine availability (Bineid & Fielding, 2003). Hence, the MRO has the opportunity to add value to the airline through all three types of solution offers.

[19] For example, Airbus reported as advertisement a worldwide average reliability of the A350 of 98.8% in December 2017 (Source: undisclosed customer communication by Airbus).

MROs can influence the TDR in solution offers through SCAMT services such as reliability management. The key is to provide these services better than an airline-internal CAMO would. To achieve this aim, MROs can make use of their Key Resources and Capabilities: for example, MROs can utilize their engineering capabilities gained on the diverse serviced fleets of different customers to professionalize reliability management and maintenance programs.

Asset Availability Availability is the second important performance indicator of MRO solutions. The MRO provides asset availability in the components, engines or the aircraft in the respective solution offering. The difference between providing availability and assuming responsibility for availability is that in the former the MRO owns the asset, while in the latter it does not. Aircraft availability is one of the major concerns for airlines (Kaelen et al., 2014), due to its influence on airline costs, punctuality and profitability (Niehues et al., 2001). Aircraft availability is defined as the average time per day (in block hours) the aircraft is available for operational service:[20]

$$\sum_{i=1}^{365} \frac{24 - \text{block hours reserved per day for maintenance}}{24}$$

The value of increased availability for airlines results from the fact that aircraft only have the opportunity to create profits when they are available for performing commercial flights. When the aircraft is on the ground, fixed direct operative costs (e.g., insurance, depreciation/leasing fee) still need to be carried by the airline, while only variable direct operating costs (i.e., flight- and passenger-related costs, such as fuel) do not incur. An exemplary calculation for an A320 (included in the Annex in Section 1) shows that an airline loses approximately $31,000 contribution margin for each day the aircraft is not available for operations. Also, higher aircraft availability allows the carrier to reduce its maintenance reserve, i.e., the amount of aircraft reserved for sustaining the operations in case of unscheduled maintenance tasks (Niehues et al., 2001). Higher aircraft availability is especially useful in hub-and-spoke operations, where it results in an increased capacity to perform aircraft changes. Alternatively, the higher fleet capacity can be used to serve more connections with the same fleet size.

In Aircraft Solutions, MROs can directly affect aircraft availability by different means such as optimizing the maintenance plan to fit with the airline's operation, extending maintenance intervals, or preventive maintenance methods to prevent unscheduled maintenance (Niehues et al., 2001; Kaelen et al., 2014). One crucial task in improving aircraft availability lies in optimizing the maintenance schedule of the airline to cope

[20]It is sensible to calculate aircraft availability over the entire business cycle of one year because more maintenance work is performed during the winter months.

with the seasonality of the airline business. Airlines require significantly more capacity in the summer months, which is why the aircraft are predominantly scheduled for base maintenance within the winter months. The MRO can optimize the availability of the fleet by allocating mandatory work packages within overnight checks throughout the year and scheduling C- and D-checks predominantly within the winter season. As with TDR, engine and component reliability directly affect the overall reliability of the entire aircraft.

Risk Reduction In stand-alone solutions offers, MROs provide value to airlines by assuming risks inherent in the operation and maintenance of their assets. In all three types of solution offerings, the provider is responsible for solution performance outcomes such as the engine, aircraft, and component availability and reliability and agrees to pay a penalty if the predetermined KPIs are not met. Risk reduction is especially relevant on new types of equipment where little experience has been gained, and teething troubles may persist.

Since solutions are flight-hour and hence output-based, the risk regarding the maintenance costs over the lifecycle is transferred from the airline to the solution provider. This aspect is especially crucial in the Engine segment, where high uncertainties regarding maintenance costs over the lifecycle of the engine exist. Again, this risk is especially pronounced on new engine types, where little or no experience is available regarding the durability of engine components throughout operations, what makes providing stand-alone solutions especially challenging for MRO service firms.[21]

Reduction of Indirect Maintenance Costs In contrast to traditional MRO service offers, in which MRO is an external cost position for the airline, MROs have the opportunity to address the airlines' indirect maintenance costs (IMC) through solution provisioning. IMC accumulate to the considerable share of approximately 50% of total maintenance costs (see Figure 4.17) and accrue from inventory, overhead, and maintenance reserves.

Directly influencing these cost positions is only possible in solution offers because the MRO can improve the airline's maintenance plan and asset base. Potential savings vary per solution and customer; however, industry consultants estimate approximately 30% cost savings of Component Solutions compared to in-house service provisioning, due to the pooling effect (Herbert & Morales, 2016). Additional savings can be achieved by reaping economies of scale inherent in providing CAMO services to larger fleets, which enables the airline to reduce the capacity of the internal CAMO function.

[21] Depending on the purchasing contract that the airline has signed with the manufacturers, some but not all risks are covered by the manufacturer, not the MRO.

Customization In line with solution literature, interviewees stated that each solution needs to be tailored to the individual airline's needs to satisfy the airline's demand better. The amount of customization required depends on the level of intertwining of the solution offering with the customer's operations.

Engine Solutions are somewhat standardized, since engines are removed from the aircraft and repaired remotely. Customization is required mainly in pricing due to different operating conditions that result in higher or lower levels of engine wear. Also, customizing the maintenance plan to optimize the end-of-life of an engine can lead to considerable cost savings. In *Components Solutions*, a medium level of standardization can be reached: the solution provider and customer jointly determine the stock and service levels of component pools at the operator's line stations, as well as delivery times. Just as engines, components are repaired remotely in workshops, which is a process that can be standardized. *Aircraft Solutions* are the most customized since this type of solution is highly intertwined with the operations. In a solution co-design phase, the maintenance schedule, processes, and KPI are jointly defined to meet the airline's individual needs and standards.

Financing of MRO Services For airlines, financing is an important issue, as almost half of the global fleet is leased from lessors such as GECAS and AerCap (FlightAscend Consultancy, 2016a). Since leasing agreements are concluded independently from MRO agreements, aircraft financing does not form part of the Aircraft Solutions Value Proposition.

Component and Engine Solutions include financial services for airlines: Engine overhaul is a very cyclical and the most important MRO cost position for airlines, accruing to approximately 36% of all MRO costs (Cooper, 2017). Coping with these fluctuating operating costs can be a challenge for airlines, as the following example shows: Assuming the costs of $5m per engine overhaul, a small airline with 12 single-aisle aircraft (thus 24 engines) incurs a one-time operative expenditure of $120m in a single year.[22] In *Engine Solutions*, these expenditures are split into predictable flight hour-based payments. These payments act like an insurance, in which the airline saves up the required amount for the engine overhaul, with the provider assuming the risk of exceeding maintenance costs. Hence, a highly cyclical, risky cost position is transformed into a predictable, usage-based cost position.

In *Component Solutions*, the MRO directly reduces the airlines' investments through access to its component pool, which eliminates the airline's need to build its own pool of components. MROs can also provide other financing services such as buy-and-lease-back of the airline's components, which is a common tactic of struggling carriers to improve their cash position.

[22]Assuming that all engines need to be overhauled in the same year.

Key Resources and Capabilities

To provide stand-alone solutions, the traditional resource and capability base of MRO firms is not sufficient. Instead, the MRO needs to develop a set of new Key Capabilities, of which the most important are integration, risk management, and multi-vendor capabilities.

Integration Capability The integration capability is the capacity of the organization to build one integral offering comprised of a bundle of different products and/or services. Integration may be performed over several dimensions such as the MRO service segments, OEMs, external service providers, or internal organizational units. While literature highlights the importance of integration capabilities especially for system integrators (Davies & Hobday, 2005; Hobday et al., 2005) the Aircraft Solutions Case shows that integration capabilities are also required for solutions consisting of mostly internally provided services. Instead of integration across different vendors, the focus here lies on the integration across different organizational (business) units required for assuming responsibilities and risks associated with performance outcomes.

In *Component Solutions*, the MRO assumes the role of an integrator of a full range of equipment and services provided by manufacturers and third-party service providers. Just as manufacturers, pure service firms need to build the integration capability to provide a seamless solution package to its customers. Integration is achieved by coordinating all actors along the supply chain, as well as material and information flows.

The appointment of designated individuals who are responsible for all integration tasks was highlighted as a success factor for building the integration capability. An interesting debate arose of whether integration provides value to the customer and is to be treated as a Value Proposition or not. While some interviewees are of the opinion that integration delivers value to the customer (e.g., VP Purchasing MRO 1: *"In my view, [integration] is the biggest value contribution. The customer gives a damn who has signed that serviceable tag"*), I rather agree with literature that states "customers are not paying just for an integrated package of products and services. They are buying guaranteed solutions for trouble-free operations" (Davies et al., 2006, p. 40). This statement is supported by the Aircraft Solutions Case, in which the customer does not pay the staff required for integration. Instead, the airline values trouble-free operations (the outcome of integration) at a predetermined performance level and the reduced internal complexity. Hence, not integration itself but its outcome represents a Value Proposition.

Risk Management Capability As Solutions involve assuming the risk for performance outcomes of the customer's operation, developing the capability to assume, manage and mitigate risks becomes a central issue for solution providers (Ulaga & Reinartz, 2011). Specific risk management capabilities need to be developed internally at the MRO provider for all three types of stand-alone solution offers: In *Aircraft Solutions*, the MRO required the capacity to manage risks across different dimensions such as the manufacturer's equipment, internal business units, and external service providers, such as local Line Maintenance specialists. Due to the complexity of this system of risks, assuming responsibility for aircraft TDR and availability is a challenging task.

In *Component Solutions*, the risk of component availability needs to be assumed. This was however seen as less of a central theme by interviewees, possibly due to the lower level of complexity of inter-related service providers and the MRO's ability to optimize component pool stock levels according to the requirements of the customer. In *Engine Solutions*, the risk of exceeding maintenance costs was stressed as the most severe and possibly endangering the business of traditional MRO firms. Here, MROs are challenged especially on new types of equipment, as offering engine flatrates without proper risk management capabilities was seen at MRO 1 as *"threatening our business."* (Engine Product Manager MRO 1). In conclusion, risk management is a Key Capability for solution provisioning and a possible determinant of whether solutions can be provided stand-alone by the MRO or only in alliance with a manufacturer.

Multi-vendor Capability While MROs make regular use of their multi-vendor capabilities in the traditional business model to provide services for the equipment of various manufacturers, this capability is not sufficient for solutions. For example, MROs can be forced to integrate parts or services from their competitors, usually if they are more price-competitive in a particular service segment. In Component Solutions, this means that overhauled material from specialized component MRO shops is used to benefit from cost advantages. As utilizing competitors' services comes at the expense of internal workshop utilization, integrating these parts or services constitutes the *"acid-test"* (Davies et al., 2006, p. 42) for MRO firms. Establishing this capability poses challenges as in the traditional business model, relying on competitors' service offers is not required.

Data Processing and Interpretation Capability The data processing and interpretation capability introduced in the traditional MRO business model includes the capacities to capture, adequately exploit, and convert this data into actionable knowledge (Kamp et al., 2017).

Recent servitization literature highlights the importance of this type of capabilities for providing solutions under the label of smart servitization (Kamp et al., 2017). Also in the Aerospace industry, increased availability of big data on aircraft drives the importance of data interpretation capabilities in general and for solutions in particular. The reason why these capabilities are of higher importance in solutions is that they are directly linked to Value Propositions that solution providers make to their customers: Data processing and interpretation enables MROs to perform predictive maintenance which has the potential to increase aircraft TDR and aircraft availability at reduced costs (Spafford et al., 2015). For MROs that compete with stand-alone solutions based on aircraft performance parameters, this capability is especially critical, which is why they need to extend their data processing and interpretation capabilities to differentiate their offers from manufacturers and other service firms.

Key Activities

Integration The activity of integrating goods and services from internal and external sources becomes one of the MRO's Key Activities to provide solutions. Internal integration is the incorporation of service offerings from a variety of internal organizational units which may possess their own distinct services, goals, sales force, service development units, customer channels, and other elements into a seamless offering that is professionally presented and delivered to the customer.

Solution delivery takes place through a single customer front-end, consisting of a central sales force capable of selling the solution offerings and a local customer service representative responsible for maintaining the customer channel. The focal company has improved the capabilities of the central sales force to sell modular integrated offerings, to not *"send a bus-load full of people to the customer anymore"* as one interviewee puts it, saving resources and nerves both at customer and MRO provider. The personal key account manager at the airline's site is responsible for internal and external integration, serving as the single customer front-end during the service delivery phase.

The second facet of integration relates to the external integration of the MRO provider's capabilities and processes into the customer's local organization. This aspect is most important in *Aircraft Solutions* since this offering is highly intertwined with the customers' operation. For Aircraft Solutions, integration includes connecting IT systems (e.g., the maintenance information system AMOS) and establishing various cross-company processes. Hence, external integration is a type of co-specialization, which requires bridging technological, organizational, and often cultural barriers.

Key Partners

Solutions in the aerospace industry are mostly delivered by relying on a network of Key Partners to cope with challenges resulting from the global scale and technological intensity of the industry. In the next two paragraphs, both the usage of local and specialized service partners by MROs and OEMs as well lessors as possible future partners are discussed. In contrast to coopetitive or two-sided solutions, OEMs are explicitly not partners in this type of configuration.

Local and Specialized Service Partners To provide solutions, MROs often rely on a set of local or specialized service partners to locally complement their maintenance network and to extend their capacities or capabilities. In *Aircraft Solutions* for example, local Line Maintenance providers or the customer's Line Maintenance unit are used since they can provide Line Maintenance services at new destinations with more flexibility and cost efficiency than MRO providers could with their internal staff. Using the customer's Line Maintenance unit also yields the advantage that (a) political costs for a solution offering can be mitigated and (b) the customer is enabled to build internal engineering and Line Maintenance capabilities to insource engineering, fleet management, and Line Maintenance at a later point in time.

To provide *Engine Solutions*, manufacturers often rely on a network of risk-sharing partners, which results in both the workbench and coopetitive solution configuration. However, MROs can, in principle, provide Engine Solutions stand-alone without a partner network if they possess the required risk management capabilities. To provide *Component Solutions*, MROs often rely on Logistics providers as these can transport component to the different pooling and line stations around the world more efficiently than internal units could.

Lessors We discussed earlier that MROs could provide airlines and lessors with aircraft transition management services as a "neutral arbitrator of interests" between the two parties. In a solution-based business model, partnering with lessors represents an appealing alternative for MROs, as MROs could target to offer a new type of dual Aircraft Solution: For airlines, the MRO would guarantee aircraft availability and performance at a fixed rate per flight hour, just as in regular solutions. For lessors, the MRO would create value by retaining a maximum of asset value by proper maintenance and documentation as well as usage of original parts.

Also industry consultants have suggested that MROs partner more actively with aircraft lessors to develop joint value propositions for airlines at the point of aircraft selection. In this logic, MROs could offer their comprehensive resources, capabilities, and services together with the lessor at aircraft purchase and thus retain channel control from the airframe manufacturers (Spafford & Rose, 2014). According to this study, 80% of MROs have considered partnering with lessors, while 60% of the lessors expect increased cooperation (Spafford & Rose, 2013, 2014). Lessors are a promising partner for MRO providers, considering that the rate of leased aircraft has risen from 7% in 1985 to 42% in 2015 (as depicted earlier in Figure 4.18).

Interviewees (23, 24, 26) however perceived lessors rather as customers than partners and proposed to build specific Value Propositions for targeting their pain points. Manager Product Management MRO 1 explains: *"There is no cooperation with lessors, which would mean that a lessor would suggest us as MRO or so. That would improve our market position. But it does not exist, and the lessor doesn't have the interest to do that. They don't want to propose a certain MRO; they want to propose a certain quality of MRO. But they are not interested in a certain MRO because then they would force an airline to go to this MRO what maybe it doesn't want to do that on other aircraft types."* (emphasis added by author). Contrasting to this statement, a significant majority of lessors favor pairing MRO services with lease agreements for both, commercial (63%) and asset marketability (100%) reasons (Spafford & Rose, 2013).

In my opinion, MROs should pursue alliances with lessors more actively, due to various reasons. First, lessors are often involved at the time of aircraft purchase and thus a powerful channel intermediary. An alliance with lessors could therefore dramatically improve the MRO's chances in participating in the initial tender involving both asset purchase and maintenance contract (Spafford & Rose, 2013). Second, they can combine their resources and capabilities and streamline the cumbersome aircraft transition phase as a neutral expert between lessors and airlines. Hopefully, it is probably only a matter of time until some MROs define better Value Propositions that fit both the lessors' and the airlines' needs and thus considerably improve their position in the supply chain. One approach could be to develop a two-sided solution not only for MROs but also for lessors that would be interesting for start-up airlines and lessors alike that wish to minimize the effort and risk usually associated with lease returns. Especially start-up airlines would profit from these services as it is more difficult for them to negotiate beneficial lease contracts. This service would ensure compliance with the documentation requirements stipulated in these contracts and lower the risks of lengthy and costly lease returns.

Besides, the usage of PMAs is often not permitted in the leasing agreement, which can however partly be alleviated through the involvement of the MRO. The improvement of conditions for using PMAs through negotiations with lessors should be a top priority for MROs, as these represent unique sources of competitive advantage that MROs possess against OEMs. Thus, alliances with lessors would allow the airline to use alternative materials to lower their DMC, improve the competitive position of the MRO and significantly reduce complications associated with the lease return process. If, in turn, manufacturers establish themselves as the lessors' MRO solution partners, the battle for who provides MRO services for leased aircraft is from the beginning.

Customer Segments

In the context of solutions, servitization literature suggests to segment customers according to their preferences about product ownership and user behavior (Manzini & Vezzoli, 2003; Matzen, 2009; Barquet et al., 2013). In the Aerospace industry, product ownership does however only play a limited role, as both the aircraft and the engine are commonly either owned by the airline or leased from a third party. Hence, ownerless consumption is rather a common misconception of servitization literature than regular business practice (Baines & Lightfoot, 2014), at least in this industry. One exception are Component Solutions, where airlines can choose to either access a common parts pool with other airlines or the management of their own parts.

The Customer Segments (and size of the market share) that MROs can target by offering solutions, depends on the solution type: *Component Solutions* are generally contracted by all types and sizes of airlines. However, the most value can be created for airlines with less than approximately 250 aircraft in a single fleet, as here most pooling effect can be achieved. Virtually all airlines rely nowadays also on Engine Solutions, especially on new technology aircraft. In consequence, not offering Engine Solutions will significantly limit the prospects in the vital engine segment that makes up approximately 36% of the MRO market (Cooper, 2017).

By offering *Aircraft Solutions*, the MRO can tap into the customer segment of start-up airlines that have limited internal capabilities to ensure airworthiness and perform fleet management. Even though these airlines may later insource engineering and SCAMT tasks, Aircraft Solutions represent an excellent opportunity for establishing an in-depth customer relationship which can be the basis for future service offers to these growing carriers.

Customer Relationship and Channels

When relying on Solutions, customers become increasingly dependent on the supplier, especially when they outsource ownership of the equipment and core processes and capabilities (Bharadwaj et al., 1993; Windahl & Lakemond, 2010). At the same time, the provider is more dependent on the customer, as it increasingly relies on Revenue Streams from operations of the hopefully successful customer (Windahl & Lakemond, 2010). To balance the increased, reciprocal interdependencies, firms align interests between buyer and supplier through performance guarantees, long-term commitment, and pain-gain sharing models (Penttinen & Palmer, 2007; Windahl & Lakemond, 2010; Kowalkowski et al., 2015).

In the Aerospace industry, customer dependence is increased through solutions to various degrees, depending on the type of solution offer. *Component Solutions* are typically contracted for a duration of approximately five years, after which the access to the components pool can be terminated. If the airline relies on additional services such as spare parts logistics at their home base, switching suppliers becomes more complicated due to the required de-entangling of IT-systems and the fact that tacit knowledge needs to be transferred to the new provider.

Engine Solutions are typically contracted between eight or ten or even up to 15 years, after which the contract can be awarded to a new supplier. Switching a supplier is however only possible if alternative suppliers to the OEM exist, which has not always been the case on all engine types. In these cases, airlines were locked-in into the buyer-supplier relationship, which has resulted in severe price increases and the loss of aircraft and engine resale value (see Section 5). *Aircraft Solutions* are the most integrated type of solution offer and hence cause the highest level of mutual interdependence. Both airline and MRO must make idiosyncratic and local upfront investments to set up the required resources, capabilities, and channels. Once established, both parties have a high reciprocal dependency: the airline's performance depends on the MRO provider, while the MRO provider incurs penalties and loss of reputation if service levels are not held. Also, everyday operations become highly intertwined, raising exit barriers of the customer: *"Once you are tied with a customer through such an essential service, like Line Maintenance — providing the aircraft for the next flight — then you can't be replaced, well you can be replaced but not that easily."* (Team Lead Aircraft Engineering Services MRO 1). Thus, the relationship can be characterized as strategically integrated (Anderson & Narus, 1990), and the complete insourcing of the CAMO organization required strong efforts and can typically span several years.

In line with solution literature, placing *Key Account Managers* as knowledge integrators and communication channel at the customer site (Hakanen, 2014) is very common in the aerospace industry. Especially Aircraft Solutions require extensive local staff directly at the customer's operation to conduct fleet management services that are tailored to the customer's operations. Hence, sufficiently skilled key account managers that can cope with complex customer problems are of increased importance, when providing solutions.

Cost Structure and Revenue Streams

Cost Structure In contrast to manufacturers, MRO firms do not require an extensive reconfiguration of their cost structure for building a service organization to provide stand-alone solutions (Gebauer et al., 2005). Instead, they can rely on their internal service network, products delivered by manufacturers, and external partners to provide the required products and services that make up the solution. Especially the use of local service partners has the potential to considerably lower the cost structure since the secondment of staff on a large scale leads to a considerable increase in labor costs. However, increasing one-off costs incur for building, training, and certifying a local labor force to work according to the processes and quality systems of the MRO.

Increasing costs also incur for integrating the different service components into one seamless solution. In the *Aircraft Solution* case, for example, the focal company is compensated on a flight-hour basis for the contracted service segments individually but does not incur any revenues for the managers that are responsible for integration. Hence, integration needs to be cross-financed internally through various service offers. These additional labor costs per segment are however insignificant compared to the considerable MRO costs that typically arise when servicing COPS such as aircraft.

Revenue Streams Solutions in the Aerospace industry are typically a combination of use- and performance-based revenue streams, which have been broadly discussed in literature (e.g., Tukker, 2004). In all types of Aerospace solution offers, the *use-based* agreement of payment per flight-hour is the predominant revenue stream. In Engine Solutions, a fixed fee is paid, per hour the engine is used[23], Component Solutions grant access to the component pool, based on a fee per flight hour, and Aircraft Solutions are typically priced per flight hour, as well (Seidenman & Spanovich, 2016a; Smith, 2013).

This primary revenue mechanism is complemented by *performance-based elements*, which involve KPI (e.g., TDR and availability) to determine the payments through penalties and gain-sharing models. While the service elements making up the solution can be priced either bundled or unbundled (Stremersch et al., 2001; Forkmann et al., 2017b), airlines prefer unbundled pricing to increase transparency and be able to assess the MRO's competitiveness in each service segment (interviewees 7, 11, 15, 23).

Conclusions

In conclusion, MROs do not require an alliance with manufacturers to provide a broad set of stand-alone solutions. As long as manufacturers provide their manufacturing-related equipment, such as spare parts, repair manuals, and test stands to MROs, these pure service firms are well-poised to provide stand-alone solutions. Instead, the manufacturers' strategies to support their downstream movement are the root cause of the need to develop alliances. Besides, servitization also creates opportunities for pure service firms that can support manufacturers in servitization or even take over parts of their service business.

[23]Due to the considerable wear of an engine during the take-off, flight cycles are typically part of the pricing equation; a flight-hour flight-cycle ratio is used to determine the price of the solution offer.

6.3.2 The OEM Workbench

In the OEM workbench configuration, the MRO provides mainly time- and material-based maintenance services as the manufacturer's sub-contractor. As described earlier, this setup is disadvantageous compared to other, more advanced, configurations, due to a high dependence on the MRO, and the loss of customer channel. This section covers the changes that MRO providers must perform to the elements of their traditional business model to reach the OEM workbench configuration (displayed in Figure 6.7).

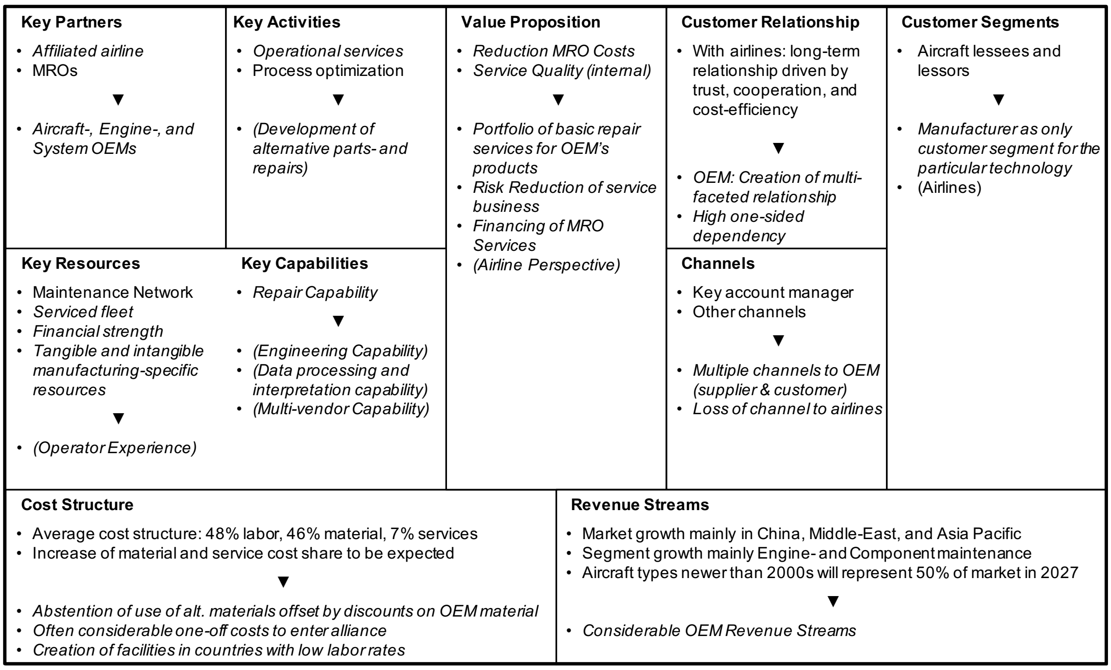


Figure 6.7: The OEM Workbench Configuration[24]

Value Proposition

In this configuration, the MRO provides *basic repair services to the OEM*, who typically integrates these services into the own solution offer. One example is the Engine Case in which the MRO provides dis-assembly, assembly, and testing services to the OEM. The manufacturer, in turn, provides spare parts, performs the underlying engineering tasks, and operates the communication channel with the customer.

[24]The Figure shows configuration-specific elements of the MRO business model in *italics*. Elements of the traditional MRO business model that need to be adapted are displayed above the arrow, items that need to be developed or discarded are shown below. Items of the traditional MRO business model that have only limited application in this configuration are displayed in brackets.

MROs can add value to the OEM's Product Service System by providing MRO *repair services at lower costs* than an internal service function would, especially if economies of scale, pooling effects or learning curves are present (Cohen et al., 2006). Providing cost-reduction to the OEM differs however from airlines as the dimension of comparison is a different one: While for airlines, the MRO's repairs need to be more competitive than an in-house repair or a repair service offered by a competing MRO, repairs for manufacturers need to be more competitive than the *production* of a new part. With margins on spare parts up to 1,000%, cost savings through repairs can be achieved only on fewer part numbers than in the traditional business model. However, for large portions of aircraft components ranging from engine parts, hydraulic and pneumatic units, and avionics, the repair is still more economical than the production of a new part. On some assets, the repair is limited to dis-assembly, exchange (not repair) of parts, re-assembly, and testing.

Service quality has been qualified as an essential enabler of a business relationship with airlines, however with limited potential for competitive differentiation and gaining price premiums. For manufacturers, service quality is especially important because a lack of service quality disrupts internal operations and since customers perceive the service provider's quality as the manufacturer's quality. Besides, even ramifications for the production business are possible, if customers attribute a lack of service quality to a lack of product quality (Jaakkola & Hakanen, 2013; Nenonen et al., 2014).

Hence, service providers should aim at providing consistent, high-quality services to minimize image risks, when they work as a sub-contractor. As many of these services are better provided by an external specialist than an internal unit, network partners support the manufacturer in achieving a differentiation advantage (Bustinza et al., 2015). One Manager in the Alliance Function at MRO 1 underlines these previous findings: *"The OEM depends on the MRO because he is the one that performs the services in the aftermarket and makes sure that [the OEM's] reputation and quality are kept on a high level"*. However, focusing on service quality is not enough to become an OEM alliance partner, as manufacturers strictly require meeting target cost levels. For example, at the time of writing $90 per manhour is the established acceptable labor rate for an engine overhaul in Europe.

Compared to the traditional MRO business model, MROs lose the ability to make use of their *airline perspective*, as the Value Proposition is limited to basic services and the fact that these services are delivered directly to the OEM, not the final customer. Compared to more advanced alliance configurations, the MRO requires however comparatively low capabilities to understand the manufacturer, due to the transactional relationship that entails only basic services and the input-based pricing mechanisms.

For manufacturers, a servitization strategy is associated with a variety of risks, such as financial risks, or risks associated with outcome-based offerings (Neely, 2008; Helander & Möller, 2007). Hence, manufacturers need to build the capabilities to recognize and mitigate these risks if they want to add services to their business model successfully (Benedettini et al., 2015). MROs can provide value to the manufacturer in the workbench configuration by *reducing both the risk and the financial exposure* associated with entering the service business. This mechanism becomes apparent in the Engine Case, where the manufacturer can share the risk of shop utilization by relying on a network of service firms that are guaranteed only a certain amount of shop load events per year. By assuming these risks, MROs even become dependent on the commercial success of the particular aircraft type that drives the future demand for MRO services. The Head of Corporate Strategy of MRO 1 vividly sums up this situation: *"we have become part of this risk game. So, we are part of the chain: the airframer needs risk partners Engine, Engine needs risk partners on the side of the aftermarket. So, we have become part of this chain"*.

Besides limiting the risk, these arrangements also limit the financial exposure associated with servitization which becomes apparent in both, the Component and the Engine Case: The component manufacturer's investment required for pursuing a servitization strategy is limited by relying on the MRO's global asset supply system and maintenance facilities. The engine manufacturer on the other hand benefits from cutting investments in the joint overhaul facility by 50% and the financing of the stock of engine parts at this facility by the MRO. Also, these arrangements also limit the financial exposure associated with servitization, as the engine manufacturer does not need to stem the investment in the facilities that comprise the service network. Besides, the manufacturer can significantly reduce its warehousing and financing costs for the stock of spare parts, as the partners are required to purchase these parts before utilization while being compensated for the material used only after completion of the engine overhaul event.

Key Resources and Capabilities

MRO firms require considerable *financial resources* to enter OEM alliances, which are coupled with the underlying ever-increasing financial requirements for all actors in the high-technology aerospace supply chain (Esposito, 2004). Through the case studies, three major types of investments were identified in the workbench configuration: (a) construction of (joint) overhaul facilities, (b) financing of spare parts, and (c) license fees.

However, the investment for the construction of overhaul facilities and the financing of high-value spare parts is required to build repair capabilities on new equipment — irrespective of whether an OEM alliance is entered or not. In contrast, sharing the investment between partners even lowers the financial requirements for MRO capability building. This effect is however offset by the license fees that are typically charged by the OEM. Hence, financial stability is a priority not only for manufacturers but also for services firms that need to extend their service business to new technologies to ensure long-term competitive survival.

Gaining or improving access to the *manufacturer's resources* has been identified in this study as the key driver for the alliance decision with manufacturers. These resources include especially instructions for continuous airworthiness, test equipment, licenses, and material. In accordance with Schneider et al. (2013), interviewees perceive the alliance as the only way to gain access to these critical resources, as the following quote shows: *"The MROs need the OEMs for the intellectual property, access to the data, so it is forcing them into a collaboration."* –VP and General Manager MRO 5.

While gaining access to these resources ensures the possibility for competitive survival, it does not result in a competitive advantage against other members of an OEM service network. The reason is that all workbench partners are typically provided with similar conditions to foster competition within the system.

In the workbench setup, MROs use mostly their *repair capabilities* that they use to provide repair services to the manufacturer. More advanced services that include engineering tasks or dynamic feedback loops are not included in this type of configuration, which is why engineering capabilities are of much less use than in the coopetitive solution configuration. Since the MRO does not provide services and solution offers to end customer, the usability of the multi-vendor and data processing and interpretation capabilities is significantly reduced.

Key Activities

In the workbench configuration, *operational services* (e.g., engine overhaul) are provided not anymore to the airline but only to the manufacturer. Changes to the traditional MRO business model regarding how these services are performed may require substantial dynamic reconfiguration capabilities. One example is an engine overhaul event that is performed according to the manufacturer's engineering working instructions that differ considerably to the engine overhaul conducted in the legacy business model. Here, the driver for the different approach are the much lower material costs for the manufacturer (production costs instead of the list price), which result in a more course approach in workscoping. The focal company's managers highlighted the fact that extensive co-specialization capabilities are required to adapt the operational service to the OEM's requirements and master the mental changes associated with this change.

In alliances that adhere to the workbench configuration, the MRO dispenses with the *development of alternative parts and repairs* and uses the manuals and materials provided by the manufacturer only. As performing these engineering tasks is one of the Key Activities of the traditional business model, service firms require considerable dynamic capabilities to change not only work instructions but also the mindset of their staff.

Key Partners

Servitization drastically increases the importance of both, the affiliated airline and manufacturers as Key Partners for MRO service firms in all three alliance configurations (workbench setup, coopetitive solution, and two-sided solution). The reason for the increased importance of the *affiliated airline* is that OEMs limit the MROs' access to manufacturing-specific resources such as ICA, spare parts and testing equipment in their pursuit of service revenues (Schneider et al., 2013).

Consequently, the vast majority of interviewees (1, 2, 3, 4, 5, 8, 9, 11, 12, 13, 14, 15, 16, 20, 22, 23, 24) named the affiliated airline with a sufficiently sized aircraft sourcing campaign as the "entry ticket" to open negotiations with the manufacturers aiming to receive access to these resources. As Manager Repair Services Business Unit 1 MRO 1 describes: *"I think absolutely that this is the entry ticket. Without this lever, we soon would not exist anymore in many fields. I am firmly convinced of this"*. The size of this lever depends on the size of the airline's sourcing campaign. Airlines placing large orders are equipped with high negotiation power and can consequently make far-reaching demands, as Emirates' influence on Airbus' A380 program demonstrates (N.N., 2014a).

The aircraft selection process provides airlines with two levers to grant their MRO of choice access to the required resources. The first lever is the product-support-agreement (PSA). It is part of the aircraft purchasing contract in which the aircraft manufacturer commits himself to support the operations of the aircraft. The PSA grants airlines with diverse rights including the right to attain spare parts from aircraft and components OEMs, guaranteed lead times, access to ICA, amongst other benefits. The airline delegates these rights to its MRO of choice who can then demand the required tangible and intangible manufacturing-specific resources from the aircraft and component manufacturers (see Figure 4.13). The second lever is the selection of aircraft components and systems for which multiple vendors exist, such as typically wheels and brakes, the auxiliary power unit, or avionics components. In these negotiations, the airline can negotiate the MRO's access and pricing to the required manufacturing-specific resources directly with the respective manufacturers.

Without the sourcing campaign, the MRO is very limited in attaining the manufacturer-specific resources required for building repair and engineering capabilities, as a Manager Market Research and Competition MRO 1 describes: *"Without this source fleet you are out because the IP access by the airframers is very limited. That means the airframers themselves or the [...] system OEMs grant licenses and the ones who first order the aircraft receive these licenses first"*. However, the source fleet provides the MRO provider only with the capability to offer services to the affiliated airline. If the MRO plans to provide services to third parties, it needs to enter into further negotiations with aircraft-, components-, and engine manufacturers.

Due to the service infusion of their business model, all three types of *manufacturers* are increasingly seeking to complete their service networks via different kinds of alliances with MRO firms. In their study, Spafford & Rose (2014) differentiate between different types of agreements that allow us to draw some conclusions about the frequency in which the of the various configurations occur.

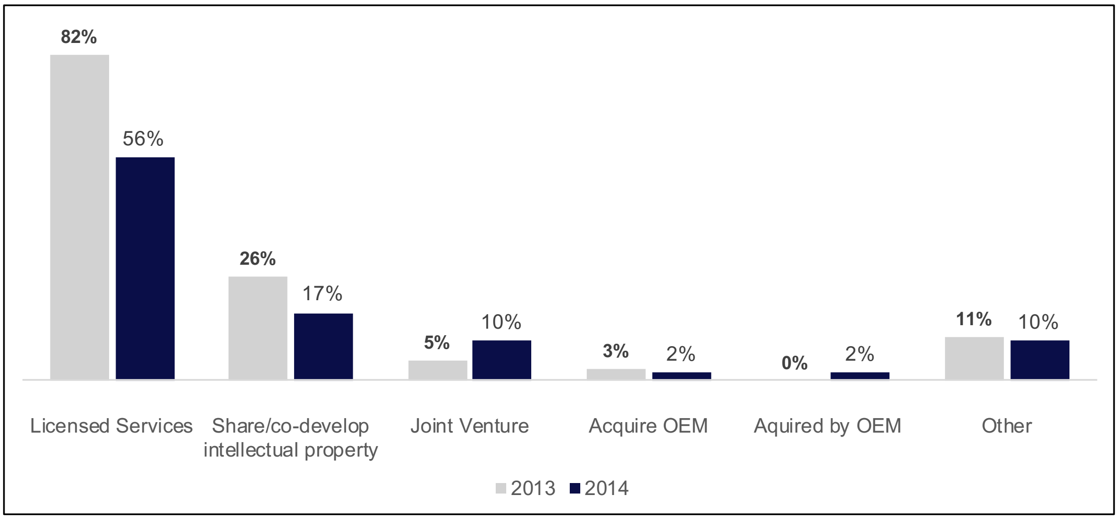


Figure 6.8: Types of Collaborative Partnerships between MROs and OEMs 2013-2014 (adapted from Spafford & Rose, 2014)

Figure 6.8 shows that licensing service providers to conduct MRO tasks is the most common type of agreement. Licensed services can either resemble the workbench or the coopetitive solution network configuration, depending on the type of license agreement. Agreements to share or co-develop intellectual property are likely to resemble the coopetitive solution configuration most closely, as value-added services are provided from the MRO to the OEM.

Joint Ventures and other arrangements can resemble the two-sided solution configuration if aftermarket services are only provided by the Joint Venture or the MRO service firm. However, it is difficult to make exact assumptions about the frequency of each occurrence as the properties of the different alliance agreements are often not made publicly available. However, Spafford & Rose (2014) report difficulties of MRO providers to build deeper relationships beyond simple license agreements that are beneficial to both parties. These difficulties underline the need for MROs to create advanced dynamic capabilities, to create additional value for both OEMs and airlines and reap the resulting benefits.

Customer Segments

The OEM workbench setup is a network structure in which the manufacturer holds all customer contracts and subcontracts certain service tasks to its partners. This results in a dual change for the MRO, who retains the *OEM as the only customer* and is forced to give up airlines as a Customer Segment for that particular service offer. However, even this setup may result in additional business that can be generated through the manufacturer (Lockett et al., 2011; Jaakkola & Hakanen, 2013), if the MRO can gain a larger market share than with the traditional MRO business model or stand-alone solutions. This is reflected in the Engine Case, where the focal company's Joint Venture becomes a *"not exchangeable part of the system"* (Head of Corporate Strategy MRO 1), being one major of approximately ten overhaul facilities worldwide. The new setup is a departure from previous market structures in which often more than twenty overhaul facilities supplied services for the worldwide demand.

Customer Relationship and Channels

Whereas MROs and OEMs have traditionally entertained a buyer-seller relationship with the OEM being the supplier, OEMs emerge through servitization as competitors that provide aftermarket services. While in the former buyer-supplier relationship OEMs have tried to maximize their aftermarket profits by increasing material prices with an average of 5-7% annually (Whyte & Von Oertzen, 2001), now they additionally aggressively compete against MROs for airlines' service contracts (Schneider et al., 2013).

By forming MRO-OEM alliances, crucial, *multifaceted relationships* are established, in which the OEM simultaneously takes the role of a supplier, partner, and customer for MRO services. These relationships can be characterized as strategic alliances that are typically designed to span decades of aftermarket support, require high idiosyncratic investments and result in mutual interdependence. While the MRO depends on the OEM to receive parts, documentation, and support, the OEM is dependent on the MRO, since the MRO is responsible for providing aftermarket services, with a direct influence on the OEM's performance and company image (Jaakkola & Hakanen, 2013; Nenonen et al., 2014).

In the workbench setup, the MRO suffers from a relatively high one-sided dependency from the manufacturer. The reasons are that the manufacturer is simultaneously the only supplier for material, the single customer for services, and the only channel to the market. This leaves the MRO without alternative options on both sides of the supply chain and hence in a very confined, dependent position. A silver lining is that the MRO may have some limited bargaining power against the OEM if it provides a considerable percentage of overhauls within the network. However, the level of profitability that can be achieved with this configuration is likely to be very low.

In the workbench setup, multiple *Channels* are established between MRO and OEM, including material, service supply, and delivery channels, as well as managerial channels to manage the alliance. The number of Channels in a workbench setup is more limited than in other, more advanced configurations, as here only input-based services and materials are exchanged, while the exchange of value-added services or the management of a joint aftermarket offering does not take place.

Cost Structure and Revenue Streams

In the aerospace industry, OEM alliances may constitute considerable *Revenue Streams* for MRO firms. As in 2027 roughly half of all legacy technology will be replaced by aircraft of newer, post-2010 vintage (see Figure 4.22), alliances will drive Revenue Streams, especially in the Engine Segment. However, also in the Component and Line Maintenance Segment, in which Component and Airframe OEMs are expanding their service offerings while relying on MROs for the fulfillment, growth of OEM-based Revenue Streams is to be expected. MROs that adhere to the workbench setup will see a decline in airline revenues which are replaced by turnover with the OEM. Hence, they are challenged to make these arrangements profitable, in spite of the high one-sided dependence on the OEM.

By partnering with manufacturers, MROs may be able to gain preferential access to spare parts, however at the expense of the usage of alternative sources such as PMAs, DER repairs, or surplus material. This also becomes relevant in the workbench setup, in which all workbench partners typically receive similar commercial conditions for spare parts. Additional one-off expenses do however incur to establish the alliance, which involves paying a license fee to the manufacturer. Also, changes in labor costs may occur if joint facilities are constructed, typically in countries with comparatively low labor rates.

Conclusions

MROs that engage in the workbench setup can realize two main benefits when entering this configuration with an OEM. First, it allows them to ensure their competitive survival and continuing participation in the service market on a certain type of technology. Second, becoming an OEM workbench partner may even allow them to increase their share of service turnover on that particular type of technology. This increase occurs if larger parts of the world fleet are serviced compared to a completely open market with more competitors.

However, the workbench setup has the major drawback that the MRO becomes a second tier supplier of MRO services in the value chain, behind the OEM, who becomes the MRO's only customer on that particular technology. Hence, the MRO loses market access, its direct Channels, and Relationships with the Customer Segments that are now served by the OEM. Since the MRO himself could have potentially contracted these customers in other types of configurations, taking the workbench setup means effectively surrendering the service market to the manufacturer. Airlines and MROs alike should insist on direct, independent MRO service offers, to ensure competition in the MRO service market.

6.3.3 The Coopetitive Solution

In coopetitive solutions, the MRO becomes a partner in a network of typically independent and OEM-owned repair shops, which compete with each for customer contracts. The cooperative aspect of this arrangement is that the OEM contributes to the alliances by equipping the MRO with all manufacturing-specific resources required to perform repairs and offer solutions (e.g., a license, repair manuals, spare parts, and tooling). The MRO contributes by providing overhaul capacity to the network of facilities and adding value to the manufacturer's service network, e.g., by providing value-added services such as mobile engine repairs and by improving the manufacturer's repair and service-relevant engineering capabilities.

The competitive aspect of the arrangement is that both OEM and MRO compete simultaneously for customer contracts with their service and solution offers. One example that resembles this configuration is the open maintenance network that has been proclaimed by the engine manufacturer CFM for the service of the LEAP engine series. In this network, CFM has licensed third-party providers such as AFI KLM, SIATEC, and Lufthansa Technik to perform maintenance work and engine overhauls for the Leap 1A and 1B engine (Derber, 2018).

Value Proposition

In principle, MROs can make the same Value Propositions to airlines than in stand-alone solution offers; however, some differences do exist: For example, MROs increase the credibility of their brand and *service quality* by marketing themselves as OEM-certified service partners (Jaakkola & Hakanen, 2013). For manufacturers, the service quality of their partners is less important than in the workbench setup because cus-

[25]The figure shows the coopetitive solutions configuration of the MRO business model with items that have undergone a change from the workbench setup and stand-alone solutions in *italics* above the arrow. Additional elements that need to be developed from the workbench and stand-alone solutions configuration are displayed below the arrow.

Key Partners

- Affiliated airline
- MROs
- Aircraft-, Engine-, and System OEMs

Key Activities

- Operational services
- *Development of alternative parts- and repairs under tight supervision and control*
- Process optimization

Key Resources

- Maintenance Network
- *Operator Experience*
- Serviced fleet
- Financial strength
- Tangible and intangible manufacturing-specific resources

Key Capabilities

- Repair Capability
- *Engineering Capability*
- Data Processing and Interpretation Capability
- Multi-vendor Capability
- Integration Capability
- Risk Management Capability

Value Proposition

to Airline:

- Getting-the-job done
- Asset availability and reliability, customization, and risk reduction
- Reduction of Direct and Indirect MRO Costs
- *Airline Perspective*
- *OEM-certified service quality*

to OEM:

- Portfolio of basic repair services
- Risk Reduction of service business
- Reduction MRO Costs

▼

- *Value-added services*
- *Improve OEM's Service Engineering Capabilities*
- *Customization*

Customer Relationship

- Airlines: increased interdependency and incentive alignment
- *OEM: multifaceted relationship including competitor*

▼

- *Aspiration: relationship on "equal footing"*

Channels

- Key account manager
- Other channels

▼

- *Multiple channels to OEM*
- *OEM may serve as sales channel to new customer segments for value-added services*

Customer Segments

- Airlines
- Aircraft lessees and lessors

▼

- *Manufacturer is customer for value-added services*
- *Access to OEM's customer segments, reduction of overall population of service firms*

Cost Structure

- Average cost structure: 48% labor, 46% material, 7% services
- Increase of material and service cost share to be expected
- Abstention of use of alt. materials offset by discounts on OEM material
- Often considerable one-off costs to enter alliance
- Creation of facilities in countries with low labor rates

Revenue Streams

- Market growth mainly in China, Middle-East, and Asia Pacific
- Segment growth mainly Engine- and Component maintenance
- Aircraft types newer than 2000s will represent 50% of market in 2027

▼

- *Revenues generated with end customer airlines, not OEM*
- *Additional revenues possible through access to OEMs' customers*

Figure 6.9: The Coopetitive Solution[25]

tomers hold direct contracts with the service partners and hence a lack in service quality is less likely to be attributed to the manufacturer.

Just as in regular solution offers, the *airline perspective* remains a Value Proposition, which is of even higher significance in the coopetitive solution configuration. The reason is that it can be used to differentiate the own service offers from the manufacturer's competing offers. To do so, the MRO must make the credible proposition that it will be capable of understanding the airline's needs better than the OEM based on its operator experience.

The *portfolio of basic and advanced services* is not necessarily only offered to airlines, but also the OEM partner. One example is the mobile engine service offer from the Engine Case, which is a value-added service that is provided by the focal company not only for its own customers but also on behalf of the manufacturer. Engine mobile services are a set of micro repairs of the engine that are performed on-wing and allow for reducing the overall maintenance costs, while simultaneously improving the reliability of the engine.

The Engine and Components Cases show how the MRO helps to *improve the OEMs service engineering capabilities* by sharing engineering know-how and operational experience in coopetitive solutions and two-sided solutions. The information of how the equipment operates and needs to be maintained serves as an input into the NPD, aiming to improve future generations of hardware. Vice President Sales MRO 1 describes the value contribution vividly: *"[We] develop repairs, also design-improvements [...] when [you] operate a part for five to ten years, then you can see its weaknesses, and then you can maybe also develop suggestions for an upgrade"*.

Value Propositions formulated for OEMs are highly *customized* and the result of an alliance negotiation phase that typically spans several years. They may range from single services in which the MRO provider acts as an extended workbench, over additional value through advanced services such as a reduction of maintenance costs through engineering support in coopetitive solutions up to assuming the responsibility of all aftermarket activities in two-sided solutions. As a manager alliance function MRO 1 recalls: *"These are contracts that are started on a blank page, we don't take any prefabricated [...] contract, we start from zero. We have a few other clauses that can be copied, but besides that, everything is newly developed and newly invented together with the partners. These [are all] different models, [...] each project, each OEM, each business case is too individual as to copy and paste."*

The level of customization depends on the configuration of the alliance: in the workbench setup, typically less customization is required, since the MRO provides standard repair services for the OEM, often in its own facilities. Although this type of t&m contracts contains collaborative aspects, such as giving a license and intellectual property to the MRO, less customization is required compared to the coopetitive setup or the two-sided solution. In these types of alliances, MROs and OEMs co-develop intellectual property such as repair methods and improvements to parts which are shared through dynamic feedback loops. Calibrating this kind of advanced service offers requires more customization than providing operational services, as for example, pain-gain sharing models need to be put in place.

Key Resources

Just as in stand-alone solutions, the MRO can make use of its Key Resources and its Key Capabilities such as the maintenance network, operator experience, and multi-vendor capability to provide solutions to airline customers. In regards to the alliance, the main difference to the workbench setup is that these resources and capabilities are also applied to provide value-added services to the manufacturer.

Especially service-specific *repair and engineering capabilities* built on operator experience are valuable to manufacturers, who possess comparatively limited service-specific engineering capabilities. The reason is that the MROs mechanics and engineers can gather tacit service-specific knowledge that is valuable for designing alternative, more price-efficient repair methods, developing maintenance programs and even improving the OEM's equipment to make it more failure resistant. In contrast, the manufacturer's design and engineering capabilities are geared more towards research, development, and production of goods.

The CEO of MRO 1 vividly explains the tacit and valuable nature of these capabilities: *"from this knowledge from over 20 years you can make very valid assumptions. You would not think so, but the ability to repair and also to have developed repair methods and to have observed their development over ten years, those are topics [. . .] that the manufacturers don't have. [. . .] and because they exactly don't have this type of engineering they look for example for us, to build this [capability] jointly."*

The value of these capabilities becomes more pronounced when service firms depart from the workbench setup and provide more value-added services to their manufacturing counterparts. Examples for the application of these capabilities are collaborations that aim to improve the product's design to allow for easier maintenance. As these service-based capabilities are valuable, non-substitutable, and difficult or time-consuming to imitate, they represent Key Capabilities that the MRO can utilize in its collaborative business models. However, the MRO needs to be cautious to not improve the repair capabilities of manufacturer-owned shops to an extent in which it will decrease the value that can be provided long-term to the alliance. As spillover effects are not entirely avoidable, the MRO should aim at keeping these capabilities internally while taking over more service-related responsibilities in the joint solution offer.

Key Partners

Key Partners take the same roles as in the stand-alone solution and OEM workbench configuration and are consequently not discussed separately in this section. Nonetheless, differences in the Relationship with manufacturers in this configuration are discussed in the respective element of the business model.

Key Activities

MROs that venture beyond the workbench setup into coopetitive solution have the opportunity to provide a range of value-added services to manufacturers that can, for example, aim to lower the OEM's maintenance costs or improve their service-related engineering capabilities. In coopetitive solutions, the role of the MRO hence changes from a provider of simple repair services to a partner that contributes with its unique resources and capabilities to add value to the network (Lusch et al., 2010). The *development of alternative parts and repairs* has been identified as one of the MRO's Key Activities in the traditional business model that is applied significantly differently when changing from a stand-alone to a coopetitive solution.

In the traditional MRO business model, developing alternative parts and repairs was used to improve the competitive position versus the OEM through lower costs or improved performance of the repaired parts. In coopetitive solutions, it is used instead to help the OEM to increase the competitiveness of its service offer. This implies changes in logic that are nicely summarized by the Manager for Repair Services at Business Unit, 1 MRO 1: *"I believe that [developing alternative repairs] is something that the OEMs are looking for with us. Right now, for example, we would like to introduce a major repair with [Engine Manufacturer 1] that does not exist in the manual yet. [...] [Also,] we have made contracts with [Engine OEM 2] for the joint development of repairs. But it happens under supervision and in tight coordination and not independent from the manufacturer. That means, we can contribute with our engineering know-how and our competence but not as a free radical but under strict control. And it always has to fit the business case of the manufacturer. For example, [the repair] has to compete with manufacturing costs, not list prices, and it must be significantly lower than manufacturing costs because I don't develop it for a marginal delta."* (emphasis added by author).

Developing alternative parts and repairs thus represents a Key Activity that allows the MRO to depart from the workbench setup into higher-value business model configurations, however under close supervision and control as part of the OEM-led service network.

Customer Segments

Compared to the workbench setup, is not forced to serve the OEM as the only customer but can sell its solution offers directly to former and new *airline customers*. *Manufacturers* remain a customer segment, albeit a much smaller one compared to the workbench setup, and relies mostly on value-added services. Besides, it is common practice for manufacturers to subcontract repair services to the service network, e.g., in case the own facilities reach their capacity limit.

Coopetitive alliances may also enable growth through *access to the OEM's customers*, with which business may be generated either directly or indirectly via the OEM (Lockett et al., 2011; Jaakkola & Hakanen, 2013). Increasing contact with these possibly different customers allows MROs to gain valuable knowledge to support their service innovation activities (Jaakkola & Hakanen, 2013) and sell value-added services, even if the customer is contracted by the OEM. Also, MROs may be able to gain larger market shares than in non-alliance business models, since manufacturer-led service networks typically involve fewer service partners compared to the legacy setup. However, MROs have difficulties in contracting those Customer Segments that prefer OEM over MRO service offers.

Relationships and Channels

MROs that employ the coopetitive solution configuration can, in principle, establish the same Relationships and Channels to their airline customers as in the stand-alone solution setup. Changes compared to the workbench setup appear towards the manufacturer, who in this configuration is not only supplier, partner, and customer but also a *competitor*. This added dimension complicates the relationship and creates tensions since network partners demand a level playing field between OEM-owned and independent service partners, which is not always the case — at least according to the perception of the interviewees. Instead, it is reported that manufacturers capture the most attractive customers for themselves while spreading the risk of less attractive customers, capacity utilization, and investment needs among the network partners.

Manager Product Management Engine Services, MRO 1 recalls: *"If they would like to have a Southwest with — how many airplanes do they have? 700 737's or so? — If they would like to contract them, then they can because they can lower their material margin that they calculate as a part of their Flatrate offer. So they earn a bit less with the Flatrate, but then they have this huge fleet in which all motors are more or less the same. It's like baking buns... They all look the same; they are all treated the same and the material costs only a fraction. We have to buy to the CLP [Contract List Price] or a bit below. [...] If the OEM really would like to have a contract then it can always win it via the material lever."*

However, the MRO is in a better position with less one-sided dependency towards the OEM in comparison to the workbench setup. The main reason is that the relationship can be characterized as a strategic alliance that is typically designed to span decades of aftermarket support, requires high mutual idiosyncratic investments, and result in mutual interdependence. While the MRO depends on the OEM to receive parts, documentation, and support, the OEM is dependent on the MRO, since the MRO is responsible for providing aftermarket services, with a direct influence on the OEM's performance and company image (Jaakkola & Hakanen, 2013; Nenonen et al., 2014). The MRO or Joint Venture can even become critical to the system, if it supplies a substantial amount of overhaul capacity (Engine Case) or is responsible for the whole aftermarket support, as in the Components Case.

This position allows the MRO to aspire to achieve a partnership *"on equal footing"* with the OEM, which is an essential aspect that has been named by a total of six interviewees (1, 6, 16, 20, 24, 26). This aspect becomes salient, for example, in the Aircraft Case in which the focal company decided to explicitly not accept the workbench setup but achieve a relationship on equal footing with Boeing. Being on an equal footing can be understood as not being the OEM's junior partner but being granted equal rights in the relationship, balancing dependencies and continuing direct channel access to airlines. The Head of Business Development Strategy of a Business Unit of MRO 1 sums up: *"There's a guiding principle: we will not be the extended workbench for the OEM. We have* *the aspiration to continue servicing airlines, and we see ourselves as strong enough to enforce this aspiration and not come into a role in which some OEMs would like to have us. As an MRO provider that only does MRO for the OEM, the OEM holds the customer contracts and subcontracts to us. Because when that happens, of course, you are de-coupled from the market, you only have one customer on which you are extremely dependent. We don't want that."*

In coopetitive alliances, *multiple channels* are established between MRO and OEM, including commercial, engineering, procurement, and dedicated alliance managers. At the same time, the alliance adds customer channels to both MRO and OEM: On one hand, the MRO can gain access to the OEM's customers to cross-sell additional services, such as mobile engine services. On the other hand, the OEM can gain additional customers, benefiting from the MRO's established customer base.

Cost Structure and Revenue Streams

Just as in the workbench setup, the MRO is granted *preferential access to spare parts and manufacturing-specific resources*. Since the manufacturer is inclined to establish a level playing field between all third-party service partners in the network, these conditions should not allow gaining a positional advantage against other network partners. However, it is reasonable to assume that all other service firms face significant barriers to providing competitive services, which is why service firms are mostly protected from competition from all firms that are not part of this network. Compared to the manufacturer, however, interviewees perceive to be at a disadvantage due to the gap between costs and list price as mentioned in the Relationships and Channels section.

A benefit of this arrangement becomes salient in the possibilities to earn *additional Revenue Streams* with the manufacturer, e.g., by providing value-added services. Also, the service firm may be able to capture a *larger market share* compared to the legacy business model or stand-alone solutions, because of the overall fewer firms that can provide services. The Engine Case is one example where the number of worldwide service suppliers has been reduced from typically over 20 on legacy engine types to five to seven on new engine types.

Conclusions

The coopetitive solution is advantageous for the MRO compared to the OEM workbench setup since the MRO has direct market access, can retain the customer channel, and pursue reaching a competitive edge with its solution offers — at least if the OEM assures a level playing field between all network partners. This results in less dependency on the OEM and better chances to establish a relationship on equal footing. In summary, a service firm can realize many of *the benefits associated with an alliance while only suffering from some of the inherent sacrifices. Strengthening the competing OEM's service offering is one of the most severe ones, may however be inevitable depending on the given situation.*

6.3.4 The Two-sided Solution

The two-sided solution is the most advanced configuration of the MRO business model and requires highly developed solution-specific and relational dynamic capabilities to be established. In this setup, the MRO provides a solution for the airline customer on behalf of the OEM in the form of a joint offering. Consequently, the MRO assumes responsibility for the outcome of the solution offer and processes that would traditionally be performed by either party. One example of a two-sided solution is the Components Case, in which the MRO has allied with a major tier 1 component supplier for the A350 aircraft. In this arrangement, the MRO is responsible for marketing and providing the entire solution offer. Simultaneously, the manufacturer has reduced its scope to manufacturing-related activities, effectively de-servitizing and focusing on its core business (Kowalkowski et al., 2017).

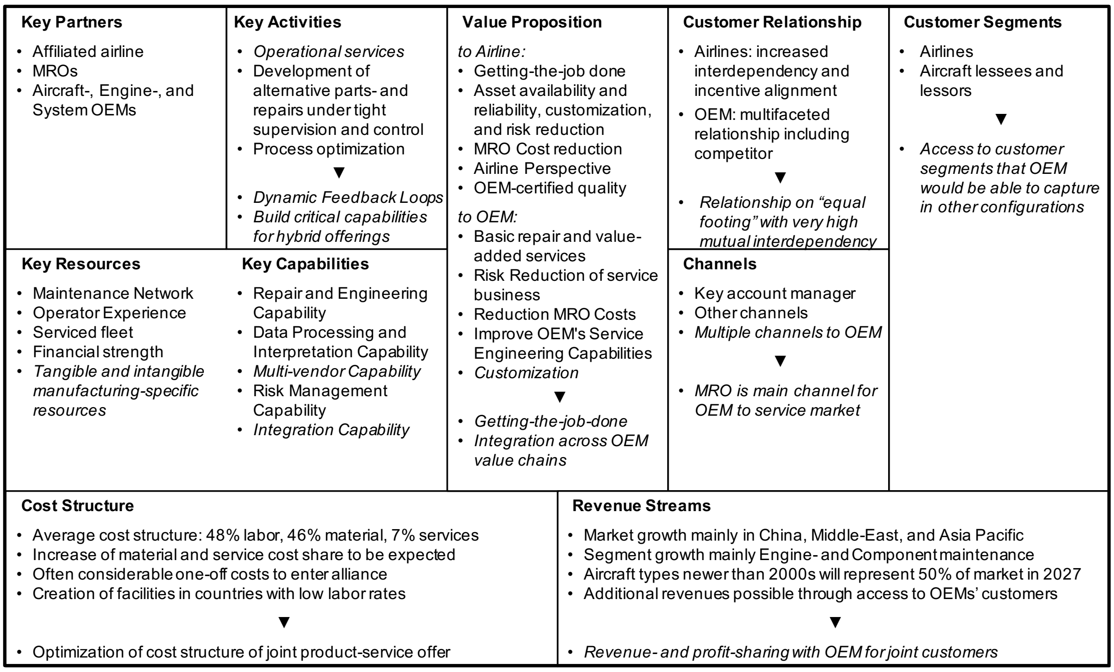


Figure 6.10: The Two-sided Solution[26]

[26]The figure shows the two-sided solution configuration of the MRO business model with items that have undergone a change from the coopetitive solution setup in *italics* above the arrow. Additional elements that need to be developed or elements that are discarded from the coopetitive solution configuration are displayed below the arrow. Items of the coopetitive solution that have only limited application in this configuration are displayed in brackets.

Value Proposition

Just as in stand-alone solutions, the end customer receives a Value Proposition that includes assuming responsibility for the customer's processes and the associated risk. One example of this business model is the Components Case, in which the MRO provides airlines with guaranteed access to a pool of components that are maintained in airworthy conditions. This offer allows airlines to effectively outsource component MRO, spare parts management, the administration of repair contracts with many external vendors, and the logistics processes associated with managing a component pool. Additionally, cost reductions can be realized due to economies of scales inherent in component pooling (see Section 3.5). For the end customer, the main difference is that the *airline perspective* Value Proposition becomes increasingly compromised. The reason is that the MRO cannot act as an independent agent between OEM and airline, but instead has become an OEM risk-and-revenue-sharing partner that optimizes the joint commercial offering. Since the incentives of MRO and OEM are effectively aligned, it is less credible that the MRO will be able to provide an OEM-independent consultancy approach to the airline. For example, MROs typically need to relinquish the use of alternative more cost-efficient parts to form an alliance.

The main innovation in the Value Proposition dimension takes place towards the OEM, as the MRO assumes full responsibility for the joint aftermarket offering. The tasks typically include the administration of customer contracts, managing the Channel and Relationship, performing repairs on the manufacturer's products, planning of inventory and logistics, and risk management. This represents a solution offer for the OES, who can overcome servitization barriers and still participate in the commercial potential of the aftermarket.

In the Component Case, a decisive part of this Value Proposition is the *integration across OEM value chains*, since the MRO offers access to a pool of line replaceable units of all tier 1 suppliers on the A350, not only the partner's. Including the competitor's equipment and its repair into the own solution offer is challenging to achieve for a tier 1 supplier, which is why only the airframers as integrators offer component solutions across all suppliers on their platforms. In consequence, integration allows the tier 1 supplier to venture beyond simple lifecycle services into solution offers that the OES would not have been able to develop without the MRO.

Key Resources

Providing two-sided solutions requires in principle the same Key Resources and Key Capabilities as stand-alone solution offers, which include the integration of product and service elements into a seamless bundle, assuming responsibility for the customer's processes and risks associated with their outcome, as well as the underlying repair network and qualified staff. However, two major differences compared to other configurations become salient: First, the MRO represents the single Key Partner of the manufacturer for the joint aftermarket offering, who receives favorable access to *manufacturing-specific resources*, which allow him to gain a positional advantage against other service providers. The Components Case is an example in which Airbus remains one of two major competitors, who can gain a similar advantage against all other third-party providers since it can negotiate favorable terms with its suppliers that have become RRSPs on the A350.

This links directly into the second difference to coopetitive solution networks: the role of the *mutli-vendor capability*. In the Components Case, this capability serves as an antecedent to the formation of this type of alliance, as it enables the OES to compete with the airframer on the same level of the supply chain with an integrated solution offer. Manufacturers that master the multi-vendor capability internally are less likely to rely on external partners to perform the integration for them. Instead, these firms are inclined to form a network of workbench partners that provide product and service components into the solution offer. When the multi-vendor capability plays a crucial role, and the manufacturer is not able or willing to build this capability internally, it makes sense to rely on one external partner that can contribute this capacity. In cases in which the multi-vendor capability plays only a peripheral role (e.g., the Engine Case), manufacturers can rely on various MRO service firms as network partners, e.g., in coopetitive solution networks. Hence, the multi-vendor capability needs to be considered as crucial for the formation of the two-sided solution configuration.

Key Partners

In the two-sided solution the *manufacturer* is the single Key Partner for the MRO, however with a more intense Relationship that is discussed in the respective section. Although the boundaries between being a solution customer or an alliance partner are somewhat blurred, the partnership aspects overweigh the customer aspects by far in the Components Case. This aspect is a contrast to most of the established solution literature that portrays the receiving party of the solution offer as a customer or client (e.g., Brady et al., 2005; Mathieu, 2001a), however acknowledging the need for additional relational processes to customize the solution offer (Tuli et al., 2007). This finding underpins the complexity of providing an aftermarket solution for the manufacturers, in which the MRO assumes the responsibility for the entire service business for a certain product type. The inherent complexity of aftermarket solution hence requires a stronger partnership approach then less complex solution offers, such as, e.g. Xerox' document management services for B2B or car availability services for B2C customers.

Key Activities

In two-sided solutions, MROs perform the manufacturer's *operational MRO services* of their equipment and assume responsibility for the outcome of these services and the overall service offering. Besides, *Dynamic Feedback Loops* (DFLs) have been identified as the most prominent Key Activity besides operational services provisioning in the alliance cases that ventured beyond the workbench setup. DFLs are inter-organizational communication routines from service staff to the manufacturer that ensure that equipment is easy to maintain when operated in the field and benefit the development of future generations of equipment (Hobday et al., 2005; Kowalkowski et al., 2011a). DFLs incorporate sharing the technical information gained in repair and overhauls events with the manufacturer to reduce MRO costs, improve asset service life and improve future asset generations.

In addition, the MRO can *support the manufacturer in building critical capabilities for successful hybrid offers*, such as the design-to-service capability that allows manufacturers to gain a positional advantage by combining products and services in a synergetic, not merely additive manner (Ulaga & Reinartz, 2011). To build this capability, manufacturers need to include service-related information in their product development process to "think service" from the beginning. One example is sharing suggestions for the improvement of a component that reduces the wear and tear and increases the service life. Another example is sharing information that allows manufacturers to design this component for easier maintainability. In the two-sided solution setup, DFLs are of the highest importance in all of the configurations, since the manufacturer refrains from performing most service activities that could provide him with valuable customer feedback that is required to develop internal capabilities further and future equipment generations.[27]

Customer Segments

By forming alliances with a manufacturer, service firms can gain access to the manufacturer's Customer Segments that would be difficult to acquire without the alliance (Jaakkola & Hakanen, 2013). The two-sided solution is the most beneficial of these arrangements due to two mechanisms: first, the MRO serves as an exclusive service partner of the OEM, which channels customers that prefer OEM offers (e.g., many Asian carriers) directly to the MRO. Second, the OEM grants preferential access to

[27] In the coopetitive solution configuration, DFLs can also become salient, however with a different focus: Here, the DFLs can also be geared at improving the manufacturer's service capabilities. However, the MRO should carefully consider which information is shared, since it may become less relevant to the OEM's solution, once the OEM has built sufficient internal capabilities to provide solutions (Schneider et al., 2013).

manufacturing-specific resources only to this single alliance partner, which allows gaining a positional advantage against most other competitors (as discussed in the Key Resources section of this configuration). In effect, it is reasonable to assume that the MRO will be able to gain substantial market shares across all Customer Segments.

Relationships and Channels

In general, Relationships with the end customer can be characterized as being similar to stand-alone solution offers and involving increased interdependencies that are managed through performance-based contracting mechanisms (Bharadwaj et al., 1993; Penttinen & Palmer, 2007; Windahl & Lakemond, 2010). Depending on the number of competitors that remain for aftermarket services, customers may, however, suffer from increased dependencies, just as in Rolls Royce' solution offer presented in the Engine Case.

The manufacturer requires a very high level of trust since it builds most service capabilities externally and relies on a single partner, with possible implications for the company image. This uncertainty implies on the other hand that the MRO needs to credibly assure that it can deliver high-quality integrated solutions (Kindström, 2010; Paiola et al., 2013). However, the relationship is not built on trust alone but safeguarded through performance-based compensation mechanisms that ensure an incentive alignment between the two risk-and-revenue-sharing partners.

Cost Structure and Revenue Streams

In the two-sided solution, manufacturer and MRO establish a risk-and-revenue-sharing model to align the initially diverging interests of selling more spare parts (manufacturer) and using alternative, more cost-efficient parts (MRO). In effect, revenues and profits but also risks and efficiency gains are shared between both parties.

Manager Alliance Function MRO 1 explains the model: *"If the prices decrease and we are not able to sell as much, then this is a risk [for the OEM] since they get less payback because the payback is linked to the sales volume and profit. If we are able — and this is also an incentive for the OEM — to sell more than in the past and also to higher prices, then they get more, and we share this; this is sharing chances and risks."*

In essence, this allows shifting the manufacturer's focus from the sales of spare parts towards optimizing the joint aftermarket offer and the MRO to focus on the development of more cost-efficient repair methods and the optimization of the overall solution offer.

Conclusions

In conclusion, the two-sided alliance configuration effectively extends the practice of risk-and-revenue-sharing along the supply chain that has been initiated through the establishment of RRSPs between airframers as well as engine manufacturers and their suppliers in the 2000s (Esposito & Raffa, 2007; Rossetti & Choi, 2008; Krol, 2011) further downwards to traditional service firms. Just as lower-tier suppliers took increasing responsibility for the financing, design, and outcome of the equipment, upper tier maintenance firms are now taking responsibility for designing and providing an effective system to provide seamless solutions for the customer. In both types of RRSPs risks and profits are shared across the different levels of the supply chain, which allows manufacturers to tap into these markets through alliances.

For MROs that are forced to form alliances with manufacturers and share the aftermarket pie, this configuration is the most beneficial, since it allows the MRO to continue to provide most services internally, design solutions offers themselves, and thus retain direct access to the customer. However, this configuration requires a significant transformation of the traditional MRO business model: developing the capabilities needed to deliver effective solutions, building risk-and-revenue-sharing partnerships with OEMs, and developing alternative parts and repairs in coordination with and not to compete with the OEM, are just a few examples. The transformation requires well-developed solution-specific and relational dynamic capabilities such as shifting the mindset from competing to alliancing with manufacturers and accepting that manufacturer have successfully entered the service market and will gain their fair share. Solution-specific and relational sensing, seizing, and reconfiguring dynamic capabilities are essential for MROs to innovate their business model in the context of servitization. I will explore these dynamic capabilities and their microfoundations in the next chapter, outlining how MROs can innovate their business model to realize the four different configurations.

6.4 Dynamic Capabilities for MRO Business Model Innovation

6.4.1 Dynamic Capabilities for Developing Solutions

Manufacturers that aim at providing solutions require a service-specific set of sensing, seizing, and reconfiguring capabilities, which have received some academic attention (e.g., den Hertog et al., 2010; Kindström, 2010). As highlighted in Section 2.3.6, it is reasonable to assume that pure service firms require different dynamic capabilities than manufacturers to provide solutions as they come from a base in services and may require manufacturing counterparts to form solution networks. Hence, not the service aspect of solutions but rather switching from an input- to an output-based logic should represent a challenge for pure service firms. Here, service firms require information about the factors that determine performance outcomes, such as expected service intervals, anticipated reliability of the equipment, and future costs of spare parts. For new assets, the manufacturer may have an advantage, as it is its designer. However, traditional service firms may have more experience with the operation of the equipment due to customer proximity and knowledge spillover effects that enable them to assess risks associated with performance-based contracts better.

In this section, I set out to explore the dynamic capabilities of pure service firms to enhance our understanding of how pure service firms in general and MROs, in particular, can innovate their business model to provide solutions either stand-alone, as part of a coopetitive network, or even for both airline customers and manufacturers simultaneously in the form of a two-sided solution.[28]

Service Firm-specific Dynamic Capability of Solution Sensing

The microfoundations for sensing include practices, processes, and methodologies used to gather and assess the information of the firm's ecosystem, including i.a. customers, complementors, suppliers, regulatory bodies, or research institutions that may yield valuable information for the identification of opportunities and threats (Teece, 2007). In the context of solution provisioning, manufacturers require specific sensing capabilities regarding customer service needs, technological developments, the service system, and service opportunities presented by it (den Hertog et al., 2010; Fischer et al., 2010; Kindström et al., 2013). My research reveals three distinctive microfoundations of sensing capabilities specific to traditional service firms.

[28]I would like to thank Dr. Zsofia Toth from Nottingham University for her support in outlining publication possibilities for dynamic capabilities of pure service firms and jointly working towards this in internationally well-regarded journals.

Microfoundations	Description	Proof Quotas
Customer need sensing	Internal and external routines to sense changing customer needs induced by servitization	*"First, there was a trigger[…]: Our colleagues from sales and […] customer service said: 'The customers are asking for something that we don't have in the drawer."* – Manager Product Management MRO1
Technology sensing	Scanning new technology employed on aircraft types for opportunities to increase efficiency and effectiveness of solutions	*„[Through] digital transformation, [...] the aircrafts generate a massive amount of data through all those sensors [...]. What we need now is the competence to filter, what data is valuable? On what topics should we be working, to provide our customers with a better dispatch reliability, less costs and more aircraft availability?"* – Vice President Sales MRO1
Risk sensing	Sensing the increased risk associated with offering solutions	*"There is a risk-driver in the [solution] itself, which means that if you venture in these kind of contracts, you have to take the essential risks, just like the OEM, who however knows the design exactly."* – CEO MRO1

Table 6.5: Service Firm-specific Dynamic Capability of Solution Sensing

Customer Need Sensing Just as manufacturers, MROs perform routines to build their customer need sensing capabilities. Interviewee 13 (Vice President Corporate Sales) vividly describes the essence of customer sensing: *"we are the ear to the customer, we should always have the ears on the tracks: what do they need? Not just to a certain strategic time, that's the main expectation of my salespeople. That they understand, that they listen, that they can draw conclusions when the customers tell them their problems."* (Emphasis added by author).

While manufacturers need to build different customer service sensing capabilities, as service-oriented values are more challenging to measure (Grönroos, 2007; Kindström et al., 2013), respondents did not mention increased requirements in customer need sensing as a challenge for MRO providers. The reason may be that MROs come from a base in services and thus were already able to build service-specific customer sensing and innovation capabilities before venturing into solutions. In the case of two-sided solution provisioning, customer need sensing capabilities increasingly overlap relational sensing capabilities, as manufacturers are simultaneously the customer and partner of the MRO firm.

Nonetheless, servitization has changed customer needs in the aerospace industry: today, airlines increasingly demand solutions, more integrated offerings, performance-based pricing coupled with longer contract durations. As Team Lead Aircraft Engineering MRO 1 describes: *"customers are asking for a full integration, but we don't have it!"* Hence, MRO providers do not need to develop new or more proficient customer-service-sensing capabilities. Instead, they need to make intensive use of their already existing dynamic capabilities to sense changing customer needs induced by servitization to develop solutions that match these needs successfully.

Technology Sensing Service innovation literature often emphasizes the sensing of external technological opportunities to innovate service offerings (Lusch & Webster, 2010). Thus, manufacturing companies perform technology sensing not only for product innovation but also to tap into technological developments to foster the service innovation process (Kindström et al., 2013).

For traditional service companies, new technology in- or outside of the OEM's product offer can provide opportunities for offering or improving solutions. Aircraft are predicted to generate 98 terabyte data volume by 2026 (Hoyland et al., 2016), which creates opportunities to improve cost-efficiency and performance, as well as the reduction of solution-specific risks. As traditional service companies are not the manufacturers of goods, they require specific technology sensing capabilities to identify the opportunities resulting from technological improvements that are not inherent in their own products. In this context, pure service firms face particular challenges as they need to overcome barriers erected by manufacturers to access the proprietary technology to develop solution capabilities.

Risk Sensing As some hybrid offerings are priced based on usage or performance (Tukker, 2004), providing them involves assuming the risk for performance outcomes of customer's operation. Developing the capability to assume, manage, and mitigate risks thus becomes a central issue for solution providers (Ulaga & Reinartz, 2011).

To develop the operational capability of risks management, solution providers need to build the dynamic capability of risk sensing. For traditional service providers, generating the required risk sensing capabilities involves a high effort and uncertainties, as they possess less information regarding the design of new equipment than the manufacturer. This makes estimating the equipment's performance and required maintenance efforts more difficult.

Another factor is that, in contrast to traditional service providers, manufacturers can partially shift the risk back to customers and third-party maintenance providers. This works by increasing prices for spare parts, which are required by customers with input-based contracts and third-party maintenance providers alike. Another option is to raise prices for intellectual property and testing equipment which is needed by maintenance firms if they would like to build service capabilities on the respective hardware. This further aggravates the difficulties to sense risks and limits the risk management capability of MROs correctly. Hence, the availability of risk sensing capabilities is a decisive factor for whether traditional service firms can develop stand-alone solutions or need to rely on an alliance with manufacturers to provide solutions to their customer.

Service Firm-specific Dynamic Capability of Solution Seizing

Firms that aim at seizing opportunities from the development of solutions require the dynamic capabilities to conceptualize, prototype, and co-create the solution together with the customer through repeated cycles of interaction. Since this service innovation process is more intangible and fuzzier than product innovation, manufacturers need to develop service-specific seizing capabilities (den Hertog et al., 2010; Kindström et al., 2013).

My research shows, somewhat surprisingly, that MRO providers are not able to provide solutions based on their long-term service experience. Instead, they need to develop a set of distinctive seizing capabilities to design integrated, outcome-based offerings. These capabilities rest on a variety of specific dynamic capabilities that include solution design, customer co-creation, sales and the increasing use of networks.

Microfoundations	Description	Proof Quotas
Solution design capability	Capacity to delineate new outcome-based business models across business units	*"Taking over responsibility in the sense of bonus-malus agreements [...] is definitely a topic that was difficult for us in the beginning because we always said: ‚There are too many factors that we cannot influence.' And also because we as a company were simply too big. That means, engineering is not accountable for component services. So, to develop this holistic service offer and […] stand accountable for it, that is something we had to learn."* – Team Lead Aircraft Engineering Services MRO 1
Customer solution co-creation capability	Routines to verify, adapt and individualize solutions to customer needs	*"Our CEO is very [customer-]driven. He says: ‚you are the spearhead to the market, you have to understand what the market needs and you have to drive this company to deliver […] what it takes to be successful.' Not the other way around, in which [we] define the solution and ask the customer 'do you want to buy it?' And this is how it has been for a long time, […] but now it works very, very well. Before, we were very production-oriented."* – Vice President Sales MRO 1
Sales force enabling capability	Routines that enable the central sales force to successfully market solutions	*"We needed to develop something to supply sales so that they don't have to travel to the customer as usual with a busload full of people to answer the questions, instead that sales is able to get through the first appointment by themselves with enough material that states: 'these are my capabilities, these are my differentiators, and that is what it costs.'"* – Manager Product Management MRO 1
Solution network formation capability	Capacity to determine which service and product modules are to be provided internally or the solution network	*„Before, we always thought: let's send our good mechanics, even our best. Just that this one mechanic costs the airline 30,000 Euro per month and the airlines cannot and don't want to afford that. They need local solutions but anyhow with the competence of [our] mechanics. […] Now we have achieved that by taking the integration in our own hands […], we enable a local provider to local costs and not expat costs to be able to do what we do."*– Vice President Sales MRO 1

Table 6.6: Service Firm-specific Dynamic Capability of Solution Seizing

Solution Design Capability Developing solutions offerings requires dynamic seizing capabilities beyond the scope of traditional service offerings. As solutions are more comprehensive than conventional service offers (Kohtamäki et al., 2013), they often need the integration of services from different business units and suppliers. Aircraft Solutions, for example, incorporate Line Maintenance, Engineering, and Component Maintenance Services. Clearly, this type of solutions cannot be developed by an individual business unit alone. Multiple interviewees (11, 15, 23, 24) recognized that the establishment of a central organizational unit responsible for new service development (NSD unit) has been very beneficial for the design of integrated offerings. The NSD unit is responsible for facilitating service innovation across the company, with customers, and with external service providers.

Developing the capacity to assume risks associated with performance-based offerings across business units is one significant barrier in providing solutions, as these units typically are not willing to assume risks that lie outside their area of influence. Hence, internal systems and routines need to be established that measure risks and profitability of the joint service offer across business units. Also, performance measurement systems installed at the interface between customer and service provider help to identify and mitigate factors that lead to risks associated with unsatisfactory performance.

Customer Solution Co-creation Capability Internal solution development is only a first step, and quick verification and further co-development with the customer are essential. Designing effecting solutions requires strong customer interaction since they rely on understanding both the customer and its needs, business goals, practice, and culture (Windahl & Lakemond, 2006). Recent research shows that firms that co-create advanced services through repeated cycles of interactive co-creation with their customers can create and seize opportunities for innovation and competitive advantage (Kindström et al., 2013).

Just as manufacturers, traditional service firms need to build customer solution co-creation capabilities. The reason is that solutions are more customer-specific than traditional service offers and require the joint definition together with the customer from his perspective. Hence, even traditional service providers need to shift their perspective further towards the customer. One example are Aircraft Solutions, where the aircraft maintenance schedule is defined and optimized based on the customer's individual operating profile, service demands, and hangar capacity. Hence, solution co-creation represents a shift from the traditional offering in which the service provider aims to optimize its own towards optimizing the customer's operation.

Sales Force Enabling Capability Servitization research highlights the fact that the manufacturer's sales force needs to acquire additional knowledge and capabilities, or may even require reorganization. The reason is that sales managers have to transform from a passive recipient of a predefined offer into more active participants in a value creation relationship typical for services (Storbacka et al., 2013). It has even been argued that a separate service organization with a dedicated sales force facilitates the creation of the service culture required to market solutions successfully (Gebauer et al., 2005).

The results show that the traditional sales capabilities of pure service providers are not sufficient to successfully sell solutions. Instead, they need to overcome two main barriers that hinder the development and marketing of solution offers. The *integrated nature of solution offerings* constitutes the first barrier. It requires sales managers to possess both broad knowledge across the different service segments and an in-depth understanding of each service offered. Traditionally, the focal company sold individual services through a team of central and business unit sales managers. For traditional services, this approach works well, as general and expert knowledge can be combined into a compelling offer. When customers started requiring integrated solutions across various service segments, this approach resulted in *"send[ing] a bus load-full of people to the customer"* as the Vice President Sales MRO 1 puts it. To overcome this barrier, the central sales force needs to be enabled to sell integrated solutions while relying on the business units' sales managers only for advanced topics.

Differentiating the own solution offers from the OEMs' solution offers constitutes the second barrier for traditional service providers. As manufacturers represent new competitors with unique resources and capabilities (Ulaga & Reinartz, 2011), unique selling points based on the strengths of their own organization compared to the manufacturers need to be developed. This capability becomes especially interesting in cases in which service firms form parts of coopetitive service networks. In these cases, they are forced to differentiate their own solution offers as a licensed service partner against their licensor, which is a task that is especially demanding since the manufacturer mostly sets the license conditions.

Solution Network Formation Capability Selecting enterprise boundaries to gain access to external resources and capabilities is a specific seizing capability required to maintain evolutionary fitness of the firm (Dyer & Singh, 1998; Teece, 2007). In the context of solutions, manufacturers rely on partners to extend their portfolio of products and services to cost-efficiently extend their capabilities and footprint (Baines et al., 2007; Gao et al., 2011; Gebauer et al., 2013). Thus, they make use of solution networks, in which each actor contributes to the offering (Lusch et al., 2010), focusing on their core competence and cooperation with other network actors (Basole & Rouse, 2008).

For manufacturers, integrating the competitor's technology into the own solution has been labeled the acid-test of if they are willing to become a real solution provider (Foote et al., 2001; Davies et al., 2006). For service providers, integrating services from competitors to benefit the customer may constitute just this acid test. For example, local service providers or the customer's organization may need to be integrated into the solution offering, to ensure the continued employment of local staff and enable a price-competitive offering. Alternatively, in cases in which manufacturers offer more competitive repair services on their equipment, traditional service providers may need to be forced to rely on these offerings on the expense of filling their own workshops.

Service Firm-specific Dynamic Capability of Solution Reconfiguring

Dynamic capabilities are capabilities that reconfigure operational capabilities, enabling a change in the product, the production process, the scale, or the customers served (Helfat & Peteraf, 2003; Winter, 2003). MRO firms need to develop a set of operational capabilities (i.e., repair and engineering-, integration-, multi-vendor-, risk management-, and data processing and interpretation) to sustain their business model and offer solutions. The development of these operational capabilities requires the reconfiguring dynamic capabilities described in this section.

Microfoundations	Description	Proof Quotas
Orchestrating the transformation of the solution network	Managing and reconfiguring the network of product- and service providers that are critical for the solution's performance.	*„We have to decide in every moment: this unit, do we want to repair it, can we do that in-house or do we have a cheaper subcontracting possibility, or do we throw it away because we get it so cheap today on the surplus market. […] So we cannot let ourselves be driven by the fact that we have a lot of production capacity, workshops that we theoretically need to fill. Because, if we are driven by the decision to fill these workshops but we are not competitive anymore because there are cheap surplus units available or there are simply smart subcontracts that have everything 20% cheaper, than we are out of the market, immediately.“* – Vice President Sales MRO 1
Adopting an outcome-oriented mental model	Changing the mental model towards the achievement of a result, assuming the responsibility for the outcome, independent of whether it can be directly influenced	*"we had to learn that it's not your or my problem, it's our joint problem."* – Team Leader Aircraft Engineering MRO 1 *"we have to dare to tackle the central topic that moves airlines: aircraft availability. […] In the end the customer doesn't give a damn if I have to move heaven and earth. The customer needs a contact person that is always there, takes away all the problems, solves them in a short time and he needs aircraft availability."* – Manager Market Research MRO 1
Customer co-specialization	Interorganizational, learning and reconfiguring routines that continuously adapt the offering to changing customer needs	*"[adapting the solution] is still very difficult, we are in a steady flow. […] Even in this partnership you are under a constant pressure to prove that you are the correct partner."* – Team Lead Aircraft Engineering Services MRO 1
Customer incentive alignment	Routines to align interests and balance dependency between solution provider and customer, such as performance guarantees, long-term commitments and pain-gain sharing models	*„I can measure whether my aircraft has a technical reliability of 90.2% or 95%. And we are compensated for this value. That means, per percentage point […] we receive a bonus. [..] we do not only promise that but if we don't deliver we have a real problem, also financially. That means all of our efforts are direct to make this happen. […] the advantage is that we have considerable more profit potential if we over-achieve this goal."* – Manager Product Management MRO 1
Installed base learning routines	Routines to codify, access and utilize knowledge from servicing the installed base aiming at forming knowledge capital and gaining a competitive advantage	*"the question will be […] how to access the dispersed knowledge from these minds? To apply it onto a new engine with a new design, new materials, and architecture to build a new [product and service portfolio], that helps us to compete against the OEM, who always has the material cost advantage. [We have to create] a unique selling proposition to convince the customer. If I only offer the same as the OEM, then I would rather choose the OEM as a customer." – Senior Manager Alliance Function MRO 1*

Table 6.7: Service Firm-specific Dynamic Capability of Solution Reconfiguring

Orchestrating the Solution Network Solution providers should actively manage the external actors that are central to the performance of the service system (Kindström et al., 2013). To effectively do so, they need to develop a common language with suppliers and customers (Gebauer et al., 2013). In the Aerospace industry, this is facilitated by the fact that common terms are defined by the airworthiness regulations of the authorities and English is generally accepted as the primary language. Nonetheless, both manufacturers and pure service firms need to make some efforts to establish common terms, definitions, communication channels and to intertwine critical IT systems.

Orchestrating the service network also includes the reconfiguration of the resource base and actors that belong to the solution network (Kindström et al., 2013). MROs as solution integrators possess no or few production facilities of their own, enabling them to select the most competitive equipment from either OEM or alternative sources (Davies et al., 2007). However, they may need to make compromises by integrating services from third parties instead of internal service functions: In the Aircraft Case, for example, one aircraft solution customer re-tenders individual service segments to the most competitive MRO regularly. If the MRO loses one of the tenders, it might be forced to integrate the services provided by the competitor to continue offering the solution. Alternatively, in Component Solutions, repair services from competitors need to be integrated if they are more competitive than an in-house repair, even at the expense of workshop utilization. As Manager Product Management MRO 1 sums up: *"[As an airline] I don't have one MRO that does everything and that needs to be the best in all areas. I believe that I have to challenge my provider constantly. And I also believe that there is no single best MRO in all areas."* Hence, just as integrating competitors' products into the solution shows the OEMs' commitment to their customers' solution (Foote et al., 2001; Davies et al., 2006), integrating third-party services to benefit the customer is something that the MRO may find challenging to do. It becomes evident however that achieving the capability to either swiftly improve the internal resource base or exchange it for resources from external partners is vital for obtaining and maintaining a competitive solution in the long term.

Adopting an Outcome-oriented Mental Model To successfully provide hybrid offerings, OEMs need to undergo a cultural change away from a product towards a service culture. Practices that facilitate establishing a service culture include creating service champions, a long-term orientation, and even building a separate organizational unit to escape the dominant product culture (Oliva & Kallenberg, 2003; Gebauer et al., 2010b; Kindström & Kowalkowski, 2014; Story et al., 2017). Traditional service firms might not be expected to require a cultural change to provide solutions since, after all, they come from a base in services.

My research shows however that even traditional service providers need to change their service culture from an input-based to an output-based logic. Instead of merely performing a contracted service (deed), the service provider needs to assure an outcome of the service that is satisfactory for the customer. While before, finger pointing at other suppliers or internal business units may be a common practice, now the responsibility for the seamless performance needs to be assumed by the solution provider, independent of the cause of the error. Interviewees were in unison in the importance of a Key Account Manager to achieve this goal. This finding is in line with (Hakanen, 2014) that notice that establishing a Key Account Managers as knowledge integrator that facilitates the solution process from design throughout the operation.

A second measure that facilitates the change towards and outcome-oriented mental model is the internal alignment of incentive systems: to optimize the entire offering, profit centers need to extend their focus away from a purely internal view on profitability towards the profitability of the whole solution. In the process, dependencies between the different service components need to be taken into account (e.g., Aircraft Reliability in Line Maintenance depends on stock level of Aircraft Components). As a result, the profitability of some business units may benefit (e.g., through increased reliability), while others may need to make sacrifices (e.g., through higher stock-levels). Overall, however, the performance of the solution and hence customer satisfaction and profitability can be increased.

Customer Co-specialization It could be assumed that after co-designing the solution with the customer only minor adjustments need to be performed that do not require distinct capabilities to reconfigure the resource base. This is however far from the truth. Especially Aircraft Solutions are highly individual and intertwined with the customer's operation and thus require a constant adaption to the customer's needs. These reconfigurations are very challenging for solution providers, as the quote in Table 6.7 illustrates. Adaptations may be very extensive and include changes in the size of operations (in this case from four to 80 aircraft), the scope of operations (extension to new countries), underlying technology (new aircraft types), areas of responsibility, and IT systems (MRO software). The efforts required may, however, result in difficult to imitate co-specialized assets (i.e., low-cost and high-performance maintenance network) and a sustainable competitive advantage for the airline (Bharadwaj et al., 1993).

Interviewees perceive inter-organizational learning and communication routines as essential to support customer co-specialization and trigger changes at both organizations. Again, the Key Account Manager was highlighted as the most important intermediary and knowledge integrator that ensures that reconfigurations are conducted in the solution provider's organization. In contrast to manufacturers, where this type of routines are known as dynamic feedback loops that aim to improve current and future generations of equipment (Hobday et al., 2005), here the main aim is to improve the overall performance of the solution offering. However, pure service firms can benefit from customer co-specialization as well. The reason is that these routines pinpoint tacit weaknesses of the organization that less integrated buyer-supplier relationships are unable to uncover. Hence, specific learning routines can be established to drive innovation and improve business performance (Nonaka & Takeuchi, 1995; Lusch et al., 2010).

Customer Incentive Alignment The level of mutual interdependence between customer and solution provider increases from pure product-, over use-based up to performance-based agreements due to co-specialization and the customer's loss of internal capabilities (Bharadwaj et al., 1993; Windahl & Lakemond, 2010). In Aircraft Solutions, for example, it typically takes a project of several years to build the internal skills that are required to replace the MRO provider entirely. While customers suffer from increased dependence, the reciprocal level of dependence of the MRO provider on its customer increases, as well. This increase is due to upfront investments and a potential loss of reputation if the solution offer does not meet the expected performance.

To balance this increased, reciprocal interdependence typical for solution offers, MROs and customers establish routines to align interests through performance guarantees, long-term commitment, and pain-gain sharing models, which have been extensively discussed in literature (Penttinen & Palmer, 2007; Windahl & Lakemond, 2010; Kowalkowski et al., 2015). As Team Lead Aircraft Engineering Services MRO 1 summarizes: *"the customer clearly wants us to feel the pain if things don't go well"* so that he can give up responsibility with a peace of mind.

Installed Base Learning Routines Through learning routines, firms can create knowledge capital, which enables competitive differentiation versus their peers. Just as other routines underlying dynamic capabilities, learning routines are not free but costly to establish and sustain (Malerba, 1992; Zollo & Winter, 2002; Winter, 2003).

Servitization literature stresses that most manufacturers possess an installed base of capital goods in operation as a unique resource (Wise & Baumgartner, 1999), which can be leveraged to build unique capabilities that pure service providers cannot attain (Ulaga & Reinartz, 2011). In the aerospace industry, large independent MRO providers however typically possess a broad customer base, servicing large and diverse fleets which allows them to perform extensive learning routines. For example, the world largest independent MRO provider Lufthansa Technik services an 'installed base' of 800 airline customers operating 3.700 aircraft (Lufthansa Technik AG, 2017). Hence, the independent service provider possesses a by far larger installed base on which it performs services than most manufacturers.

As occurrence and contents of maintenance, repair, and overhaul are less predictable than the production of goods (Auramo & Ala-risku, 2005), it relies to a greater extent on knowledge gained from learning routines. The importance of learning routines is further increased by the manufacturers' servitization tactics to withhold or thin-out repair instructions, as MRO providers cannot anymore rely purely on manuals to receive all information required to perform MRO services successfully. A central challenge in this regard is the codification and storage of the tacit knowledge that is created through learning-by-doing (Malerba, 1992). Accessing and utilizing the expertise possessed by engineers and mechanics is regarded as vital for service innovation and differentiation from the manufacturer as the proof quota in Table 6.7 shows.

In consequence, installed base learning routines are more critical to pure service firms as they represent a significant form of gaining knowledge about the manufacturers. The importance of these learning routines is further amplified by the fact that manufacturers increasingly withhold vital repair information to inhibit other competitors from servicing their equipment. For pure service firms, departing from stand-alone solutions towards alliances with manufacturers represents an opportunity to deepen their installed base learning routines by establishing two-sided dynamic feedback loops such as engineering councils which can give them advantages over other providers that are not able to build such an in-depth product knowledge.

6.4.2 Relational Dynamic Capabilities

While manufacturers require relational capabilities to build and make use of service networks (Gebauer et al., 2013), traditional service providers require a distinct set of capabilities to capitalize on these networks. My research uncovers that traditional service providers perform sensing routines to identify the opportunities presented by the manufacturers' service networks, seizing routines connected with joining the networks, and reconfiguring routines, required for providing and appropriating value from the network. These service provider-specific dynamic capabilities are delineated in the next sections.

Service Firm-specific Dynamic Capability of Relational Sensing

Microfoundations	Description	Proof Quotas
OEM competitor sensing	Identifying (a) changes in the competitive position on the market level and (b) the competitive profile of the manufacturer	*"I would say that … the OEMs are actually another type of competitor, when they enter [the market]. Some are more aggressive, others less. But they are an additional competitor. And of course, a good sales man needs to know his competitors and know their strengths and weaknesses to know what to highlight in my own offerings […]." – Vice President Sales MRO1*
OEM partner sensing	building a deep understanding of the OEM's core logic and needs	*"we have taken a long, long time to learn everything. So, we have had an initial phase with the OEM in which we took one and a half years to understand each other, I think now that has changed very much, now we have a good mutual understanding, and now it's all about improving that even further."* – OEM Cooperation Manager at MRO1
Customer partner sensing	Increasing sensing routines with customers to mitigate threats of monopolization of service market	*"I believe that it is the biggest risk for the MRO if everything runs via the airframer. Because monopolization increases even further and because of that less competition is taking place. And at the same time this is also the biggest risk for the airline. The awareness has already increased strongly due to [the development in the engine market]. Because everybody needed to sign with the OEM although they did not want to."* – CEO MRO1

Table 6.8: Service Firm-specific Dynamic Capability of Relational Sensing

OEM Competitor Sensing OEM Competitor sensing is a microfoundation at the very basis of sensing dynamic capabilities that is required for all types of alliances. It is performed on two levels: on the market level, it is geared at detecting the development of changes in the competitive landscape induced by the manufacturers' hybrid offerings, such as increased competition for tenders, manufacturers previously did not care about (Schneider et al., 2013). On the level of the individual manufacturer, it aims at identifying the OEMs' competitive moves and positioning, strengths and weaknesses, its service offers, and their commercial success. One aspect is the identification of new technologies used in the latest generations of equipment and the manufacturers' attempts to erect barriers to service provisioning through this technology.

As a competitor, OEMs differ from competing traditional service providers, as they possess unique resources and capabilities that can be used to gain a competitive advantage against conventional service firms (Ulaga & Reinartz, 2011). A related advantage of the manufacturer is its unique position as both a competitor and a supplier of material and intellectual property, which may be required to perform the service on the particular asset. Hence, OEM competitor sensing is a servitization-specific capability and differs from traditional competitor sensing on the same level of the supply chain.

Depending on the individual configuration, the competitor sensing capability becomes salient on different levels. Whereas for the workbench setup it can be interpreted as a prerequisite to enter the alliance, it is on top of that continuously required in a coopetitive alliance configuration to continually differentiate the own against the manufacturers' service offerings.

OEM Partner Sensing OEM partner sensing aims to establish a profound understanding of the OEM, its core logic and servitization strategy to develop opportunities for collaboration. As the OEM's core logic differs considerably from the familiar logic of pure service providers, OEM partner sensing can be a time-consuming and complicated task. Besides possible areas of collaboration, OEM partner sensing also encompasses potential negotiation levers that can be applied to improve the bargaining power in negotiations, such as usage of alternative materials, or the vendor selection in the course of the customer's aircraft purchasing campaigns. OEM partner sensing is a microfoundation that is required to establish all kind of alliances with the manufacturers. However, more advanced partner sensing capabilities allow service firms to understand the core logic of the manufacturer's business model, such as the importance of the spare parts business and the involved repair versus replace tradeoff. This, in turn, permits service firms to make more advanced Value Propositions to the manufacturer and thus enables configurations from coopetitive alliances up to providing a two-sided solution offer.

OEM Partner sensing is somewhat reciprocal to manufacturers' service system sensing capabilities as described by Kindström et al. (2013), as it represents the relational sensing capabilities from the service provider's side.

Customer Partner Sensing Customer partner sensing is a capability that aims to identify common grounds with the customers to jointly oppose the risk of monopolization of the service market caused by the OEMs servitization practices. Here, the service provider's and customer's interests are aligned, as both prefer alternatives to the OEM's offering. However, interviewees reported a limited willingness of airlines to oppose OEM monopolization of the service market (see Table 6.4). Financial sacrifices associated with establishing an independent service provider and attractive OEM pricing for large customers with the respective bargaining power were named as the main reasons, inhibiting this type of strategic market-shaping.

Apparently, many airlines lack the strategic insight, resources, or expertise to formulate a market-shaping strategic sourcing strategy, which is why the maintenance decision is often based on short-term standard criteria of price, quality, and turn-around-time, instead of long-term strategic market considerations. Customer partner sensing is a microfoundation of dynamic sensing capabilities that support the formation of coopetitive solution alliances, as it identifies the customer's needs of having a choice in their maintenance decision, which is to be considered an antecedent for this configuration.

Service Firm-specific Dynamic Capability of Relational Seizing

Microfoundations	Description	Proof Quotas
OEM tactics capability	Routines to develop strategies to react to OEM competition	*"We should be prepared to see where […] Boeing really has an advantage. And then we have to think: ‚where can we compete with our means? Do we believe that we can stand up to them or is it rather as with the engine manufacturers?' […] And then you have to simply say: ‚if you can't compete, you better cooperate' and then you have to look if there is a possibility to maybe cooperate with Boeing on certain fields." – Vice President Sales MRO 1*
Alliance capability	Routines to co-create joint business models with OEMs	*"We engaged with Boeing from the onset. They needed a network of partners on which they can rely on for the 787 airframe maintenance, where and when the need arises. [MRO 3] was one of the first seven selected – the only one in Asia. They effectively closed the market to anyone who is not in the network."* – Executive VP MRO 3
Cultural change capability	Capacity to overcome antiquated beliefs and embrace new business logics and value constellations	*„Clearly the MROs are being asked things that are out of their comfort zones. The OEMs are slowly moving in but the Airlines want speed and they want lower costs. So if they have to meet the Airline requirements, the MROs will need to partner with OEMs at both the airframe and systems level so they can cooperate and provide a service that is fast and nimble."* – VP and General Manager MRO 5 *"Every situation, the old as the new, is taken by itself not that difficult. […] The problem is the change management between. How do I get an organization to collaborate that has embraced a clear bogeyman for thirty years […]? And that's why almost all larger collaborations begin with the two bosses that say: 'let's do something together.' And then the whole organization comes and tells you why it's not possible and where the risks lie." – CEO MRO 1*

Table 6.9: Service Firm-specific Dynamic Capability of Relational Seizing

OEM Tactics Capability Traditional service providers such as MROs need to build the capability for formulating tactics of "how to deal with" each OEM that has entered or is about to enter the service market. This capability enables them to decide whether to compete or cooperate with manufacturers and to delineate a plan to pursue desirable cooperative or competitive aftermarket configurations. Although many points are to consider in this decision, the tactic development can be based on a simple rule: *"If you can't compete you better cooperate."* (Vice President Sales MRO 1). However, tactics development (i.e., identifying whether competing is a feasible option) takes time and is costly since decision protocols are not limited to this simple rule, as the interviewee points out: *"This is not a process that 'bam!' we look at once and [. . .] then we do it exactly like that. [. . .] It is rather something that develops depending on the signals we receive from the market."* Consequently, the MRO may define a strategic direction of increased cooperation with OEMs; however, each alliance is idiosyncratic, and decisions are made on a case-by-case basis.

The OEM tactics and the capability required for its formulation differ considerably from competitive tactics against the traditional competitors on the same level of the value chain. The two main reasons are that (a) manufacturers possess unique resources and capabilities that they can leverage to achieve a competitive advantage (Ulaga & Reinartz, 2011), and that (b) MROs generally experience a higher dependency on OEMs than on their competitors, as they are often the sole source of parts and repair manuals. The OEM tactics capability allows service firms to decide whether to compete or cooperate with the OEM and choose the configuration of the alliance. For example, this capability was extensively used in the Aircraft Case to determine the strategic positioning of the MRO as a competitor of the OEM and only pursue punctual collaborations on equal footing.

OEM Alliance Capability Once a cooperative OEM tactic has been set, MROs require a specific OEM alliance capability to form an OEM alliance of the desired configuration. The alliance capability builds on a profound understanding of the OEM's needs through OEM sensing activities.

Thriving OEM alliances are typically not built with an all-encompassing approach. Instead, it is crucial to identify single fields of cooperation in which to create a win-win situation. Routines include a phase of workshops in which the parties get to know each other, build trust, and start co-creating a joint business model: *"at the beginning it's like in a dark room, you are palpating each other, you don't know exactly, who it is, what he's doing, and how he's behaving."* (Director Finance and Product Sales MRO 2). Not surprisingly, more advanced alliance capabilities are required for more advanced configurations. One example is the two-sided solution in which a complex pain-gain-sharing model was established to overcome the repair versus replace tradeoff and align the interests of the OEM and the MRO.

Cultural Change Capability Strategic flexibility involves the firm's responsiveness to pressures (Young-Ybarra & Wiersema, 1999) and a proactive rather than reactive attitude to change (Bock et al., 2012). The corporate culture refers to the values and beliefs of employees, and it can work as a de facto governance system mediating the behavior of individuals and the firm (Teece et al., 1997). Hence, the corporate culture may foster or inhibit the firm's strategic flexibility to innovate its business model (Bock et al., 2012).

MRO providers require strategic flexibility to reconfigure their business model to develop solutions and proactively form alliances with OEMs. Interviewees perceive the cultural change needed to collaborate with OEMs as especially critical. The reason is that MROs have to discard the traditional beliefs held about the roles in the industry, a change in the company's mission, and adapting to new operating routines following different business logic. For example, production and engineering staff has traditionally developed alternative repair methods and parts to compete with expensive OEM spare parts and deliver value for airlines. In OEM alliances, these developments are increasingly restricted or follow a different business logic: in the new business model, cost savings benefit first and foremost the OEM (the old bogeyman in the beliefs of many employees) and only indirectly the airline (the valued customer).

Somewhat counter-intuitively *fewer* cultural change capabilities are required for more advanced configurations with the OEM. This becomes apparent in the workbench setup in which the MRO provides basic repair services to the OEM as the only customer and according to the OEM's engineering instructions. This posits a much stronger cultural change, then, for example, coopetitive solutions in which the MRO continues servicing airline customers, just as part of the manufacturer's network. However, even in this setup cultural change capabilities are required since the development of alternative repairs is performed under supervision and control of the manufacturer and does not aim to improve the competitive positioning against this player.

Service Firm-specific Dynamic Capability of Relational Reconfiguring

A key to successful and sustainable growth is the capability to reconfigure the resources of the firm, adapting them to external changes such as dynamic markets or technologies (Teece, 2007, 2012). In cases in which firms are confronted with significant levels of environmental dynamism, a mere fine-tuning of business models is not sufficient. Instead, firms will require more substantial reconfigurations to remain competitive (Helfat et al., 2007; Teece, 2007). In the aerospace industry, servitization represents such an increase of environmental dynamism for MRO service firms that need to form alliances with manufacturers to remain competitive in an increasingly OEM-dominated industry (Schneider et al., 2013).

Microfoundations	Description	Proof Quotas
OEM co-specialization	Idiosyncratic development of joint resources such as facilities and activities such as overhaul procedures between OEM and MRO	*„we have already formed some partnerships […], but what kind of change does that mean for us? […] When we say: 'we are doing the Joint Venture', then nothing stays as it was, but you have to change and adapt to the partner.“* – Manager Market Research and Competition MRO 1 *"So, it is in fact an entry ticket that we have purchased and now we have to shape this thing, don't we? So, keep on developing, always promise value and develop it over time"* – Head of Corporate Strategy MRO 1
OEM incentive alignment	Establishment of mechanisms such as outcome-based revenue models, equity-sharing and management meetings to ensure the alignment of interests between MRO and OEM	*"it's always the crux when you bring together an OEM and an MRO is the topic of replace versus repair. The OEM always wants to sell material and we always want to lower costs. And what we have achieved in this model is to make the OEM participate from our repair development, on all our cost-savings measures"* – Manager Alliance Function MRO 1
Value appropriation capability	Increasing transparency about costs and value of services, making them more tangible and marketable to manufacturers	*"We sell especially engineering as a mush of different services […], they are smeared via overhead, […] they are not transparent. For an airline this is OK, but for the OEM we need to develop and sell them. […] I think this is one of the capabilities that we have to gain as a company, it is something that we are not good at today."* – Senior Manager Alliance Function MRO 1
Coopetition management capability	Establishment of coopetitive function and (learning) routines that enable steering both competitive and cooperative facets of the OEM-MRO relationship	*This [multilateral relationship] is indeed a problem and one of the reasons why we have founded […] a small team, where this tension is concentrated in very few people. […] The cooperation management should be active for a very long timeframe and manage these very, very different streams of activity, we will continue purchasing a mad amount of material and repair services from them, […] but now we also have a multiplying sales stream, […] and the third stream is this field of technological cooperation. Long story short, this cooperation management has to somehow manage these very different streams of activities.* – Senior Manager Alliance Function MRO 1

Table 6.10: Service Firm-specific Dynamic Capability of Relational Reconfiguring

When a traditional service provider enters an alliance with a manufacturer, a multilateral relationship between the two actors evolves, in which the manufacturer can take multiple roles such as alliance partner, supplier, customer, and competitor. My research uncovers a specific set of microfoundations of dynamic capabilities that service providers require for creating for and appropriating value from these multilateral relationships.

OEM Co-specialization Co-specialization — the idiosyncratic development and usage of resources and activities such as assets, R&D activities, or human resources between firms — is a microfoundation of dynamic capabilities, providing opportunities for achieving a competitive advantage through both cost savings and unique offerings such as integrated solutions (Teece, 2007).

While the exchange of simple services requires less co-specialization, the level increases in cases in which joint resources or a joint venture are created. One example of a pronounced type of co-specialization is present in the engine case, where the focal company and the OEM jointly create an engine overhaul facility. While the OEM contributes with manufacturing-specific resources such as test-equipment, manuals required for the overhaul process, and material, the MRO provider contributes by providing its knowledge about efficient overhaul processes and the design requirements of the facilities. As both parties co-create by providing their unique resources and capabilities, this co-specialized asset may be difficult to imitate by single competitors alone.

However, co-specialization is not an easy task and requires effort and commitment to create joint processes, a common language and working culture as Senior Manager Alliance Function MRO 1: *"currently we are still in the phase in which we have a lot of friction and have to calibrate with one another. For now, we are nowhere near the phase in which we start to raise synergies, as to say one plus one is more than two. Just the opposite is true. Currently, it rather feels like one plus one is still less than two."*

OEM Incentive Alignment Incentive alignment in strategic alliances is a governance issue that has received broad academic attention (e.g., Gulati & Singh, 1998; Zollo et al., 2002). Alliance literature discusses an extensive set of methods to ensure incentive alignment, including hierarchical control, equity sharing (e.g., the foundation of a joint venture), incentive systems, standard operating procedures, dispute resolution procedures, and non-market pricing systems (e.g., cost-plus models) (Gulati & Singh, 1998). Establishing inter-organizational routines (stable patterns of two firms defined and repeated during recurrent collaborations, Zollo et al. (2002), p. 701) enable partnering firms to achieve their strategic objectives. Thus, it is likely to be critical to business performance, and a key microfoundation of dynamic capabilities (Teece, 2007).

In the context of coopetitive alliances and two-sided solutions between traditional service providers and manufacturers, the previously mentioned "repair versus replace tradeoff" becomes salient as a specific type of governance issue: balancing cost improvements through the reduction of material consumption versus the manufacturer's incentive to protect its spare part business. While the former is a primary way the MRO can contribute value to the OEM, the latter is a crucial Revenue Stream for the OEM and has even been associated with solution-specific dynamic capabilities of OEMs (Fischer et al., 2010). Aligning these contrary incentives becomes possible by defining an outcome-based pain-gain-sharing model between OEM and MRO provider. By establishing these profit-sharing routines, both parties are incentivized to minimize maintenance costs and material consumption. In the workbench setup, the microfoundations of incentive alignment are less relevant as here, the workscope is defined by the manufacturer, while the service firm is compensated on an input-based t&m logic.

Coopetition Management Capability It may be assumed that by establishing an alliance between an MRO and a manufacturer, a cooperative relationship across a broad set of equipment, topics and organizational functions evolves. However, this is not the case. Rather, the alliance is typically limited to one type of equipment, which results in the forming of a multifaceted relationship, in both parties take multiple roles such as alliance partners, suppliers, customers, and competitors. For this reason, interviewees highlighted the MRO's need to develop the dynamic capability to manage this type of multifaceted business relationships in all types OEM alliances, not only the coopetitive solution configuration. The identified microfoundations supporting this capability entail the establishment of learning and inter-organiza-tional routines that are bundled at a central coopetition function in the enterprise.

Institutionalizing alliance management routines into a dedicated alliance function is known to lead to a higher alliance success rate, greater abnormal stock-market gains, and an improved capability to form more alliances and attract better partners. This is achieved by different mechanisms such as knowledge management and learning, granting external visibility and support, internal coordination and problem-solving and interventions to fix problems (Dyer et al., 2001; Kale et al., 2002). In line with these previous findings, interviewees (1, 6, 8, 9, 15, 16, 19) perceived a central alliance function as a crucial element for successfully establishing and managing the OEM alliances.

In this context, the central coopetitive function is better able to form alliances than decentral managers for a variety of reasons: first, it can systematically and proactively perform sensing and seizing routines. Hence, opportunities are actively created, instead of only seized when they present themselves. Second, coopetition managers can integrate needs and OEM-related activities across different business units into one bundled negotiation. This profound understanding is a precondition for making valuable propositions to the manufacturer and increases the possibility of establishing a configuration which allows a relationship on equal footing. Hence, a more advanced coopetition capability will enable MROs to develop more advanced alliance configurations. Fourth, coopetition managers can establish relationships of mutual trust with OEM decision makers that increases with the duration of the relationship.

In conclusion, MROs as pure service firms require a distinct set of dynamic capabilities to successfully create solutions and ally with manufacturers. The differences compared to manufacturers' dynamic capabilities in this context stem on one hand from the service background. On the other hand, also the position in the supply chain, the high level of dependence, and changing roles in the industry shape these dynamic capabilities and their microfoundations.

7
Conclusions

Contents

7.1 Academic Contributions

By exploring strategic options for business model innovation of traditional maintenance, repair, and overhaul firms in the aerospace industry, this study aims to make three main contributions to servitization research and research on aerospace business models. The first and main contribution is clarifying the role of pure service firms in servitization research and the development of strategic options for MROs to cope with servitization practices of manufacturers through business model innovation. Second, this study takes a first step in unveiling the "dark side of servitization", uncovering the currently obscure less favorable aspects of this phenomenon. Third, I describe business models of MRO firms that have been overlooked in the efforts of describing changing airlines' and manufacturers' business models.

7.1.1 Strategic BMI Options for Pure Service Firms to Cope with Servitization

The main contribution of this study is the identification of viable strategic options for pure service firms to cope with servitization through business model innovation. In order to do so, I first conducted a systematic literature review to clarify the role of pure service firms in servitization research. Then, I developed a portfolio of strategic options (i.e., business model configurations) for MRO service firms including a contingency-based decision model that allows pure service firms to select the most appropriate type of their business model. This decision is undergirded by my examination of competitive advantage between pure service firms and manufacturers in hybrid offerings. To complete the examination of BMI, I explore the dynamic capabilities that are required by pure service firms to actually transform their traditional business model into the desired configuration. This represents a contribution to servitization literature that has mostly focused on manufacturers that wish to add services to their business model, competitive advantage (Lightfoot et al., 2013), and effects on firm performance (Kastalli et al., 2013; Parida et al., 2014a). In contrast, business model innovation of service firms and evolutions on an industry level in the context of servitization has received minimal attention (Raddats et al., 2019).

Systematic Literature Review In a first step, this study enhances our understanding of pure service firms in the context of servitization and the limitations of servitization research. By performing a systematic literature review, I have consolidated the dispersed knowledge stocks and anecdotal evidence towards a more systematic and granular understanding of traditional service firms in this context.

The results indicate that most servitization studies show a focus on manufacturers, while the role of service firms remains under-explored (Martín-Peña & Ziaee Bigdeli, 2016; Mountney et al., 2016). Studies that do take service firms into account do this mostly in the form of network partners (Paiola et al., 2013; Gebauer et al., 2013; Forkmann et al., 2017b), however neglecting the competitive aspects of these relationships. Besides, very few efforts have been made to understand the possibly disruptive changes caused by the entry of manufacturers onto pure service firms (Schneider et al., 2013) and onto the service market and its customers.

This study reveals disparities in the presentation of traditional service firms in literature: on one hand, service firms can compete in the field of solutions by integrating the equipment from various manufacturers and services into a seamless solution to fulfill increasing customer needs (Brady et al., 2005; Davies et al., 2007). In doing so, traditional service firms, however, need to compete with manufacturers that possess unique resources and capabilities that they can leverage into a cost and differentiation advantage (Ulaga & Reinartz, 2011).

On the other hand, traditional service firms have also been portrayed as network partners in manufacturers' solution networks (Paiola et al., 2013; Gebauer et al., 2013). However, academia has focused on the cooperative aspects of these relationships, failing to observe the inherent competitive characteristics. Only recently, network actors have received limited academic attention, e.g., Jaakkola & Hakanen (2013) identify benefits and sacrifices that network partners experience when joining manufacturer-led solution networks, and Story et al. (2017) investigate the capabilities that firms that aspire to become network partners need to develop.

The literature review generates a stronger platform to explain the phenomenon of traditional service firms offering solutions and becoming part of the manufacturers' networks. As a central element, Table 2.4 gathers empirical evidence of companies that venture into solution provisioning from a base in services. These findings demonstrate the disparity in high relevance of traditional service firms offering solutions and the sporadic nature with which this phenomenon has been studied. In conclusion, the academic contribution provided by the literature review is providing a systematic and granular understanding of this phenomenon, the description of research gaps, and the identification of future research directions.

The MRO Business Model Portfolio Second, by creating the MRO Business Model Portfolio (Figure 6.3) — a two-dimensional framework containing five different configurations of MRO business models — I outline the strategic options that these firms can employ to cope with servitization. The portfolio represents an extension of current literature from two anecdotally reported generic BMI paths towards strategic options that that pure service firms can employ to cope with servitization. This represents a contribution to servitization literature that has remained anecdotal in regards to how traditional service firms need to transform their business model to become part of these networks.

The MRO Business Model Portfolio outlines the opportunities for developing stand-alone solutions and different configurations of alliances between pure service firms and manufacturers. These findings considerably expand our knowledge regarding the types of different business models employed by pure service firms when faced with servitization: First, service firms can develop stand-alone solutions without forming alliances with manufacturers given the necessary access to manufacturing-specific resources such as intellectual property rights. Second, alliancing with manufacturers is not necessarily a time-limited approach with lacking added customer value (Schneider et al., 2013); instead the different configurations of partnerships differ considerably in their setup and effects for both MRO and the final customer.

Stand-alone Solutions of Traditional Service Firms The study finds that solution business model employed by pure service firms differ from the common perception of manufacturers' solution business models in various aspects. To design effective solutions, companies require a comprehensive understanding of the aspired underlying business model to resolve alignment issues between product, marketing, sales, and operations management (Storbacka, 2011). Established servitization literature hence is of only limited help to pure service firms in developing effective solution business models.

Here, this study contributes by gathering and synthesizing existing empirical evidence of pure service firms that offer solutions (see Table 2.4), and strengthening the current anecdotal empirical base with three service firm solution cases. The systematic visualization in the Business Model Canvas highlights differences between solution business models employed by manufacturers and pure service firms and guides service firms in their transformation path towards solutions (Adrodegari et al., 2016).

First, the common perception of established servitization literature should be adapted from a notion that solutions are a type of "integrated product and service offering that delivers value in use" (Baines et al., 2007, p. 3). Instead, traditional service firms provide pure service solutions, in which the underlying product does not always form part of the bundle. For example, in Aircraft and Engine Solutions, ownership is transferred to the airline or a lessor, whereas the solution consists in providing engineering, planning, and repair services for the airline for a fixed fee per flight hour, however not the operation of the asset itself. This arrangement departs from much of the established servitization literature, in which the common perception remains that asset ownership remains with the supplier who often operates the asset (Baines & Lightfoot, 2014).

Second, traditional service firms can base their solution offers partly on different Value Propositions that are difficult for manufacturers to imitate, namely (a) a unique customer perspective based on their operator experience and neutral position between manufacturer and customer, and (b) providing services or solutions across different types of manufacturer's equipment, which is highly challenging for manufacturers. This unique differentiation advantage is especially valuable, as solutions are typically used to achieve competitive differentiation in commoditized markets (Matthyssens et al., 2009).

Another aspect uncovered by this study is the duality of roles of the final customer. For pure service firms, the customer does not only play the role as co-creator of the joint solution (Storbacka, 2011); instead, he is also Key Partner that ensures access to the manufacturer's materials, test equipment, and intellectual property such as repair manuals. Hence, the customer's role differs from manufacturers, where customers do not play this Key Partner role. This is because manufacturers typically do not require the end customer as a partner to manage dependencies across different levels of the supply chain. This finding complements servitization literature on buyer-supplier relationships and linkages that has overlooked this service-firm specific aspect so far (Bastl et al., 2012).

Third, traditional service firms need to employ the elements of their business model in different ways to successfully deliver solutions and sustain competition. One example is the positional advantage that manufacturers can gain by using their preferred channel access to the final customer and pre-empt competition. In this context, traditional service firms need to rely on their long-term trustful customer relationships with service content to offset this supposed advantage of the manufacturer.

MRO-OEM alliance configurations The identified alliance configurations range from setups with high manufacturing dependence, low added customer value, and little competition in the aftermarket (the OEM Workbench setup), via coopetitive solution networks that provide space for rivalry and providing value-added services, up to two-sided solutions that place pure service firms in a favorable competitive position vis-à-vis their peers. The two-sided solution underpins the recent interest in the phenomenon of de-servitization (Valtakoski, 2017; Kowalkowski et al., 2017) that is likely to be of rising importance in the future due to the increasing occurrence of servitization and thus cases of servitization failure. Hence, alliancing with manufacturers is not necessarily a time-limited approach with little customer value added, as previously assumed. Instead, service networks are very likely to be of high importance in the future, as manufacturers and OEMs can combine their resources and capabilities to create superior offerings to their customers. The value added to the customer depends on the configuration employed. However, all arrangements except the workbench setup retain at least some, albeit a lower level of competition in the service markets. Overall, however, the level of competition depends on the arrangements within the networks and airlines' efforts to restrain OEM hegemony.

This work contributes to this strand of literature by clarifying that not one but multiple types of network partner business models exist that differ considerably in the perceived benefits and sacrifices for pure service firms (see Table 7.1). Also, this work identifies previously unknown sacrifices of service firms that are rooted in the coopetitive aspects of those networks.

Benefits	OEM Workbench	Coopetitive Solution	Two-sided Solution
Growth			
• Increase in revenue	Y/N	Y	Y
• Access to new customer segments	N	Y	Y
• Access to most profitable customer segments	N	N	Y
• Extension of the service offering	N	Y	Y
Cost/Effort Reduction			
• Increased learning and economies of scale	Y/N	Y/N	Y
• Reduced effort for sales activities	Y	N	Y
Access to Knowledge Resources			
• Input in R&D from other customer segments	N	Y	Y
• Increased product-knowledge	Y	Y	Y
Improvement of Company Image			
• Credibility for being partner of a known OEM network	Y/N	Y	Y
• Access to bigger customers that can be used as reference	Y/N	Y/N	Y
Sacrifices	**OEM Workbench**	**Coopetitive Solution**	**Two-sided Solution**
Investment and Sales			
• High upfront investments	Y	Y	Y
• Delay of profits	Y	Y	Y
• Limited potential to affect solution contents, sales targets and -efforts	Y	N	N
• Decrease of revenues	Y/N	N	N
Access to Knowledge Resources			
• Lack of information sharing by solution provider	Y	N	N
• Lack of access to intellectual property	N	N	N
Culture and Governance			
• Professional's reluctance to act as mere resource providers	Y	N	N
• Lack of trust in each other's competences	Y/N	Y/N	N
• Lack of incentive alignment between partners	Y	Y/N	N
Coopetition			
• Strengthening a competitor's service offering	N	Y	N

Table 7.1: Proposed Benefits and Sacrifices of OEM Network Partners per Configuration

In the OEM workbench setup, the MRO provider becomes a subcontractor of the OEM for MRO services, which does not allow it to reap most of the associated benefits, while it still has to bear most of the sacrifices that are potentially associated with an alliance. The most prominent examples are the benefit of continuing to be able to provide services on new technology and improved product knowledge, which comes however at the sacrifice of increased dependency and loss of channel access to the end customer.

Coopetitive solutions allow pure service firms to experience more benefits such as the opportunity of providing traditional, value-added and solution offers to both end customers and the manufacturer. This configuration places traditional service firms in a better long-term competitive position since they can retain market access which results in a somewhat lower dependency on the manufacturer, given satisfactory license conditions. One major drawback in common with the workbench setup is that pure service firms are unlikely to capture value from the most profitable customers since these are typically contracted by the manufacturer. However, coopetitive solutions entail fewer sacrifices compared to the workbench setup, as the provider can determine solution contents to a greater extent and does not suffer from the staff's reluctance to act as a mere subcontractor to the OEM.

The two-sided solution configuration provides the most benefits and requires the fewest sacrifices compared to the other two alliance configurations. In this setup, pure service firms take over the service business of the manufacturer, hence providing simultaneously a solution to the manufacturer and the end customer alike. This arrangement offers the most benefits for the service firm, as it enjoys preferential access to manufacturing-specific resources that may create a competitive advantage against other firms that have more limited access to these resources. The preferential access and the lack of competition with the manufacturer provide a solid basis for capturing the most profitable customers, robust opportunities for growth, and tapping into economies of scale. Yet, one drawback of this configuration is that the MRO loses the capability to perform a credible OEM-independent consulting approach that is in the best interest of the airline. Instead, OEM and MRO interests become completely aligned through risk-and-revenue-sharing-mechanisms. For customers, a drawback of this configuration is the limited competition that results from such a setup. A common denominator of all OEM alliances is that they require a substantial upfront investment for licenses and possibly facilities and hence delay the earning of profits.

In conclusion, the benefits and sacrifices that pure service firms experience depend on how they innovate their business model and the associated configuration of alliance business models that they achieve. Some of the sacrifices that have previously been associated with becoming a network partner such as the lack of information sharing by the manufacturer or the professional's reluctance to act as a pure resource provider (Jaakkola & Hakanen, 2013) can be mitigated by developing more advanced configurations of network partner business models.

By employing the holistic business model lens to explore the different configurations of the network partner business model of traditional service firms, a basis is created on which future research can base its efforts. The findings indicate that developing a network partner business model is less straight forward than might be assumed. The reason is that service firms need to cope with both competitive and cooperative aspects of the relationships and take a strategic decision of whether to ally with manufacturers that enter the "own" service market. Besides, service firms need to develop specific Value Propositions for servitizing manufacturers that deviate from those formerly provided to end customers.

Competitive Advantage between Pure Service Firms and Manufacturers Extending the knowledge-base regarding competitive advantage between firms with a manufacturing and service background in hybrid offerings is the third backbone of my first contribution, aiming to answer the call for research by the in this regard seminal paper by Ulaga & Reinartz (2011). Currently, research on competitive advantage between both players has so far only taken the manufacturer's perspective, is mostly based on resources and capabilities, lacks empirical underpinnings on the service firm side, and does not take the buyer-supplier relationships and positions in the supply chain into account. Hence, current servitization literature has limited explanatory power regarding the competitive advantage between manufacturers and pure service firms.

Consequently, the proposed contribution is threefold. The first aspect is synthesizing the academic and strengthening the empirical underpinnings of manufacturers' unique sources of competitive advantage against service firms that have received only little and dispersed academic attention (e.g., Ulaga & Reinartz, 2011; Schneider et al., 2013). The second aspect is exploring the service-provider side of competitive advantage and comparing the results with manufacturers, hence improving our understanding of the phenomenon from both sides. The final third aspect is extending the employed theoretical lenses from the RBV towards the holistic business model perspective that can explain competitive advantage through the combination of business model elements, not only resources and capabilities (Morris et al., 2005).

This study is the first one to identify sources of competitive advantage of pure service firms and taking a first step in explaining competitive advantage from both sides (see Table 6.1). By focusing on service firms in my sample, I was able to overcome the limitation of Ulaga & Reinartz (2011) that have used a sample comprised of manufacturers.

The results have four essential implications regarding the competitive advantage between both parties. First, the service-based empirical evidence strengthened some of the assumptions regarding the competitive advantage of the manufacturer's business model elements. However, some items that previously were assumed to be unique to manufacturers are also present in the business model of pure service firms. Third, additional mechanisms, by which manufacturers can leverage their business model into a competitive advantage, were identified. However, also traditional service firms possess unique business model elements that they can employ to reach cost leadership or differentiation advantage against manufacturers.

One example of manufacturers' unique business model elements and their effect on competitive advantage that were replicated is the manufacturers' risk management capability. This capability allows manufacturers to assess, manage, and mitigate risks inherent in the maintenance of the equipment better than their pure service counterparts (Ulaga & Reinartz, 2011). Interviewees perceived this capability as especially relevant on products with new technology in COPS industries, where risks are difficult to assess and may result in significant financial losses due to the high value and technical complexity of the assets. These findings shed light on the under-researched risk aspect of solution offerings, where the scope and magnitude of these risks still have to be determined from a supplier and customer perspective (Raddats et al., 2019).

The results also indicate that some resources and capabilities are — unlike previously assumed — unique to manufacturer business models. Instead, these elements also form part of the business model of pure service firms. One example is the manufacturers' product sales force that requires additional knowledge and capabilities to successfully market services (Gebauer et al., 2005), whereas a pure service firms' sales force was found to have more experience with the sales of services and hence better meet customer needs. This finding is however limited by the fact that it is based on the perception of managers of a service organization and may thus underlie a certain bias.

Third, the results extend our current understanding by indicating additional mechanisms by which manufacturers leverage their unique resources and capabilities: for example, product development and manufacturing assets such as tools, patents, and licenses are used primarily to construct entry barriers for service firms that wish to service the manufacturers' installed base. This practice hints at additional, previously unknown isolation mechanisms (e.g., intellectual property rights cause certain causal ambiguity of resource-based sustainable competitive advantage of manufacturers, Dierickx & Cool, 1989) that may depend on the perception of the party employing or being hindered by these isolating mechanisms.

Fourth, the study identified business model elements that service firms can leverage to gain a competitive advantage against manufacturers in service and solution offerings. One example is the multi-vendor capability that allows traditional service firms to provide solutions across different types or the specific scope of the equipment of one manufacturer. This capability facilitates the reduction of costs and complexity at customers that operate various types of equipment and is required for a credible manufacturer-independent consultancy approach (Schneider et al., 2013; Raddats & Easingwood, 2010). In contrast, for manufacturers, developing this capability has been labeled the acid-test (Foote et al., 2001; Davies et al., 2006) and is particularly challenging to create, as the Aircraft and Components Cases demonstrate. These findings complement established literature, challenging the general assumption that manufacturers can gain a competitive advantage by venturing into the service space. This result constitutes an impactful contribution, as I have refined our current understanding to discern between inter-manufacturer and manufacturer-service provider competition and a have taken a first stride to understand the latter.

In conclusion, an empirically founded two-sided approach to understanding competition between servitizing manufacturers and pure service firms was created that, by taking the business model lens, generates a systematic and granular understanding of the phenomenon (Amit & Zott, 2001; Zott et al., 2011). This approach departs from the primary focus on resources, capabilities, and networks for creating competitive advantage in solution provisioning towards the more holistic business model perspective. While some studies in hybrid value provisioning have taken a more rigorous view on the business model (e.g., Forkmann et al., 2017b), these studies mostly focus on the business model reconfiguration process and not competitive advantage. Findings of this thesis provide empirical evidence on the innovation of incumbent firms' traditional business models blurring or converging industry boundaries (Zott & Amit, 2010; Foss & Saebi, 2017), with particular regards to service and manufacturing domains.

A Contingency Approach to Becoming a Network Partner While for manufacturers a plethora of strategic approaches regarding the alliance decision has been developed (Salonen & Jaakkola, 2015), this work is the first attempt to develop a contingency approach for traditional service firms alliance options. For traditional service firms, competing or collaborating with manufacturers is a critical decision, since on one hand manufacturers can severely limit the service firm's critical operational capabilities, e.g., by withholding mandatory repair manuals (Schneider et al., 2013) while on the other hand, pure service firms may lose their privileged established market position when forming an alliance (Turunen & Finne, 2014).

The contingency approach contributes to our understanding of antecedents of alliances between OEMs and service firms from the currently under-developed service firm side. This study sheds light on dependence-based mechanisms that lie behind the formation of these networks that have formerly received little or no attention. The common perception has been that service firms perceive a set of specific benefits and sacrifices when joining manufacturer-led networks (Jaakkola & Hakanen, 2013), do however not base their collaboration decision on dependence considerations. In contrast, I find that the collaborative decision is not a question of weighing benefits and sacrifices but rather a question of power, i.e., whether manufacturers can protect their equipment from third-party services. This power perspective has received only little academic attention so far in research on solution networks and has focused on tier one manufacturers, not service firms (Finne et al., 2015).

Besides, my findings complement earlier studies that find that partners in solution networks strive for powerful positions. On one hand, network partners from a base in manufacturing mainly aim to improve their power position through the development of proprietary technology that forms part of the overall solution (Finne et al., 2015). On the other hand, pure service firms that, unlike the capital goods sector, rely to a low extent on proprietary R&D but instead use the technologies transmitted from manufacturers for service innovation (Barras, 1986). Hence, the identified approaches by service firms to secure the power required for participating in and benefiting from solution networks differs considerably from the procedures developed by manufacturers. Instead of relying on proprietary technology, pure service firms aim to establish a relationship *"on equal footing"* by developing Value Propositions to the manufacturer building on their service-based business model that are difficult for the manufacturer to develop internally. Another identified approach is reaching a critical size in the service network that increases the service firm's bargaining power and hence ensures a beneficial rent distribution. Finally, relying on the bargaining power of the end customer of the solution has repeatedly been labeled the *"entry ticket"* to join a manufacturer's solution network and enable sustainable commercial conditions to do so.

Dynamic Capabilities of Traditional Service Firms To successfully perform the transformation of the business model as a reaction to the environmental change that servitization poses, traditional service firms need two specific, complementary sets of sensing, seizing, and reconfiguring capabilities, i.e., solution-specific and relational dynamic capabilities. Here, I aim to contribute by shedding the first light on how traditional service firms can adapt to a changing environment induced by servitization to ensure long-term competitive survival or even advantage by means of dynamic capabilities.

First, I demonstrate that the microfoundations of *dynamic solution capabilities* required by traditional service firms differ considerably from manufacturers. As illustrated in Table 7.2, only three similar microfoundations were identified in both types of firms, while the remaining 15 where either different from manufacturers (six), only available at manufacturers (four), or only available at pure service firms (five). This finding supports the initial claim that the sensing, seizing, and reconfiguring capabilities required for delivering solutions depend on whether a firm comes from a base in products or services.

Microfoundations of Traditional Service Firms …	No.	Example
… similar to manufacturers	3	**Orchestrating the solution network:** both types of firms reconfigure the solution network to adapt it to changing customer needs and operational requirements.
… different from manufacturers	6	**Adapting a service-oriented versus outcome-oriented mental model:** pure service firms do not have to develop a service-oriented model, as they already possess this as part of their traditional business model. Instead, changing their mental model is rather focused on providing output-based service offers, which entails assuming risks from other business units or even across firm boundaries.
… only available at manufacturers	4	**Protection of spare parts business:** not required for pure service firms that do possess a manufacturing business. This differentiates pure service firms from manufacturers, as the latter are not incentivized to reduce their spare parts business, except in pure outcome-based offers. Also, pure service firms can make use of alternative, more cost-efficient parts which manufacturers are unlikely to do to not endanger their spare parts business.
… only available at pure service firms	5	**Installed base learning routines:** unique dynamic capability of pure service firm that allows it to employ learning routines across the equipment of various manufacturers (e.g., different types of engines), in service. However, pure service firms also require more learning routines as they possess less design knowledge compared to manufacturers.
Total	**18**	

Table 7.2: Comparison of Dynamic Solution Capabilities of Traditional Service Firms and Manufacturers

Even though solution business models of manufacturers and pure service firms are similar, the dynamic capabilities that are required to transform traditional business models from either a base in services or manufacturing differ considerably. First, unlike manufacturers, pure service providers do not need to adopt a service-oriented mental model (den Hertog et al., 2010; Kindström et al., 2013), as they come from a base in services.

However, they need to shift their mindset from performing a deed towards achieving an outcome, which constitutes one of their main barriers for solution provisioning.

Second, manufacturers require more dynamic capabilities to change the product-part of the solution, e.g., technology sensing routines (Kindström et al., 2013) or the adaption of the product to facilitate unique service offers (Fischer et al., 2010). In contrast, pure service firms can rely on the equipment of multiple manufacturers or alternative vendors (Hobday et al., 2005) to differentiate their solution offer.

Third, integrating competitors' services, not products, into the solution offering constitutes the acid test (Foote et al., 2001; Davies et al., 2006) for pure service providers. Pure service providers should consider doing so, as it (a) shows their commitment to act in the customers' interest, (b) firmly establishes them as the customer's solution integrator, (c) allows them to provide a superior offering by balancing strengths and weaknesses of their internal service functions (Kowalkowski et al., 2011b; Kindström et al., 2013), and (d) provides them with the opportunity to improve the own operations by learning from the competitor.

The findings also indicate that traditional service firms that wish to transform the business model to become a *network partner* in the manufacturer's solution network require relational sensing, seizing, and reconfiguring capabilities that are undergirded by specific microfoundations. While for manufacturers, the dynamic capabilities to form and orchestrate solution networks have been studied relatively well (Fischer et al., 2010; den Hertog et al., 2010; Kindström et al., 2013; Gebauer et al., 2012), I have taken the first step to identify the dynamic capabilities needed for joining these networks.

My findings suggest that network partners require specific relational dynamic capabilities that allow them to form part of a solution integrator's network. For example, the relational dynamic capability is undergirded by microfoundations that enable the service firm to understand the solution integrator's business model and seize opportunities to either compete with or complement the solution network. Besides, service firms with sufficient dynamic capabilities can form alliances in a way that appropriates some of the created value and change its culture and beliefs about roles in the industry along the way. Here, I contribute by identifying the required dynamic capabilities and their microfoundations of network partners to survive and thrive in manufacturer-led solution networks and thus contribute to successful solution provisioning. Developing coopetitive solutions and two-sided solutions are particularly demanding ways of innovating the MRO business model, as this requires simultaneously building solution-specific and relational dynamic capabilities.

In conclusion, this study explains BMI of service firms in the context of servitization in the following dimensions: *what* needs to be transformed (i.e., the content of the business model), *how* the business model can be reconfigured (i.e., by the means of which dynamic capabilities), and *when* (i.e., in which case) which configuration of business model is the most appropriate.

7.1.2 Unveiling the “Dark Side” of Servitization

My second contribution is to increase the understanding of the effects of servitization on pure service firms and service markets, which is an area where close to no research has taken place. Instead, the few studies that research servitization on a market level, examine the contingency factors on market level and their influence on manufacturers and their servitization efforts (Turunen & Finne, 2014).

My approach is inverse to these studies, as it takes a first step in exploring the effects of servitization on incumbent service firms and customers on an industry level. Here, I contribute to the servitization literature by employing a process perspective (in line with Kowalkowski et al., 2015; Forkmann et al., 2017b), which complements the dominant outcome perspective in current research (Baines et al., 2009; Eggert et al., 2014). The phase model of servitization (see Figure 2.12) allows gaining further insights into the dynamics of competition between manufacturers and pure service firms over time.

In the pre-servitization phase, manufacturers often perceive services as a necessary evil, which results in customers providing maintenance services themselves and the growth of professional service organizations for maintenance, repair, and overhaul. In the servitization phase, customers profit from increased high-value solution offers and possibly price-based competition with traditional service firms. Simultaneously, service firms need to innovate their business model due to (a) increasing competitive pressure by manufacturers, (b) the emergence of high-value solution offerings, and (c) the manufacturers’ needs of partners to provide solutions in service networks.

The competitive survival of pure service firms is not only an end in itself but has important implications for functioning service markets, as well. Current research portrays servitization to be associated with positive effects, such as competitive differentiation, reduced risk, increased customer value, and the customer being locked-on, not locked-in (Wise & Baumgartner, 1999; Vandermerwe, 2000; Shankar et al., 2007; Ng et al., 2009). However, the manufacturers’ downstream movement can have severe effects on customers that are left with few or no service choices for the lifecycle of their equipment. The resulting dependency is especially severe in industries such as aerospace that operate complex product systems. These industries are characterized by long product lifecycles, where services such as maintenance constitute a significant proportion of the total cost of ownership for the customer (Davies & Hobday, 2005). For commercial aircraft, MRO costs accrue to 1.5 to 2 times the costs for purchasing and financing; for engines, even 70% of the lifecycle costs emerge from maintenance, not the initial purchase (Berger, 2014). Besides, competitive MRO services play a crucial role for airlines in ensuring aircraft reliability and punctuality (Niehues et al., 2001).

By identifying the manufacturer's tactics to erect insurmountable barriers for service firms or bind them into their service networks, I shed light on the "dark side" of servitization. Explicitly, I identify the specific mechanisms that manufacturers employ to erect barriers to hinder pure service firms in providing services for their equipment. These barriers differ considerably from the previously assumed mechanisms of how manufacturers can gain a positional advantage versus service firms (i.e., by leveraging distinctive capabilities based on their unique resources from their manufacturing background).

Alas, all critics of the dark side of servitization must not forget that these practices have evolved due to the enormous discounts that manufacturers grant airlines at the point of sales of the aircraft. The initially low prices realized for the equipment create the need to shift the profitability into the aftermarket. Hence, servitization is a two-sided medal that involves lower prices on equipment and more encompassing service offers. However, these gains are more likely than not offset by the resulting long-term dependency.

Nevertheless, a rising resilience of customers towards accepting solution offers was uncovered. This resilience is mostly caused by increased customer dependency, which results in aftermarket monopolies, increased risks, and higher prices for end customers. This dark side of servitization is a relatively new topic, as most literature has analyzed benefits, challenges, and risks of servitization through the manufacturer's perspective (Turunen & Finne, 2014), while only little is known about the sacrifices and adverse effects of solution provisioning (Gesing et al., 2014). The general assumption seems to be that "customers are more likely to receive increased performance at decreased costs" (Hypko et al., 2010, p. 460), and that suppliers benefit from solutions by concentrating on the core competence (Gesing et al., 2014). Here, industry practice seems to proceed before academia, as the European Commission has performed various example of legal intervention to ensure fair competition between manufacturers and repair shops in the automotive industry, limiting anti-competitive behavior that manufacturers exhibit in their servitization strategies (European Commission, 2003, 2007). The ability of manufacturers to lock-in customers through solutions has, in contrast, only been mentioned sporadically, not systematically in academia (e.g., Rabetino et al., 2015). By providing empirical evidence regarding the tactics that manufacturers employ to increase customer dependence and erect competitive barriers for pure service firms, I contribute to this barely researched topic, adding a first understanding of this phenomenon.

7.1.3 MRO Business Model Innovation

A third contribution is made to business model literature in the commercial aviation industry. So far, research in this area has been limited to explaining innovative approaches to compete based on business model innovation of aerospace manufacturers (e.g., Ng et al., 2013; Batista et al., 2015; Ferreira et al., 2016) and airlines (e.g., Bieger & Agosti, 2005; Doganis, 2010; Daft & Albers, 2013).

To my knowledge, the present work is the first attempt to capture the core logic of aerospace MRO service firms in a comprehensive business model framework. In general, maintenance, repair, and overhaul is commonly not understood as a viable business model but rather as an internal function that is part of operations management. However, this is an insufficient understanding given the development of large, independent aircraft maintenance firms and the increasing outsourcing practices of airlines. Literature remains very limited on the topic and focuses mostly on the optimization of this internal function through effectiveness and efficiency gains, which can be achieved by employing maintenance information systems, optimization models, and performance management (Garg & Deshmukh, 2006). Most available MRO literature has so far only focused on specific aspects of the MRO business, such as maintenance management (Tsang, 1998, 2002). Aircraft MRO is analyzed mostly as a function that airlines need to perform or outsource to external parties (Potter et al., 2015), and hence has focused on outsourcing decision, its impact on performance (Al-kaabi et al., 2007b), and the resulting configurations of airlines (Al-kaabi et al., 2007a).

In contrast, knowledge regarding the performance of (aircraft) maintenance, repair, and overhaul as a business model, not an internal cost center remains very limited. This study builds on earlier work such as Hinsch (2012) who details the organization and operational requirements that aerospace MRO firms need to fulfill to comply with legislation, or (Schneider et al., 2013) who introduce innovation and marketing aspects of MRO business models, remain however superficial in the description of the core logic of MROs. Here, this work contributes by carving out the properties of the business model that occupies the central position in the supply chain with OEMs as suppliers and airlines as customers. One critical aspect of the MRO business model is the tacit knowledge in the form of operator experience that manufacturers do not possess. This knowledge allows these specialized service firms to maintain and optimize the operation of the complex equipment present in this industry better than their manufacturing counterparts. Operator experience is complemented by service-specific engineering and repair capabilities and underlying service-specific resources such as maintenance facilities that enable MROs to offer a portfolio of diversified maintenance services across the equipment of different manufacturers.

The current lack of MRO business model literature is especially critical as simultaneously much academic work has advanced our understanding of business models and their innovation of other firms operating in the aerospace industry such as airlines (e.g., Albers et al., 2005; Daft & Albers, 2015; Daft, 2015) and manufacturers (Esposito, 2004; Baines et al., 2007, 2013; Ferreira et al., 2016). Here, I aim to contribute by taking the first steps in filling the blind spot between airlines and manufacturers by defining an empirically grounded business model of this highly intertwined $75.6bn industry (Cooper, 2017). The findings presented in this study complement earlier attempts by Scott et al. (2005) to describe business models at each tier of the aerospace value chain and the links that exist between the different levels. One example of links and interdependencies are buyers, suppliers, and partners on different tiers of the industry that simultaneously innovate their business model, which creates the need for MROs to do so as well. Then, the resulting MRO-OEM partnerships reciprocally affect business models of manufacturers that choose to de-servitize, leaving the service arena to their traditional service partners. These developments are empirical evidence of the earlier notion that solution-focused business model innovation practices can shape markets and dramatically alter the competitive arena (Ferreira et al., 2016).

MROs need to understand and adapt the core logic of how they conduct business, as business models of both their suppliers and customers change dramatically. When doing so, they can leverage unique elements of their business model to create a positional advantage by achieving strategic fit in times of increased environmental dynamism. One example is using the well-developed service-related engineering capabilities to develop new digitally-enhanced service offers, which will be decisive for gaining a competitive edge in the commercial aerospace industry within the next years.

7.2 Managerial Implications

This study claims to make a threefold of managerial contributions: First, *managers of maintenance, repair, and overhaul firms* can make use of the findings to drive the innovation of their business model and ensure long-term competitiveness when faced with servitization. Second, the findings inform *airline managers* who are responsible for the development of the technical operations function, the MRO make-or-buy decision, and procurement of MRO services. Third, *managers at aerospace manufacturers* can benefit from the insights developed in this thesis to either differentiate their service offers by relying on MRO service partners or even relying on these firms to deservitize and focus on their core manufacturing business.

Managers at MRO Firms Managers of aerospace Maintenance, Repair, and Overhaul firms need to understand that servitization has become an imperative for manufacturers. Servitization is a strategy for these players to cope with the increasing financial burden for commercial aircraft, with simultaneously decreasing yields on the initial sale of the product. In effect, aerospace manufacturers rely on the large and lucrative service market to bridge the decade that lies between initial development costs and product revenues. For MROs, servitization is both a threat as well as an opportunity.

To cope with manufacturer's servitization strategies, MROs cannot use a one-size-fits-all approach. Instead, they need to decide case-by-case based on the contingency factors identified in this study, whether it makes more sense to compete, cooperate or coopete. I hope that the provided *MRO Business Model Portfolio* (Figure 6.3) can act as a guidance for these managers in choosing the appropriate configuration based on the identified *contingency factors* (Figure 6.5). Also, the proposed *benefits and sacrifices* that are inherent in the different alliance configurations (Table 7.1) allow managers to predict the results of the alliance decision better. These three contributions can facilitate the decision of MRO managers of whether or not to ally with manufacturers and for which alliance type to aim. This decision is deemed as especially critical, as on the one hand, it may enable but on the other hand compromise sources of competitive advantage (e.g., the ability to provide a credible OEM-independent consulting approach representing the airline's best interest against manufacturers).

In this context, the research uncovered that the MRO's *alliance decision* shows a bias towards contingencies resulting from dependence on the manufacturer. This again hints at the necessity to unlearn antiquated beliefs about the roles of the different actors in the industry and develop a more proactive approach that takes sensing and seizing opportunities from these new exciting value constellations into account (e.g., based on the identified benefits and sacrifices). Managers will have to find answers to the question of how the business model can be transformed to leverage its inherent strengths into new Value Proposition that simultaneously solve the manufacturers' and airlines' challenges using the MRO business model and its BMI paths.

To compete with manufacturers that enter the aftermarket, MROs should formulate attractive Value Propositions based on their unique resources and capabilities grounded in their core business that differentiate themselves clearly from the OEMs. When doing so, MRO marketing managers can rely on the *competitive advantage framework* (Table 6.1) that contains sources of competitive advantage of both manufacturers and MRO service firms. The findings show that MROs can set a focus on their differentiation strategies on customer-centricity, which makes life easier for the customer. Shorter, easier to understand service contracts, rapid troubleshooting, high service quality, and a service mindset that centers around the customer, are properties of this differentiation opportunity against manufacturers that typically receive only mediocre scores in customer satisfaction surveys regarding service quality (AeroDynamic Advisory, 2018).

For MROs, one attractive option is to *develop more stand-alone solutions* to cater to airlines that increasingly demand service bundles that solve their technical operation's problems. In this regard, many options exist to increase their responsibilities along the value chain by making use- and value-based offers. One example would be to provide integrated Cabin Solutions. In such an offer, the MRO could take responsibility for financing, procurement, integration, installation, and modifications of an aircraft cabin, for which airlines would pay a flight hour-based fee. This offer would allow airlines to fly attractive cabin interiors while smoothing the financial burden that is typically associated with cabin refurbishment. Besides, airlines could mitigate the workload peak for their engineering team, while simultaneously relying on one responsible provider for the entire campaign. Overall, Cabin Solutions may be an attractive offer especially for smaller carriers that are reluctant to stem the one-time invest and engineering effort and prefer a risk- and hassle-free solution. In Cabin Solutions, MROs can differentiate themselves from airframer competition, since MROs can rely on internal base maintenance facilities to perform cabin installation and thus assume true end-to-end responsibility.

Another option for stand-alone solutions would be the development of a Consumable & Expandable solution offer. For all but the largest carriers, optimizing the supply chain for the large quantity of these low-value commodities is undoubtedly not core to their business. MROs can provide value to airlines by assuming responsibility for the supply and optimization of C&E stock in hubs and outstations. By establishing favorable purchasing contracts with a multitude of vendors and distributors as well as organizing an efficient logistics supply system, MROs can optimize airlines' costs while simultaneously reducing the complexity of their operations.

MROs that choose to ally with manufacturers should *avoid the Workbench setup*, as it leaves them in a confined, dependent position as a sub-tier supplier of the manufacturer. Hence, the workbench setup is indeed a short-term, time-limited approach that may ensure competitive survival, however at the expense of sustainable profitability and growth. Instead, MROs should aim to *establish coopetitive solution networks* with manufacturers that guarantee a direct customer channel and a higher level of competition on the MRO market. Even though the level of dependency on the manufacturer remains relatively high, MROs should use their opportunities to develop a relationship on equal footing with the OEMs. This position can be achieved by becoming an indispensable part of the network (e.g., by providing a considerable share of the overhaul capacity), or by providing difficult to imitate value-added services to manufacturers and airlines.

Two-sided solutions are an even better type of alliance that MROs should embrace if opportunities present themselves. This setup allows MROs to regain most of the service business that they may have lost due to the manufacturer's incursion and places them at a favorable integrator position within the supply chain. Furthermore, this setup allows them to gain a positional advantage vis-à-vis their peers, at least for the proportion of products that the alliance partner fabricates. Also for manufacturers, this setup is attractive because it allows them to focus on their core business while participating from service revenues at reduced risk. However, even in this setup, MROs are forced to give up their independence from the manufacturers. Hence, MROs exchange their differentiation for a cost advantage, which is a tradeoff they will have to perform in changing market conditions.

This study has several implications for managers of *independent MRO firms*, as well. These firms lack the affiliated airline and hence sourcing campaign which can be used to gain operator experience and enter OEM alliance discussions. Furthermore, independent MROs are often excluded from the MRO sourcing decision, which airlines increasingly take at the point of asset purchase. For these reasons, independents are most likely to be forced to abandon Engine Maintenance on new aircraft types since they will not be able to receive a license. However, independent MROs are not doomed. Instead, they can innovate their business model to ensure competitive survival, prosper in individual MRO market segments, or even thrive in niche markets.

One opportunity to ensure competitive survival might be to become a *workbench partner* for aircraft manufacturers. To capture additional revenues in Components or Base Maintenance, this is a viable, however, neither very profitable nor advisable configuration to ensure competitive survival. In these less material- and IP-intensive market segments, independent MROs should instead pursue an *OEM-independent approach* to thwart the airframers' aspirations to dominate the aftermarket.

In Base Maintenance, remaining independent is a better choice than forming part of the airframer's solution networks for various reasons. First, this configuration does not strengthen the airframer's position and overall service offer but increases insecurity since the airframer needs to find partners to allocate base maintenance slots. Second, it does not endanger total revenues, considering the increasing shortage of base maintenance capacity worldwide. Third, this approach ensures direct customer contact — and the airframers may well be one of these customers.

Prospects for continuing business independently are also in *Component Maintenance*. In this segment, independent MROs can offer Components Solutions by integrating internal MRO capabilities with parts overhauled by the manufacturers. However, it will be challenging to achieve the same cost-base as airframers with possibly better contractual conditions and airline MROs that can leverage sourcing campaigns of their airlines to achieve cost advantages against these independent players. In effect, independent MROs need to employ other measures to reach an attractive cost-base. Using PMAs and surplus material are two cost levers that tackle material costs. An excellent logistics system can enable competitive differentiation by allowing quicker access to components and simultaneously decrease capital costs. Ideally, MROs should aim to establish partnerships with component manufacturers to improve their competitive position vis-à-vis their peers and the airframer.

A third type of BMI that independent MROs can employ is to *ally with lessors*. Such a partnership would allow improved access to aircraft sourcing campaigns at the point of aircraft sales, which is the second large disadvantage that independents face. Value Propositions to lessors could be formulated based on the operator experience and service-specific engineering capabilities that lessors do not possess. MROs should aim to find solutions to the lessors' pain points such as residual asset value and a flawless aircraft transition process. Independents that, in contrast, intent to leverage their completely *independent market position* into a positional advantage may have trouble in doing so. In practice, airlines have only few concerns when contracting the maintenance arm of a competing airline. For example, Air France KLM has contracted more than 100 airlines for their Components Solution offer (AFI KLM E&M, 2019), and Lufthansa relies on the independent Base Maintenance specialist HAECO for layovers of their long-haul fleet (HAECO Group, 2019), even though they possess an in-house maintenance arm.

In principle, *alliancing with other MROs* does not resolve the threats caused by servitization. The reason is that MRO alliances will hardly improve access to the manufacturer-owned IP or enable them to participate in tenders during the sourcing decision. However, in the face of consolidating manufacturing markets on all tiers of the supply chain, forming alliances to increase the bargaining power, stem the required investments, and reap economies of scale is an attractive option for MROs. These alliances will however instead take shape as acquisitions of the smaller players by the industry leaders and not as an alliance between equal partners. For smaller independent MROs, inorganic growth or a partnership with airline affiliated MROs may be a promising option to avoid an acquisition. To achieve the latter, independents would need to formulate attractive Value Propositions based on their unique resources and capabilities. One option would be to provide innovative services that could be included in the service portfolio of other MROs. Opportunities may lie in performing additional services within a B-, C-, or D-check performed by another provider. These services could be complex cabin modifications such as the installation of an antenna, structural repairs (e.g., the cracked wings of the A380 were repaired by a specialized task force), or mobile engine services. At the time of writing, becoming a licensed provider for mobile engine services seems a promising growth path, considering the enormous challenges that all participants in the supply chain face coping with the increasing technical difficulties of modern engine types.

Finally, we are only scratching the surface of understanding and realizing the possibilities for cost and differentiation advantage that can be leveraged through by *digitization*. Digitization will increasingly replace preventive through predictive and on-condition maintenance, which will allow cost savings through reduced material consumption and efficiency gains, as well as quicker troubleshooting in the daily Line Maintenance business. Today, MROs may gain a first mover advantage by defining applications jointly with airlines and possibly manufacturers. Simultaneously, airlines need to secure data ownership and unlimited, unencrypted access to all available data. Only then can airlines mitigate the threat of even further monopolization of the MRO marked through smart servitization.

Airline Managers This study also has implications for airline managers in charge of the technical operations function as well as the MRO supply chain. Technical fleet management is a core function of airlines that enables safe, reliable, and cost-efficient operations for passengers onboard the aircraft. Disruptions in the internal and external technical supply chain lead to delays and cancellations, which directly impact customer perception, loyalty, airline performance (Knotts, 1999). External MRO services provided by traditional MRO service firms and OEMs represent a significant proportion of the technical operations value chain of the airline. Hence, managing performance and lifecycle costs of these external parties is paramount to ensure smooth operations and a competitive cost-base. MRO and OEM solution offers have become an attractive option for lowering the risks associated with the operation and maintenance of the complex technical system aircraft. Especially Engine and Components Solutions allow most airlines to focus on their core business, mitigate risks, and establish a predictable cost base. Moreover, especially small and start-up airlines can outsource most of their technical operation by relying on comprehensive Aircraft Solutions. This move can provide them with the technical competence required to start their operations, as well as more reliable and possibly even cost-efficient operations.

Is it time to sit back, relax, and let the solution supplier do the work? Well, not exactly. First, Aircraft Solution offers come at hefty flight hour rates and strong dependence on the supplier. Here, I hope that the provided information supports their decision-making and the contractual design of these comprehensive contracts, limiting customer dependence and supporting gain-sharing models. In all types of solution offers, suppliers take increasing responsibility for the airline's technical operations, which decreases the airline's control over its performance and costs. Hence, KPI and pain/gain sharing models including enforceable long-term maintenance cost guarantees need to be established to counter the resulting one-sided dependency.

Second, airline managers should closely monitor the *manufacturers' servitization strategies*, which include creating increasing market barriers for independent MRO firms and aim at monopolizing the service market for their equipment. On one hand, airlines should welcome OEMs and their offers on the aftermarket. The reason is that the different resources and capabilities and approaches to the aftermarket, based on the previously product-centered business model, allows OEMs to drive innovation in the MRO industry. Improved levels of innovation and competition can reduce airlines' costs and increase the reliability and availability of the fleet. However, airlines simultaneously need to ensure the continuous access of independent MROs in all market segments and their capability to make service offers independent from the manufacturers. Otherwise, the formation of coopetitive networks or even two-sided solution agreements will further consolidate the supply chain leaving airlines with less bargaining power. While two-sided solutions are the most promising setup for MROs, they bear the threat of even further supply chain consolidation for airlines. Hence, airline managers should be wary of these developments. In conclusion, it remains to be seen whether even higher OEM dominance in the supply chain will occur, or if airlines and MROs will be able to hold a market equilibrium that includes a competitive aftermarket.

One critical battleground is the open access to aircraft data that is applied in the nascent field of smart servitization and digitally supported solutions. In this field, competition should not be determined via the ownership of data but instead based on who can develop the most competitive service offers based on data made available to all parties. This approach would ensure competition between OEMs, MROs, and independent analysts to the benefit of the airlines. Hence, airlines should pursue joint action to safeguard unlimited, unencrypted access and ownership of the data generated by their aircraft.

In conclusion, airlines can benefit from servitization through more players with a different background and increased competition; however, they need to ensure that competition prevails long-term and that the OEM's attempts to shut-off third party access to the installed base are unsuccessful. Here, airlines are in a unique position as the customer of both the manufacturers' products and services to make the required demands and lead those tough negotiations. If airline managers fail to ensure the continued existence of third-party MRO firms, they will be confronted with monopolization, lock-in situations, increased OEM-dependence, and exaggerated prices for MRO services.

Aerospace Manufacturers Ultimately, also managers in the manufacturing industry can benefit from this work, as it provides unique insights into *competitive positioning and alliance approaches of MROs* in their unique role of competitors and potential partners for the manufacturer's servitization efforts. In contrast to most of the servitization literature, this work sheds light on the strengths of partners in service networks and the dynamic capabilities that these firms first need to develop to become partners in manufacturer-led service networks. I hope that managers responsible for the development of the manufacturer's service business find the results helpful for forming effective service networks, e.g. by actively extending their supplier's capabilities.

Manufacturers that struggle to implement a profitable service business are encouraged to *deservitize*, by relying on a two-sided solution offer by a single MRO. Here, the service firm takes over the responsibility for the manufacturer's service business while gain-sharing models ensure participation of both parties in the profit potential of the service market. The main advantages of this model are that both firms can concentrate on their core business, participate in the aftermarket, and create a joint superior offering vis-à-vis their competitors by combining their respective strengths. I hope that this example may encourage manufacturers to depart from the mainstream paths of solution provisioning into new, potentially more promising ways to go downstream while simultaneously concentrate on their core business.

7.3 Limitations and Further Research

Like any other academic work, this study is not free of limitations. First, the empirical setting of all three cases in the aerospace industry may limit the generalization of the findings. The aerospace industry possesses characteristics such as complex technology, long product lifecycles, a high installed base ratio, and manufacturers with intellectual property rights. Consequently, the findings are likely to be generalizable for other COPS industries, where servitization is a typical phenomenon (Oliva & Kallenberg, 2003; Hobday et al., 2005), but be more limited for industries with less complex goods. In the latter type of sectors, dependency on the manufacturer and competitive advantage of pure service firms may differ from the findings presented in this study.

One example is the automotive industry, where independent car repair shops were repeatedly protected by the legal intervention from the manufacturers' servitization efforts to benefit consumer welfare and mitigate monopolization of the aftermarket. However, also other markets such as energy production, building operations, and farm or medical equipment exist, where servitization may be a relevant phenomenon to which traditional service firms need to find competitive responses. Future studies could replicate this study in other empirical settings to improve the generalizability of the findings and possibly identify other alliance configurations.

Second, the case studies are based on interviews with MROs and airlines only. Including manufacturers in the sample would allow triangulating whether the sources of competitive advantage and the proposed mechanisms are equally perceived by manufacturers. This reciprocal approach is especially intriguing, as the proposed mechanisms by which manufacturers achieve competitive advantage against pure service firms (Ulaga & Reinartz, 2011) were only partly confirmed by this study. Another limitation of the competitive advantage framework is that it has little explanatory power in explaining differences in competitive advantage in traditional (input-based) versus solution (output-based) offerings. Refining the provided framework would enable scholars and practitioners to gain a more fine-grained understanding of competition between manufacturers and traditional service providers.

Third, other prospects outside of the realm of business model innovation may be promising to ensure the competitive survival of pure service firms. For example, MROs might aim to merge with or acquire a manufacturer to integrate upwards and thus reduce dependency. Another option would be to pursue lateral growth opportunities in other industries.

Fourth, the identified contingency factors have some limitations. The first limitation is the interviewees' focus on dependency when taking the alliance decision. Future studies could determine further contingency factors that shape the alliance decision, which could be based on the identified benefits and sacrifices attached to such a decision. Besides, the contingency factors have limited power in explaining the resulting type of alliance configuration. Other factors that could not be identified in this study might be of high importance in this regard. For example, solutions with a high value derived from tangible characteristics might foster workbench and coopetitive setups, while solutions, where value is created mainly through interaction between provider and client, might foster the creation of two-sided solutions (Kuijken et al., 2017). Moreover, other antecedents to deservitization and the related two-sided solution such as the realization of cost-savings by relying on lower-cost producers (Kowalkowski et al., 2017) may be identified by future studies. Further research could aim to clarify which contingency factors determine the appropriate configuration of alliances between manufacturers and pure service firms.

Another limitation is the list of dynamic capabilities and their microfoundations that is, consistent with Eisenhardt & Martin (2000) and Teece (2007), neither extensive nor exhaustive. For example, microfoundations to sense and seize opportunities resulting from digitization emerged as a highly relevant topic that could be explored further. Besides, the microfoundations of dynamic capabilities have been identified along the two dimensions "developing solutions" and "alliancing with manufacturers", remain however unspecific to the different configurations. It is likely that reaching the more advanced types of the MRO business model requires more advanced dynamic capabilities. For example, providing a two-sided solution requires extensive co-specialization between manufacturer and service provider, while the workbench is a comparatively simple cooperative setup. A future opportunity would be to develop a maturity model of microfoundations of dynamic capabilities required to reach each of the configurations.

The limited coverage of the emerging field of predictive aircraft maintenance enabled by the increasing use of sensor technology, data transmission, and data analysis represents another limitation. The improved transparency during operation of the aircraft, the quicker identification of errors, and the usage of predictors to remove components before failure are promising approaches to reduce MRO costs and further increase aircraft reliability. While this technological advancements allow firms to achieve both cost and differentiation advantages, increasing data availability is unlikely to be disruptive. The reason is that newer generations of aircraft already have a high reliability (except for considerable teething trouble) and that data-based aircraft reliability management is already common practice. However, this new technology may shift large parts of maintenance from preventive to predictive maintenance logics based on live transparency of the aircraft status. MROs need to master this change by innovating their business model, no matter whether they, airlines, or manufacturers derive the predictions.

While airlines are per default the owners of the data generated by their fleet, manufacturers are aggressively pursuing strategies to protect this very data generated by their proprietary equipment. Digital servitization, defined as the provision of digitally supported services embedded in a physical product (Vendrell-Herrero & Wilson, 2017) allows manufacturers on one hand to provide better product and service offers to their customers. On the other hand, manufacturers can make use of the data to erect barriers that impede MROs from competing and use the information advantage to increase their bargaining power towards airlines. A solution to this dilemma may be to make data available to all parties, which would allow competition in digitally supported MRO services without the downside of even further monopolization and positional advantage. In conclusion, digitization, digital servitization, and predictive maintenance methods are important trends that require the attention of all industry players alike. As we are just starting to understand the possibilities, limitations, and implications of these trends, researchers should engage in this exciting emerging research field.

Another avenue for further research would be linking service infusion and research on coopetitive business models more systematically. Studies could investigate the antecedents, management methods and results of coopetition in solution networks, taking, for example, Dorn et al. (2016) and the developed configurational approach as points of departure.

Finally, my study has only taken the first steps in exploring the dark side of servitization. The findings indicate that servitization is less favorable than previously assumed but instead may lead to increased buyer dependency up to lock-in situations, and consequently adverse effects on buyers' firm performance. In the aerospace industry, first signs of resilience against manufacturers' service offerings and market strategies to dominate the aftermarket have become clearly visible not only in the interviews but also in the complaint that the IATA has filed against engine manufacturer CFM (a joint venture between GE and Safran). By prematurely agreeing to CFM's proposal, airlines have lost the opportunity to ensure sustainable competition in the engine market. Even though CFM waives license fees to third-party providers and allows limited usage of PMAs, the vast majority of MROs will not risk the investment to build engine service capabilities. This will enable CFM to pursue its monopolization aftermarket tactics even more aggressively backed by the carte blanche issued by airlines and the European Commission. This case represents a perfect example of the lack of strategic sourcing capabilities and long-term thinking of many airlines that lack the in-depth understanding of the servitization in the aerospace industry. Hence, the aerospace industry is a suitable point of departure for future studies in the field of servitization in analogous or digitally supported form. In regards to the adverse effects of servitization, studies could employ quantitative methods to measure these effects over time either on a buyer-supplier dyad or on a market level.

As servitization in the aerospace industry remains a complex, dynamic, and highly exciting research field, I strongly encourage further empirical investigations amongst manufacturers, MROs, and airlines.

Bibliography

Aaronson, M., Schaar, D., Mallory, G., Aaronson, M., Schaar, D., & Mallory, G. (2016). Can Airplane OEMs Increase Their Share of Profits? *bcg.perspectives*, *16*(10), 1–5.

Acha, V., Brusoni, S., & Prencipe, A. (2007). Exploring the Miracle: Strategy And Management of the Knowledge Base In the Aeronautics Industry. *International Journal of Innovation and Technology Management*, *04*(01), 15–39.

Adrodegari, F., Alghisi, A., Ardolino, M., & Saccani, N. (2015). From Ownership to Service-oriented Business Models: A Survey in Capital Goods Companies and a PSS Typology. *Procedia CIRP*, *30*, 245–250.

Adrodegari, F., Saccani, N., & Kowalkowski, C. (2016). A Framework for PSS Business Models: Formalization and Application. *Procedia CIRP*, *47*, 519–524.

AeroDynamic Advisory (2018). 2018 Air Transport Aftermarket Customer Satisfaction Survey. In *Farnborough International Airshow*, (pp. 1–10).

Aeronautical Repair Station Association (2013). Global MRO Market - Economic Assessment. Tech. rep.

AFI KLM E&M (2018). Key Figures.
URL http://www.afiklmem.com/AFIKLMEM/en/g{_}page{_}standard/AboutAFIKLMEM/KeyFigures.html (Accessed at 2.3.2019)

AFI KLM E&M (2019). Adaptive MRO Solutions – Components: Overview.
URL http://www.afiklmem.com/AFIKLMEM/en/g{_}page{_}standard/GlobalSolutions/Components/GlobalSolutions{_}Components{_}Overview.html (Accessed at 19.2.2019)

Agarwal, R., & Selen, W. (2009). Dynamic capability building in service value networks for achieving service innovation. *Decision sciences*, *40*(3), 431–475.

Air Berlin (2013). Air Berlin stellt sich "Lean & Smart" auf.
URL http://www.airberlingroup.com/de/presse/pressemitteilungen/2013/01/15-airberlin-stellt-sich-Lean-und-Smart-auf (Accessed at 2017-11-28)

Air France (2012). Strategic Business Plan.
URL http://corporate.airfrance.com/en/strategy/transform2015/strategicbusinessplan/ (Accessed at 2017-10-10)

Air France KLM (2017). Full Year 2016 results.
URL http://www.airfranceklm.com/sites/default/files/communiques/fy{_}2016{_}press{_}release{_}en.pdf (Accessed at 2017-07-25)

Airbus (2011). Airbus to acquire Satair A/S.
URL http://www.airbus.com/presscentre/pressreleases/press-release-detail/detail/airbus-to-acquire-satair-as/ (Accessed at 2015-05-08)

Airbus (2015). Tigerair signs Flight Hour Services Tailored Support Package (FHS-TSP) contract with Airbus for its A320 fleet.
URL http://www.airbus.com/newsroom/press-releases/en/2015/11/tigerair-signs-flight-hour-services-tailored-support-package-fhs-tsp-contract-with-airbus-for-its-a320-fleet.html (Accessed at 2017-12-28)

Airbus (2017a). A320neo.
URL http://www.airbus.com/aircraftfamilies/passengeraircraft/a320family/a320neo/ (Accessed at 2017-05-25)

Airbus (2017b). Airbus Group Annual Report 2016.
URL https://www.airbus.com/content/dam/events/annual-general-meeting/airbus-ra-rf-2016-en-02.pdf (Accessed at 2017-12-19)

Airbus (2017c). Airbus Support Services.
URL https://www.airbus.com/aircraft/support-services.html (Accessed at 2017-12-19)

Airbus (2017d). Asiana Airlines signs FHS Components contract with Airbus for its A380 fleet.
URL http://www.airbus.com/newsroom/press-releases/en/2014/01/asiana-airlines-signs-fhs-components-contract-with-airbus-for-its-a380-fleet.html (Accessed at 2017-12-28)

Airbus (2017e). Malaysia Airlines signs FHS support agreement with Airbus.
URL http://www.airbus.com/newsroom/press-releases/en/2017/06/malaysia-airlines-signs-fhs-support-agreement-with-airbus.html (Accessed at 2017-12-28)

Al-kaabi, H., Potter, A., & Naim, M. (2007a). An outsourcing decision model for airlines' MRO activities. *Journal of Quality in Maintenance Engineering*, *13*(3), 217–227.

Al-kaabi, H., Potter, A., & Naim, M. (2007b). Insights Into the Maintenance, Repair and Overhaul Configurations of European Airlines. *Journal of Air Transportation*, *12*(2), 27–42.

Alam, I. (2006). Removing the fuzziness from the fuzzy front-end of service innovations through customer interactions. *Industrial marketing management*, *35*(4), 468–480.

Albers, S. (2010). Configurations of alliance governance systems. *Schmalenbach Business Review (SBR)*, *62*(3), 204–233.

Albers, S., Koch, B., & Ruff, C. (2005). Strategic alliances between airlines and airports - Theoretical assessment and practical evidence. *Journal of Air Transport Management*, *11*(2), 49–58.

Amit, R., & Schoemaker, P. J. H. (1993). Strategic assets and organizational rent. *Strategic management journal*, *14*(1), 33–46.

Amit, R., & Zott, C. (2001). Value creation in e-business. *Strategic management journal*, *22*(6-7), 493–520.

Anderson, J. C., & Narus, J. A. (1984). A model of the distributor's perspective of distributor-manufacturer working relationships. *The journal of marketing*, (pp. 62–74).

Anderson, J. C., & Narus, J. A. (1990). A model of distributor firm and manufacturer firm working partnerships. *Journal of Marketing*, (pp. 42–58).

Anderson, J. C., & Narus, J. A. (1998). Business marketing: understand what customers value. *Harvard business review*, *76*, 53–67.

Anselmo, J. (2017). GE Chief On Big Data , Disruptive Technologies And Climate Change.
URL http://aviationweek.com/commercial-aviation/ge-chief-big-data-disruptive-technologies-and-climate-change (Accessed at 2017-04-30)

Anselmo, J., & Norris, G. (2017). Boeing CEO's $ 50 Billion Target.
URL http://aviationweek.com/commercial-aviation/boeing-ceo-s-50-billion-target (Accessed at 2017-06-12)

Arendt, N. (2015). *Vertical integration in the aviation service industry: Strategies for independent service providers*. Master thesis, European School of Management and Technology.

A.T. Kearney Inc. (2003). *Restructuring the Global Aerospace Industry: The Shifting role of Suppliers*. Chicago: A.T. Kearney Inc.

A.T.U Auto-Teile-Unger GmbH & Co. KG (2017). ATU Homepage.
URL http://www.atu.de/pages/service/filialen/f{_}index.html (Accessed at 2017-12-03)

Auramo, J., & Ala-risku, T. (2005). Challenges for going downstream. *International Journal of Logistics*, *8*(4), 333–345.

Aurich, J. C., Wolf, N., Siener, M., & Schweitzer, E. (2009). Configuration of product-service systems. *Journal of Manufacturing Technology Management*, *20*(5), 591–605.

Avia Solutions Group (2017). PMA parts and DER DER-repairs: bringing alternatives to the aircraft aftermarket.
URL http://www.aviasg.com/en/press-release/pma-parts-and-der-repairs-bringing-alternatives-to-the-aircraft-aftermarket.html (Accessed at 2017-03-17)

Azarenko, A., Roy, R., Shehab, E., & Tiwari, A. (2009). Technical product-service systems: some implications for the machine tool industry. *Journal of Manufacturing Technology Management*, *20*(5), 700–722.

Baden-Fuller, C., & Morgan, M. S. (2010). Business models as models. *Long Range Planning*, *43*(2-3), 156–171.

Baines, T., Braganza, A., Kingston, J., Lockett, H., Martinez, V., Michele, P., Tranfield, D., Walton, I., & Wilson, H. (2007). State-of-the-art in product service-systems. *Journal of Engineering Manufacture*, *221*(10), 1543–1552.

Baines, T., & Lightfoot, H. (2013). Servitization of the manufacturing firm. *International Journal of Operations & Production Management*, *34*(1), 2–35.

Baines, T., & Lightfoot, H. (2014). Servitization in the Aircraft Industry: Understanding Advanced Services and the Implications of Their Delivery. In G. Lay (Ed.) *Servitization in Industry*. Cham Heidelberg New York Dordrecht London: Springer.

Baines, T., Lightfoot, H., Benedettini, O., & Kay, J. (2009). The servitization of manufacturing: a review of literature and reflection on future challenges. *Journal of manufacturing technology management*, *20*(5), 547–567.

Baines, T., Lightfoot, H., & Smart, P. (2011). Servitization within manufacturing Exploring the provision of advanced services and their impact on vertical integration. *Journal of Manufacturing Technology Management*, *22*(7), 947–954.

Baines, T., Lightfoot, H., Smart, P., & Fletcher, S. (2013). Servitization of manufacture: Exploring the deployment and skills of people critical to the delivery of advanced services. *Journal of Manufacturing Technology Management*, *24*(4).

Baines, T., Ziaee, A., Oscar, B., Victor, F. B., Shi, G., Baldwin, J., & Ridgway, K. (2017). Servitization: revisiting the state-of-the-art and research priorities. *International Journal of Operations & Production Management*, *37*(2), 256–278.

Ballantyne, T. (2015). Manufacturers winning the battle for MRO business.
URL http://www.orientaviation.com/articles/1080/manufacturers-winning-battle-for-mro-business{%}0A1) (Accessed at 2016-02-08)

Bandle, L. (2013). *Analyse und Bewertung von Geschäftsmodellen in der Luftfahrtindustrie*. Ph.D. thesis, Universität Stuttgart.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, *17*(1), 99–120.

Barney, J. (1999). How a firm's capabilities affect boundary decisions. *Sloan Management Review*, *40*(3), 137.

Barney, J., & Hesterley, W. (2012). *Strategic Management and Competitive Advantage*. New Jersey: Pearson Education Limited, 4th ed.

Barquet, A. P. B., de Oliveira, M. G., Amigo, C. R., Cunha, V. P., & Rozenfeld, H. (2013). Employing the business model concept to support the adoption of product–service systems (PSS). *Industrial Marketing Management*, *42*(5), 693–704.

Barras, R. (1986). Towards a theory of innovation in services. *Research Policy*, *15*(4), 161–173.

Basole, R. C., & Rouse, W. B. (2008). Complexity of service value networks: conceptualization and empirical investigation. *IBM systems journal*, *47*(1), 53–70.

Bastl, M., Johnson, M., Lightfoot, H., & Evans, S. (2012). Buyer-supplier relationships in a servitized environment: An examination with Cannon and Perreault's framework. *International Journal of Operations & Production Management*, *32*(5-6), 650–675.

Batista, L., Davis-Poynter, S., Ng, I., & Maull, R. (2015). Servitization through outcome-based contract – A systems perspective from the defence industry. *International Journal of Production Economics*, *192*, 133–143.

Baumol, W. J. (1982). Contestable markets: an uprising in the theory of industry structure. *1The American Economic Review*, *72*(1), 1–15.

Baveja, S. S., Gilbert, J., & Ledingham, D. (2004). From products to services: why it's not so simple. *Harvard Management Update*, *9*(4), 3–5.

Bazargan, M. (2016). Airline maintenance strategies – in-house vs. outsourced – an optimization approach. *Journal of Quality in Maintenance Engineering*, *22*(2), 114–129.

Belobaba, P., Odoni, A., & Barnhart, C. (2009). *The Global Airline Industry*. Chichester: Wiley.

Benedetti, M., Cesarotti, V., Holgado, M., Introna, V., & Macchi, M. (2015). A Proposal for Energy Services' Classification Including a Product Service Systems Perspective. *Procedia CIRP*, *30*, 251–256.

Benedettini, O., Neely, A., & Swink, M. (2015). Why do servitized firms fail? A risk-based explanation. *International Journal of Operations & Production Management*, *35*(6), 946–979.

Benkard, C. (2000). A dynamic analysis of the market for wide-bodied commercial aircraft.

Bensaou, M. (1999). Portfolios of Buyer-Supplier Relationships. *Sloan Management Review*, *40*(4), 35–44.

Berger, J. M. (2013a). MRO Market Consolidation - Forecast & Trends. In *MRO Americas*. ICF International.

Berger, J. M. (2013b). MRO Market Forecast & Industry Dynamis. In *Latin America and Caribbean Engineering & MRO Summit*. ICF International.

Berger, J. M. (2014). MRO Market Overview and Trends. In *2014 Annual Transportation Review Board Meeting*.

Bermig, C. (2005). Competition policy in European aviation markets. In W. Delfmann, H. Baum, S. Auerbach, & S. Albers (Eds.) *Strategic Management in the Aviation Industry*, (pp. 19–40). London and New York: Routledge.

Berrittella, M., Franca, L. L., Mandina, V., & Zito, P. (2007). Modelling strategic alliances in the wide-body long-range aircraft market. *Journal of Air Transport Management*, *13*(3), 139–148.

Best, R. (2016). Top 7 Aerospace Companies in the World.
URL https://www.investopedia.com/articles/company-insights/082516/top-7-aerospace-companies-world-ba-utx.asp (Accessed at 2017-12-08)

Beuren, F. H., Gomes Ferreira, M. G., & Cauchick Miguel, P. A. (2013). Product-service systems: a literature review on integrated products and services. *Journal of Cleaner Production*, *47*, 222–231.

Bharadwaj, S. G., Varadarajan, P. R., & Fahy, J. (1993). Competitive Advantage in Service Industries: A Conceptual Model. *Journal of marketing research*, *57*(4), 83–99.

Bieger, T., & Agosti, S. (2005). Business models in the airline sector – evolution and perspectives. In W. Delfmann, H. Baum, S. Auerbach, & S. Albers (Eds.) *Strategic Management in the Aviation Industry.*, (pp. 41–64). Aldershot/Burlington: Ashgate Publishing, Ltd.

Bineid, M., & Fielding, J. P. (2003). Development of a civil aircraft dispatch reliability prediction methodology. *Aircraft Engineering and Aerospace Technology*, *75*(6), 588–594.

Bock, A. J., Opsahl, T., George, G., & Gann, D. M. (2012). The effects of culture and structure on strategic flexibility during business model innovation. *Journal of Management Studies*, *49*(2), 279–305.

Boeing (2017a). 737max.
URL https://www.boeing.com/commercial/737max/ (Accessed at 2017-05-25)

Boeing (2017b). Boeing Commercial Services Homepage.
URL http://www.boeing.com/services/index.page{#}/support (Accessed at 2017-12-19)

Boeing (2017c). Current market outlook 2017-2036.
URL http://www.boeing.com/resources/boeingdotcom/commercial/market/current-market-outlook-2017/assets/downloads/2017-cmo-6-19.pdf (Accessed at 2017-12-05)

Bombardier (2016). C Series Fact Sheet.
URL http://commercialaircraft.bombardier.com/content/dam/Websites/bca/literature/cseries/Bombardier-Commercial-Aircraft-CS100-FactSheet-en.pdf (Accessed at 2016-02-08)

Boston Consulting Group (2012). The European Automotive Aftermarket Landscape.
URL https://www.bcg.com/documents/file111373.pdf (Accessed at 2016-08-24)

Bourke, R. (2018). Aero-engine MRO industry analysis fleet, market, and trends. In *Aero-Engines Europe*. London: Oliver Wyman.

Brady, T., Davies, A., & Gann, D. M. (2005). Creating value by delivering integrated solutions. *International Journal of Project Management*, *23*(5), 360–365.

Brandenburger, A. M., & Nalebuff, B. (1996). *Co-opetition*. New York: Currency/Doubleday.

Brax, S. (2005). A manufacturer becoming service provider – challenges and a paradox. *Managing Service Quality*, *15*(2), 142–155.

Brax, S. A., & Jonsson, K. (2009). Developing integrated solution offerings for remote diagnostics: A comparative case study of two manufacturers. *International Journal of Operations & Production Management*, *29*(5), 539–560.

Brax, S. A., & Visintin, F. (2017). Meta-model of servitization: The integrative profiling approach. *Industrial Marketing Management*, *60*, 17–32.

Brecken, S. (2017). Honeywell and Lufthansa Technik Create World's Largest Maintenance Repair and Overhaul Capability for Airbus A350 Fleets.
URL https://www.honeywell.com/newsroom/pressreleases/2017/11/honeywell-and-lufthansa-technik-create-worlds-largest-maintenance-repair-and-overhaul-capability-for-airbus-a350-fleets (Accessed at 2017-12-22)

Broderick, S. (2013a). Boeing Eyes Bigger Slice Of Commercial Aftermarket Pie.
URL http://aviationweek.com/commercial-aviation/boeing-eyes-bigger-slice-commercial-aftermarket-pie (Accessed at 2015-04-28)

Broderick, S. (2013b). The Surplus Part's Starring Role.
URL http://aviationweek.com/awin/surplus-part-s-starring-role (Accessed at 2017-12-11)

Broderick, S. (2014). Leasing, Surplus Parts Demand Creating Openings For PMA Suppliers.

URL http://aviationweek.com/awin/leasing-surplus-parts-demand-creating-openings-pma-suppliers (Accessed at 2018-07-25)

Broderick, S., Tegtmeier, L. A., & Torr, J. (2014). Singapore Joint Venture Set To Be Boeing's Largest MRO Partnership.
URL http://aviationweek.com/mro/singapore-joint-venture-set-be-boeing-s-largest-mro-partnership (Accessed at 2015-04-27)

Brown, R. (2014a). Global MRO Outlook. In *ap&m The Global MRO Procurement Expo*. ICF International.

Brown, R. (2014b). MRO Market Overview & Trends. In *North American Airline Maintenance & Engineering Conference*. Seatlle, Washington: ICF International.

Brown, R. (2015). MRO Market Forecast & Key Battlegrounds. In *MRO Europe 2015*.

Brown, R. (2016). MRO Market Update & Industry Trends. In *AP&M Europe*, May.

Bryant, A., & Charmaz, K. (2007). *The Sage handbook of grounded theory*. London: SAGE Publications.

Buchanan, L. (1992). Vertical trade relationships: the role of dependence and symmetry in attaining organizational goals. *Journal of Marketing Research*, *29*(1), 65–75.

Bureau of Labor Statistics (2014). Occupational Employment statistics: NAICS 336400 - Aerospace Product and Parts Manufacturing.
URL http://www.bls.gov/oes/current/naics4{_}336400.htm (Accessed at 2015-07-02)

Bustinza, O. F., Bigdeli, A. Z., Baines, T., & Elliot, C. (2015). Servitization and Competitive Advantage. *Research Technology Management*, *58*(5), 53–60.

Canaday, H. (2016). Aircraft Spare Parts Pooling: Art Or Science?
URL http://aviationweek.com/mro/aircraft-spare-parts-pooling-art-or-science (Accessed at 2016-10-19)

Canaday, H. (2017a). How Might Blockchain Be Used To Manage Aircraft Assets?
URL http://www.mro-network.com/maintenance-repair-overhaul/how-might-blockchain-be-used-manage-aircraft-assets (Accessed at 2017-07-24)

Canaday, H. (2017b). Next Steps in Harnessing Big Data for MRO.
URL http://www.mro-network.com/print/10869 (Accessed at 2017-02-23)

Carpenter, R., & Henderson, A. (2008). Keep them flying: Find your winning position in the MRO game.
URL http://www-935.ibm.com/services/us/gbs/bus/pdf/gbw03020-usen-00{_}keep{_}flying.pdf (Accessed at 2015-07-17)

Casadesus-Masanell, R., & Zhu, F. (2013). Business model innovation and competitive imitation: The case of sponsor-based business models. *Strategic management journal*, *34*(4), 464–482.

Casciaro, T., & Piskorski, M. (2005). Power imbalance, mutual dependence, and constraint absorption: A closer look at resource dependence theory. *Administrative science quarterly*, *50*(2), 167–199.

Chen, D., & Trivedi, K. S. (2005). Optimization for condition-based maintenance with semi-Markov decision process. *Reliability Engineering and System Safety*, *90*, 25–29.

Chesbrough, H. (2010). Business model innovation: Opportunities and barriers. *Long Range Planning*, *43*(2-3), 354–363.

Claas (2019). CLAAS CARE Wartungsvertrag - Optimale Kostenkontrolle bei höchster Zuverlässigkeit.
URL https://www.claas.de/service/serviceprodukte/wartungsvertrag-deutschland (Accessed at 2019-04-01)

Clark, P. (2007). *Buying the Big Jets: Fleet plannig for airlines*. Aldershot/Burlington: Ashgate Publishing, Ltd., 2nd ed.

Clayton, R. J., Backhouse, C. J., & Dani, S. (2012). Evaluating existing approaches to product-service system design: A comparison with industrial practice. *Journal of Manufacturing Technology Management*, *23*(3), 272–298.

Cohen, M. A., Agrawal, N., & Agrawal, V. (2006). Winning in the aftermarket. *Harvard business review*, *84*(5), 129.

Cole, J. (1996). Boeing Agrees to Acquire Archrival McDonnell Douglas.
URL http://www.wsj.com/articles/SB850664260619716000 (Accessed at 2016-02-08)

Comac (2016). C919 Program.
URL http://english.comac.cc/products/ca/pi/ (Accessed at 2016-02-08)

Conrady, R., Fichert, F., & Sterzenbach, R. (2012). *Luftverkehr: Betriebswirtschaftliches Lehr-und Handbuch*. München: Oldenbourg Wissenschaftsverlag, 5th ed.

Cook, M., Bhamra, T., & Lemon, M. (2006). The transfer and application of Product Service Systems: from academia to UK manufacturing firms. *Journal of Cleaner Production*, *14*(17), 1455–1465.

Cooper, T. (2017). Global Fleet & MRO Market Forecast Summary.
URL http://www.oliverwyman.com/our-expertise/insights/2016/apr/mro-survey-2017.html (Accessed at 2017-10-14)

Corbin, J., & Strauss, A. (1990). Grounded theory research: Procedures, canons and evaluative criteria. *Zeitschrift für Soziologie*, *19*(6), 418–427.

Corbo, L. (2017). In search of business model configurations that work: Lessons from the hybridization of Air Berlin and JetBlue. *Journal of Air Transport Management*, *64*, 139–150.

Corsaro, D., Ramos, C., Henneberg, S. C., & Naudé, P. (2012). The impact of network configurations on value constellations in business markets – The case of an innovation network. *Industrial Marketing Management*, *41*(1), 54–67.

Cousins, P. D., & Crone, M. J. (2003). Strategic models for the development of obligation based inter-firm relationships: A study of the UK automotive industry. *International Journal of Operations & Production Management*, *23*(12), 1447–1474.

Cox, A. (2001). Understanding buyer and supplier power: A framework for procurement and suppy competence. *Journal of Supply Chain Management*, *37*(1), 8–15.

Cox, A. (2015). Sourcing portfolio analysis and power positioning: towards a "paradigm shift" in category management and strategic sourcing. *Supply Chain Management: An International Journal*, *20*(6), 717–736.

Croft, J. (2016). Honeywell Eyes New Connectivity-Driven Business Models. URL http://aviationweek.com/connected-aerospace/honeywell-eyes-new-connectivity-driven-business-models (Accessed at 2016-10-19)

Crook, T., & Combs, J. (2007). Sources and consequences of bargaining power in supply chains. *Journal of Operations Management*, *25*, 546–555.

Cros, G. (2015). Industry Trends Maintenance Cost. In *IATA 3rd Airline Cost Conference*.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. London: Sage.

Dachs, B., Biege, S., Borowiecki, M., Lay, G., Jäger, A., & Schartinger, D. (2014). Servitisation of European manufacturing: evidence from a large scale database. *The Service Industries Journal*, *34*(1), 5.

Daft, J. (2015). *Die Ähnlichkeit von Geschäftsmodellen: Eine empirische Untersuchung der europäischen Airline-Industrie*. Köln: Kölner Wissenschaftsverlag.

Daft, J., & Albers, S. (2013). A conceptual framework for measuring airline business model convergence. *Journal of Air Transport Management*, *28*, 47–54.

Daft, J., & Albers, S. (2015). An empirical analysis of airline business model convergence. *Journal of Air Transport Management*, *46*, 3–11.

Darr, E. D., Argote, L., & Epple, D. (1995). The acquisition, transfer, and depreciation of knowledge in service organizations: Productivity in franchises. *Management science*, *41*(11), 1750–1762.

Davies, A. (2004). Moving base into high-value integrated solutions: A value stream approach. *Industrial and Corporate Change*, *13*(5), 727–756.

Davies, A., & Brady, T. (2000). Organisational capabilities and learning in complex product systems: towards repeatable solutions. *Research Policy*, *29*(7), 931–953.

Davies, A., Brady, T., & Hobday, M. (2006). Charting a path toward integrated solutions. *MIT Sloan Management Review*, *47*(3), 39.

Davies, A., Brady, T., & Hobday, M. (2007). Organizing for solutions: Systems seller vs. systems integrator. *Industrial Marketing Management*, *36*(2), 183–193.

Davies, A., Brady, T., Tang, P., Hobday, M., Rush, H., & Gann, D. (2003). *Delivering integrated solutions*. SPRU.

Davies, A., & Hobday, M. (2005). *The business of projects: managing innovation in complex products and systems*. Cambridge University Press.

Davis, G., & Cobb, J. (2010). Resource dependence theory: Past and future. *Research in the Sociology of Organizations*, *28*, 21–42.

de Reuver, M., Bouwman, H., & MacInnes, I. (2009). Business models dynamics for start-ups and innovating e-businesses. *International Journal of Electronic Business*, *7*(3), 269–286.

Delfmann, W., Baum, H., Auerbach, S., & Albers, S. (2005). Moving targets: strategic trends in the aviation sector. *Strategic Management in the Aviation Industry. Aldershot, Cologne: Ashgate/Kölner Wissenschaftsverlag*.

Demeter, K., & Szász, L. (2013). Towards solution based thinking: Characteristics of servitization at Hungarian manufacturing companies. *Journal for East European Management Studies*, (pp. 309–335).

Demil, B., & Lecocq, X. (2010). Business Model Evolution: In Search of Dynamic Consistency. *Long Range Planning*, *43*(2-3), 227–246.

den Hertog, P., van der Aa, W., & de Jong, M. W. (2010). Capabilities for managing service innovation: towards a conceptual framework. *Journal of Service Management*, *21*(4), 490–514.

Derber, A. (2013). No afterthought: Rolls-Royce and the aftermarket.
URL http://mro-network.com/print/1345 (Accessed at 2016-07-11)

Derber, A. (2014). HAECO Cabins To sell PMA Parts.
URL http://www.mro-network.com/maintenance-repair-overhaul/haeco-cabins-sell-pma-parts (Accessed at 2017-09-04)

Derber, A. (2017). Maintaining Diversity for CFM support.
URL http://www.mro-network.com/maintenance-repair-overhaul/maintaining-diversity-cfm-support (Accessed at 2017-05-15)

Derber, A. (2018). AFI KLM E&M Adds LEAP Capabilities.
URL https://www.mro-network.com/maintenance-repair-overhaul/afi-klm-em-adds-leap-capabilities (Accessed at 2018-12-24)

Derber, A., Holland, J., & Davies, H. (2014). *The Engine Yearbook*. Emingsville, PA, USA: OAG Aviation Publications Ltd.

Deshpandé, R. (1983). "Paradigms Lost": On Theory and Method in Research in Marketing. *Journal of Marketing*, *47*(4), 101–110.

Di Stefano, G., Peteraf, M., & Verona, G. (2014). The Organizational Drivetrain: a Road To Integration of Dynamic Capabilities Research. *Academy of Management Perspectives*, *28*(4), 307–327.

Dierickx, I., & Cool, K. (1989). Asset Stock Accumulation and the Sustainability of Competitive Advantage.

DiMaggio, P. J. (1988). Interest and agency in institutional theory. *Institutional patterns and organizations: Culture and environment*, *1*, 3–22.

Doganis, R. (2010). *Flying off course: The economics of international airlines*. London and New York: Routledge, 4th ed.

Donaldson, L. (2001). *The contingency theory of organizations*. London: Sage.

Dorn, S., Schweiger, B., & Albers, S. (2016). Levels, phases and themes of coopetition: A systematic literature review and research agenda. *European Management Journal*, *34*(5), 484–500.

Dpa-AFX, & Ddp (2009). TUI Travel storniert 787 Bestellungen.
URL http://www.airliners.de/tui-travel-storniert-787-bestellungen/19215/print (Accessed at 2015-05-08)

Dubois, A., & Gadde, L.-E. (2002). Systematic combining: an abductive approach to case research. *Journal of business research*, *55*(7), 553–560.

Dubois, A., & Gibbert, M. (2010). From complexity to transparency: managing the interplay between theory, method and empirical phenomena in IMM case studies. *Industrial Marketing Management*, *39*(1), 129–136.

Duddu, P. (2016). Masters of the sky: the top 10 aerospace companies.
URL http://www.aerospace-technology.com/features/featuremasters-of-the-sky-the-top-10-aerospace-companies-4911697/ (Accessed at 2017-12-08)

Dul, J., & Hak, T. (2008). *Case study methodology in business research*. Routledge.

Dussauge, P., & Garrette, B. (1999). Cooperative strategy-Competing successfully through strategic alliances.

Dwyer, R. F., Schurr, P. H., & Oh, S. (1987). Developing Buyer-Seller Relationships. *Journal of Marketing*, *51*, 11–27.

Dyer, J., & Singh, H. (1998). The relational view: cooperative strategy and sources of interorganizational competitive advantage. *Academy of management review*, *23*(4), 660–679.

Dyer, J. H., Kale, P., & Singh, H. (2001). How To Make Strategic Alliances Work. *MIT Sloan Management Review*, *42*(4), 37–43.

Eggert, A., Hogreve, J., Ulaga, W., & Muenkhoff, E. (2014). Revenue and Profit Implications of Industrial Service Strategies. *Journal of Service Research*, *17*(1), 23–39.

Eggert, A., Thiesbrummel, C., & Deutscher, C. (2015). Heading for new shores: Do service and hybrid innovations outperform product innovations in industrial companies? *Industrial Marketing Management*, *45*, 173–183.

Eisenhardt, K., Furr, N. R., & Bingham, C. B. (2010). Microfoundations of performance: Balancing efficiency and flexibility in dynamic environments. *Organization Science*, *21*(6), 1263–1273.

Eisenhardt, K., & Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic management journal*, *21*(10-11), 1105–1121.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review*, *14*(4), 532–550.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory Building From Cases: Opportunities and Challenges. *Academy of Management Journal*, *50*(1), 25–32.

Eislein, S. (2018). Die C-Series heißt jetzt Airbus A220.
URL https://www.aerotelegraph.com/die-c-series-heisst-jetzt-airbus-a220 (Accessed at 2018-11-10)

Eloranta, V., & Turunen, T. (2015). Seeking competitive advantage with service infusion: a systematic literature review. *Journal of Service Management*, *26*(3), 394–425.

Eloranta, V., & Turunen, T. (2016). Platforms in service-driven manufacturing: Leveraging complexity by connecting, sharing, and integrating. *Industrial Marketing Management*, *55*, 178–186.

Esposito, E. (2004). Strategic alliances and internationalisation in the aircraft manufacturing industry. *Technological Forecasting and Social Change*, *71*(5), 443–468.

Esposito, E., & Raffa, L. (2007). Global reorganisation in a high-technology industry: the aircraft industry. *International Journal of Globalisation and Small Business*, *2*(2), 166–184.

European Commission (2003). New rules for car sales and servicing.

European Commission (2007). Antitrust: Commission ensures carmakers give independent garages access to repair information.

European Commission (2010). Comission Regulation (EU) 461/2010.

Fan, X., & Zhang, H. (2010). Aligning product-service systems with market forces: a theoretical framework. In *Internation Conference on Service Sciences (ICSS)*, (pp. 110–114).

Fang, E., Palmatier, R. W., & Steenkamp, J.-B. E. M. (2008). Effect of Service Transition Strategies on Firm Value. *Journal of Marketing*, *72*(5), 1–14.

Ferreira, F., Cova, B., Spencer, R., & Proença, J. F. (2016). A dynamics-based approach to solutions typology: A case from the aerospace industry. *Industrial Marketing Management*, *58*, 114–122.

Ferreira, F., Proença, J. F., Spencer, R., & Cova, B. (2013). The transition from products to solutions: External business model fit and dynamics. *Industrial Marketing Management*, *42*(7), 1093–1101.

Field, D. (2005). Delta moves to outsource.
URL https://www.flightglobal.com/news/articles/delta-moves-to-outsource-196925/ (Accessed at 2017-01-01)

Finne, M., & Holmström, J. (2013). A manufacturer moving upstream: triadic collaboration for service delivery. *Supply Chain Management: An International Journal*, *18*(1), 21–33.

Finne, M., Turunen, T., & Eloranta, V. (2015). Striving for network power: The perspective of solution integrators and suppliers. *Journal of Purchasing and Supply Management*, *21*(1), 9–24.

Fischer, T., Gebauer, H., Gregory, M., Ren, G., & Fleisch, E. (2010). Exploitation or exploration in service business development? *Journal of Service Management*, *21*(5), 591–624.

FlightAscend Consultancy (2016a). Commercial Market Update Webinar Q2 2016.

FlightAscend Consultancy (2016b). Commercial Market Update Webinar Q3 2016.

Flottau, J. (2018). Boeing to Take 80 % of Embraer Commercial JV.
URL http://aviationweek.com/farnborough-airshow-2018/boeing-take-80-embraer-commercial-jv (Accessed at 2018-07-17)

Flottau, J., Warwick, G., & Norris, G. (2017). Airbus / Bombardier C Series Deal Has Broad Implications.
URL http://aviationweek.com/commercial-aviation/airbusbombardier-c-series-deal-has-broad-implications (Accessed at 2017-10-30)

Foote, N., Galbraith, J., Hope, Q., & Miller, D. (2001). Making solutions the answer. *The McKinsey Quarterly*, (p. 84).

Forkmann, S., Henneberg, S. C., Witell, L., & Kindström, D. (2017a). Driver Configurations for Successful Service Infusion. *Journal of Service Research*, *20*(3), 275–291.

Forkmann, S., Ramos, C., Henneberg, S. C., & Naudé, P. (2017b). Understanding the service infusion process as a business model reconfiguration. *Industrial Marketing Management*, *60*, 151–166.

Foss, N. J., & Saebi, T. (2017). Fifteen Years of Research on Business Model Innovation: How Far Have We Come , and Where Should We Go ? *Journal of Management*, *43*(1), 200–227.

Fowler, J., & Reisenwitz, T. (2013). A Review of Interfirm Networks: A Deeper Understanding of the Relationships Paradigm. *Journal of Business Strategies*, *30*(1), 22–64.

Frank, C.-B., Sauerberg, B., & Gefäller, T. (2010). Civil Aviation 2025: A.T. Kearney's perspective on success factors for the Civil Aviation business of tomorrow.

Galbraith, J. R. (2002). Organizing to deliver solutions. *Organizational dynamics*, *31*(2), 194–207.

Gao, J., Yao, Y., Zhu, V. C. Y., Sun, L., & Lin, L. (2011). Service-oriented manufacturing: a new product pattern and manufacturing paradigm. *Journal of Intelligent Manufacturing*, *22*(3), 435–446.

Garg, A., & Deshmukh, S. G. (2006). Maintenance management: literature review and directions. *Journal of Quality in Maintenance Engineering*, *12*(3), 205–238.

Gassmann, O., Frankenberger, K., & Csik, M. (2013). *Geschäftsmodelle entwickeln: 55 innovative Konzepte mit dem St. Galler Business Model Navigator*. Carl Hanser Verlag GmbH Co KG.

Gebauer, H. (2008). Identifying service strategies in product manufacturing companies by exploring environment–strategy configurations. *Industrial Marketing Management*, *37*(3), 278–291.

Gebauer, H. (2011). Exploring the contribution of management innovation to the evolution of dynamic capabilities. *Industrial Marketing Management*, *40*(8), 1238–1250.

Gebauer, H., Edvardsson, B., & Bjurko, M. (2010a). The impact of service orientation in corporate culture on business performance in manufacturing companies. *Journal of Service Management*, *21*(2), 237–259.

Gebauer, H., Edvardsson, B., Gustafsson, A., & Witell, L. (2010b). Match or Mismatch: Strategy-Structure Configurations in the Service Business of Manufacturing Companies. *Journal of Service Research*, *13*(2).

Gebauer, H., Fleisch, E., & Friedli, T. (2005). Overcoming the Service Paradox in Manufacturing Companies. *European Management Journal*, *23*(1), 14–26.

Gebauer, H., & Friedli, T. (2005). Behavioral implications of the transition process from products to services. *Journal of Business & Industrial Marketing*, *20*(2), 70–78.

Gebauer, H., Gustafsson, A., & Witell, L. (2011). Competitive advantage through service differentiation by manufacturing companies. *Journal of Business Research*, *64*(12), 1270–1280.

Gebauer, H., Paiola, M., & Edvardsson, B. (2012). A capability perspective on service business development in small and medium-sized suppliers. *Scandinavian Journal of Management*, *28*(4), 321–339.

Gebauer, H., Paiola, M., & Saccani, N. (2013). Characterizing service networks for moving from products to solutions. *Industrial Marketing Management*, *42*(1), 31–46.

Gesing, J., Maiwald, K., Wieseke, J., & Sturm, R. (2014). Are IPS2 always a Solution? Obstacles towards Buying Industrial Product Service Systems. *Procedia CIRP*, *16*, 265–270.

Gillen, D., & Morrison, W. (2003). Bundling, integration and the delivered price of air travel: are low cost carriers full service competitors? *Journal of Air Transport Management*, *9*(1), 15–23.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2012). Seeking Qualitative Rigor in Inductive Research : Notes on the Gioia Methodology. *Organizational Research Methods*, (pp. 1–17).

Goh, B., & Hepher, T. (2017). Ready for take-off ? China's answer to Boeing now just needs to sell.
URL https://www.reuters.com/article/us-china-aviation-comac-analysis/ready-for-take-off-chinas-answer-to-boeing-now-just-needs-to-sell-idUSKBN17Q2F8
(Accessed at 2017-12-09)

Grant, R. M. (2010). *Contemporary Strategy Analysis*. Chichester: John Wiley & Sons Ltd, 7th ed.

Gremyr, I., Löfberg, N., & Witell, L. (2010). Service innovations in manufacturing firms. *Managing Service Quality: An International Journal*, *20*(2), 161–175.

Gresov, C. (1989). Exploring fit and misfit with multiple contingencies. *Administrative Science Quarterly*, *34*(3), 431–453.

Grönroos, C. (2000). *Service management and marketing - a customer relationship management approach*. Chichester: Wiley.

Grönroos, C. (2007). *Service management and marketing: customer management in service competition*. John Wiley & Sons.

Grönroos, C., & Ojasalo, K. (2004). Service productivity: Towards a conceptualization of the transformation of inputs into economic results in services. *Journal of Business Research*, *57*(4), 414–423.

Gubisch, M. (2011a). Gathering Legions. *Airline Business*, *27*(11), 38–42.

Gubisch, M. (2011b). MRO companies need to form partnership networks. URL https://www.flightglobal.com/news/articles/mro-companies-need-to-form-partnership-networks-363711/ (Accessed at 2016-02-16)

Gubisch, M. (2012). MAEL denies Goldcare conflict with LOT. URL https://www.flightglobal.com/news/articles/mael-denies-goldcare (Accessed at 2016-06-03)

Gubisch, M. (2013). Special Report: Maintenance 2013. *Airline Business*, *December*, n.p.

Gulati, R., & Gargiulo, M. (1999). Where do interorganizational networks come from? *American journal of sociology*, *104*(5), 1439–1493.

Gulati, R., & Singh, H. (1998). The architecture of cooperation: Managing coordination costs and appropriation concerns in strategic alliances. *Administrative science quarterly*, (pp. 781–814).

Günzel, F., & Holm, A. B. (2013). One size does not fit all—understanding the front-end and back-end of business model innovation. *International Journal of Innovation Management*, *17*(01), 1–34.

HAECO Group (2019). Interview with Lufthansa Technik AG. URL http://enews.haeco.com/node/2744 (Accessed at 2019-02-19)

Hakanen, T. (2014). Co-creating integrated solutions within business networks: The KAM team as knowledge integrator. *Industrial Marketing Management*, *43*(7), 1195–1203.

Hakanen, T., & Jaakkola, E. (2012). Co-creating customer-focused solutions within business networks: a service perspective. *Journal of Service Management*, *23*(4), 593–611.

Hambrick, D. C. (1983). High Profit Strategies in Mature Capital Goods Industries: A Contingency Approach. *The Academy of Management Journal*, *26*(4), 687–707.

Hamel, G., & Prahalad, C. K. (1990). The core competence of the corporation. *Harvard business review*, *68*(3), 79–91.

Hancock, M. Q., John, R. H., & Wojcik, P. J. (2005). Better B2B selling. *McKinsey Quarterly*, *38*(3), 15–21.

Hannan, M. T., & Freeman, J. (1989). *Organizational ecology*. Cambridge: Harvard University Press.

Harkonen, J., Haapasalo, H., & Hanninen, K. (2015). Productisation: A review and research agenda. *International Journal of Production Economics*, *164*, 65–82.

Harrison, M. P., Beatty, S. E., Reynolds, K. E., & Noble, S. M. (2012). Why Customers Feel Locked Into Relationships: Using Qualitative Research to Uncover The Lock-in Factors. *The Journal of Marketing Theory and Practice*, *20*(4), 391–406.

Haubensak, M., Wessmann, P., Lamb, D., Mickelson, S., & Graef, A. (2010). MRO on the move: Transformation towards integrated industrial MRO services in Europe. URL https://www.atkearney.de/documents/856314/1214912/EB{_}MRO{_}on{_}the{_}move.pdf/ (Accessed at 2017-11-07)

Hax, A., & Wilde II, D. (2001). The Delta Model—discovering new sources of profitability in a networked economy. *European Management Journal*, *19*(4), 379–391.

Heide, J. B., & John, G. (1988). The role of dependence balancing in safeguarding transaction-specific assets in conventional channels. *The Journal of Marketing*, *52*(1), 20–35.

Helander, A., & Möller, K. (2007). System supplier's customer strategy. *Industrial Marketing Management*, *36*(6), 719–730.

Helfat, C. E., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D. J., & Winter, S. G. (2007). *Dynamic capabilities: Understanding strategic change in organizations*. Oxford UK: Blackwell Publishing.

Helfat, C. E., & Lieberman, M. B. (2002). The birth of capabilities: market entry and the importance of pre-history. *Industrial and corporate change*, *11*(4), 725–760.

Helfat, C. E., & Peteraf, M. A. (2003). The dynamic resource-based view: Capability lifecycles. *Strategic management journal*, *24*(10), 997–1010.

Henningsen, A. (2010). Globalization for Growth in the Aviation Maintenance Repair and Overhaul Industry. In R. Ijioui, H. Emmerich, M. Ceyp, & J. Hagen (Eds.) *Globalization 2.0*, (pp. 37–56). Heidelberg u.a.: Springer.

Herbert, K., & Morales, J. (2016). Boeing and the services market: understanding CAS and the financial impact. Tech. Rep. August, Canaccord Genuity.

Hertz, S., & Alfredsson, M. (2003). Strategic development of third party logistics providers. *Industrial marketing management*, *32*(2), 139–149.

Herzog, T. (2010). *Strategisches Management von Koopetition. Eine empirisch begründete Theorie im industriellen Kontext der zivilen Luftfahrt*. Ph.D. thesis, Wirtschaftsuniversität Wien.

Hillman, A., Withers, M., & Collins, B. (2009). Resource dependence theory: A review. *Journal of management*, *35*(6), 1404–1427.

Hinsch, M. (2012). *Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe*. Heidelberg: Springer Vieweg, 2nd ed.

Hobday, M., Davies, A., & Prencipe, A. (2005). Systems integration: a core capability of the modern corporation. *Industrial and Corporate Change*, *14*(6), 1109–1143.

Holland, J., & Davies, H. (2014). The MRO Yearbook. *The MRO Yearbook*.

Hollinger, P., Powley, T., & Oliver, C. (2015). EU launches aircraft maintenance probe. URL http://www.ft.com/cms/s/0/9b7a7434-6e9b-11e5-aca9-d87542bf8673.html (Accessed at 2016-02-16)

Honeywell (2017). Services. URL https://www.honeywell.com/industries/aerospace-and-defense/services (Accessed at 2017-12-21)

Horng, T.-C. (2007). *A comparative analysis of supply chain management practices by Boeing and Airbus : long-term strategic implications*. Ph.D. thesis, Massachusetts Institute of Technology.

Horwitz, D. (2019). Adapt to Survive. *Engine Yearbook*, (pp. 15–19).

Hoyland, T., Spafford, C., & Medland, A. (2016). MRO big data — a lion or a lamb?

Hsu, C.-C., & Liou, J. J. H. (2013). An outsourcing provider decision model for the airline industry. *Journal of Air Transport Management*, *28*, 40–46.

Humphreys, P., Lo, V., & McIvor, R. (2000). A decision support framework for strategic purchasing. *Journal of Materials Processing Technology*, *107*, 353–362.

Hunt, S. D., & Morgan, R. M. (1995). The comparative advantage theory of competition. *The Journal of Marketing*, *59*(2), 1–15.

Hygate, D. (2013a). Regional propulsion maintenance capabilities & impact of new engines. In *MRO Eastern Europe, Baltics and Russia 2013 Conference*. Team SAI.

Hygate, D. (2013b). The Engine MRO Market. In *Aero-Engines Europe*, October. Team SAI.

Hypko, P., Tilebein, M., & Gleich, R. (2010). Benefits and uncertainties of performance-based contracting in manufacturing industries. *Journal of Service Management*, *21*(4), 460–489.

IATA (2012). Keeping Airline Options open. URL http://airlines.iata.org/analysis/keeping-airline-options-open (Accessed at 2015-06-16)

IATA (2015). IATA Guidance Material and Best Practices for PMA Parts and DER Repairs.
URL https://www.iata.org/whatwedo/workgroups/Documents/MCTF/PMA-DER-2nd-Edition.pdf (Accessed at 2017-07-06)

IATA (2017a). Economic performance of the airline industry.
URL http://www.iata.org/whatwedo/Documents/economics/IATA-Economic-Performance-of-the-Industry-mid-year-2017-report.pdf (Accessed at 2017-12-05)

IATA (2017b). FACT SHEET: Industry Statistics.
URL http://www.iata.org/pressroom/facts{_}figures/fact{_}sheets/Documents/fact-sheet-industry-facts.pdf (Accessed at 2017-12-05)

Informa USA (2018). MRO Europe Agenda.
URL https://mroeurope.aviationweek.com/en/conference/agenda.html (Accessed at 11.9.2018)

International Aero Engines (2017). Fleet Hour Agreements.
URL http://www.i-a-e.com/fleethour.html (Accessed at 2017-12-29)

Isaksson, O., Larsson, T. C., & Rönnbäck, A. Ö. (2009). Development of product-service systems: challenges and opportunities for the manufacturing firm. *Journal of Engineering Design*, *20*(4), 329–348.

Jaakkola, E. (2011). Unraveling the practices of "productization" in professional service firms. *Scandinavian Journal of Management*, *27*(2), 221–230.

Jaakkola, E., & Hakanen, T. (2013). Value co-creation in solution networks. *Industrial Marketing Management*, *42*(1), 47–58.

Jarillo, J. C. (1988). On Strategic Networks. *Strategic Management Journal*, *9*(1), 31–41.

Jenner, G. (2009). Airlines Deepen Ties with Outsourcing Partners.
URL https://www.flightglobal.com/news/articles/airlines-deepen-ties-with-outsourcing-partners-325543/ (Accessed at 2018-01-20)

Johnson, M. W., Christensen, C. M., & Kagermann, H. (2008). Reinventing Your Business Model. *Strategy*, *86*(12), 58–67.

Johnstone, S., Dainty, A., & Wilkinson, A. (2008). In search of 'product-service': evidence from aerospace, construction, and engineering. *Service Industries Journal*, *28*(6), 861–875.

Johnstone, S., Dainty, A., & Wilkinson, A. (2009). Integrating products and services through life: an aerospace experience. *International Journal of Operations & Production Management*, *29*(5), 520–538.

Kaelen, J., Santema, S. C., & de Boer, R. J. (2014). A Model To Improve Aircraft Availability in the MRO & U Triad.

Kale, P., Dyer, J., & Singh, H. (2002). Alliance capability, stock market response, and long-term alliance success: the role of the alliance function. *Strategic Management Journal*, *23*, 747–767.

Kamp, B., Ochoa, A., & Diaz, J. (2017). Smart servitization within the context of industrial user–supplier relationships: contingencies according to a machine tool manufacturer. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *11*(3), 651–663.

Kamp, B., & Parry, G. (2017). Servitization and advanced business services as levers for competitiveness. *Industrial Marketing Management*, *60*(Supplement C), 11–16.

Kano, N. (1984). Attractive quality and must-be quality. *J. Jpn. Soc. Quality Control*, *14*, 39–48.

Kashyap, A. (2012). Supply chain optimization within aviation MRO. *International Journal of Computer Applications in Engineering Sciences*, *2*(2), 95–101.

Kastalli, I. V., Van Looy, B., & Looy, B. V. (2013). Servitization: Disentangling the impact of service business model innovation on manufacturing firm performance. *Journal of Operations Management*, *31*(4), 169–180.

Keller, J. (2012). ST Technics to undertake line maintenance for easyJet eet of Airbus A320 passenger jets in Ireland, Scotland, and England.
URL http://www.intelligent-aerospace.com/articles/2012/06/st-technics-mro-for-easyjet.html (Accessed at 2017-04-18)

Kindström, D. (2010). Towards a service-based business model - Key aspects for future competitive advantage. *European Management Journal*, *28*(6), 479–490.

Kindström, D., & Kowalkowski, C. (2009). Development of industrial service offerings: a process framework. *Journal of Service Management*, *20*(2), 156–172.

Kindström, D., & Kowalkowski, C. (2014). Service innovation in product-centric firms: A multidimensional business model perspective. *Journal of Business & Industrial Marketing*, *29*(2), 151–163.

Kindström, D., Kowalkowski, C., & Alejandro, T. B. (2015). Adding services to product-based portfolios. *Journal of Service Management*, *26*(3), 372–393.

Kindström, D., Kowalkowski, C., & Sandberg, E. (2013). Enabling service innovation: a dynamic capabilities approach. *Journal of business research*, *66*(8), 1063–1073.

Kinnison, H., & Siddiqui, T. (2004). *Aviation maintenance management*. New York: McGraw-Hill, 2nd ed. ed.

Kjelgaard, C. (2017a). Pratt & Whitney looks for more PW1000G MRO partners.

Kjelgaard, C. (2017b). Thales Adds Another MRO Score for Singapore. URL http://www.mro-network.com/maintenance-repair-overhaul/thales-adds-another-mro-score-singapore (Accessed at 2017-07-02)

Klaas, T., & Delfmann, W. (2005). Notes on the Study of Configurations in Logistics and Supply Chain Design. In R. Koster, & W. Delfmann (Eds.) *Supply Chain Management - European Perspectives*, chap. 2, (pp. 2–36). Koge, Denmark: Copenhagen Business School Press.

Klooß, K. (2013). Flugzeugbauer wollen Werkstätten der Lüfte werden. URL http://www.manager-magazin.de/unternehmen/industrie/mro-geschaefte-von-airbus-und-boeing-und-luftfahrtmesse-in-le-bourget-a-905779.html (Accessed at 2016-02-16)

Knotts, R. M. H. (1999). Civil aircraft maintenance and support Fault diagnosis from a business perspective. *Journal of quality in maintenance engineering*, *5*(4), 335–348.

Koenen, J. (2017). Lufthansa: Kleiner Cashflow, große Pläne. *Handelsblatt*, (86), 18–21.

Kohtamäki, M., & Helo, P. (2015). Industrial services – the solution provider's stairway to heaven or highway to hell? *Benchmarking: An International Journal*, *22*(2), 170–185.

Kohtamäki, M., Partanen, J., Parida, V., & Wincent, J. (2013). Non-linear relationship between industrial service offering and sales growth: The moderating role of network capabilities. *Industrial Marketing Management*, *42*(8), 1374–1385.

Kowalkowski, C., Gebauer, H., Kamp, B., & Parry, G. (2017). Servitization and deservitization: Overview, concepts, and definitions. *Industrial Marketing Management*, *60*, 4–10.

Kowalkowski, C., Kindström, D., Alejandro, T. B., Brege, S., & Biggemann, S. (2012). Service infusion as agile incrementalism in action. *Journal of Business Research*, *65*(6), 765–772.

Kowalkowski, C., Kindström, D., & Brehmer, P.-O. (2011a). Managing industrial service offerings in global business markets. *Journal of Business & Industrial Marketing*, *26*(3), 181–192.

Kowalkowski, C., Kindström, D., & Witell, L. (2011b). Internalisation or externalisation? Examining organisational arrangements for industrial services. *Managing Service Quality: An International Journal*, *21*(4), 373–391.

Kowalkowski, C., Windahl, C., Kindström, D., & Gebauer, H. (2015). What service transition? Rethinking established assumptions about manufacturers' service-led growth strategies. *Industrial Marketing Management*, *45*(1), 59–69.

Kowalkowski, C., Witell, L., & Gustafsson, A. (2013). Any way goes: Identifying value constellations for service infusion in SMEs. *Industrial Marketing Management*, *42*(1), 18–30.

Kranz, B. (2011). Lufthansa Technik schließt Flugzeuglackierung. *Hamburger Abendblatt*, (16.11.2011).

Krishnan, B. C., & Hartline, M. D. (2001). Brand equity: is it more important in services? *Journal of services marketing*, *15*(5), 328–342.

Krol, S. (2011). Geteiltes Leid – Strukturwandel der Luftfahrtbranche. Zu den Gründen, Risiken und Chancen der neuen Dimension der abflachenden Fertigungstiefe bei den Flugzeugherstellern.
URL https://www.altran.de/fileadmin/medias/DE.alt-ran.de/documents/Pressemeldungen/Pressemeldungen{_}2011/20101510{_}lieferantenmanagement.pdf (Accessed at 2014-06-20)

Kuijken, B., Gemser, G., & Wijnberg, N. M. (2017). Effective product-service systems: A value-based framework. *Industrial Marketing Management*, *60*, 33–41.

Lavie, D. (2006). The competitive advantage of interconnected firms: An extension of the resource-based view. *Academy of management review*, *31*(3), 638–658.

Lazonick, W., & Prencipe, A. (2002). Corporate Governance, Innovation, and Competitive Performance in the Commercial Turbofan Industry: The Case of Rolls-Royce.

Lele, M. M. (1997). After-sales service – necessary evil or strategic opportunity? *Managing Service Quality: An International Journal*, *7*(3), 141–145.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development. *Strategic management journal*, *13*(S1), 111–125.

Lightfoot, H., Baines, T., & Smart, P. (2013). The servitization of manufacturing: A systematic literature review of interdependent trends. *International Journal of Operations and Production Management*, *33*(11), 1408–1434.

Lockett, H., Johnson, M., Evans, S., & Bastl, M. (2011). Product Service Systems and supply network relationships: an exploratory case study. *Journal of Manufacturing Technology Management*, *22*(3), 293–313.

Ludwig, G., & Pemberton, J. (2011). A managerial perspective of dynamic capabilities in emerging markets: the case of the Russian steel industry. *Journal for East European Management Studies*, *03*, 215–236.

Lufthansa Group (2013). Shaping the future together -Expert Session on LH Passenger Airlines and the new germanwings.
URL http://investor-relations.lufthansagroup.com/fileadmin/downloads/en/charts-speeches/LH-SCORE-Expert-Session-2013-10.pdf

Lufthansa Technik AG (2017). Products & Services.
URL https://www.lufthansa-technik.com/services (Accessed at 2017-08-23)

Lufthansa Technik AG (2018). Annual Report 2017.
URL https://www.lufthansa-technik.com/documents/100446/101423/LHT+Annual+Report+2017.pdf/53bf2682-8073-4512-8011-52157f0e842a (Accessed at 2019-03-02)

Lusch, R., & Webster, F. (2010). Marketing's Responsibility for the Value of the Enterprise. *Marketing Science Institute working paper series*, *10*(111), 1–48.

Lusch, R. F., Vargo, S. L., & Tanniru, M. (2010). Service, value networks and learning. *Journal of the Academy of Marketing Science*, *38*(1), 19–31.

Lynn, M. (1998). *Birds of prey: Boeing vs. Airbus: A Battle for the Skies*. New York: Four Walls Eight Windows, 2nd ed.

MacPherson, A., & Pritchard, D. (2007). Boeing's diffusion of commercial aircraft technology to Japan: surrendering the US industry for foreign financial support. *Journal of Labor Research*, *28*(3), 552–566.

Magretta, J. (2002). Why business models matter. *Harvard Business Review*, *80*(5), 86–87.

Malerba, F. (1992). Learning by firms and incremental technical change. *The economic journal*, *102*(413), 845–859.

Malleret, V. (2006). Value creation through service offers. *European Management Journal*, *24*(1), 106–116.

Manzini, E., & Vezzoli, C. (2003). A strategic design approach to develop sustainable product service systems: examples taken from the 'environmentally friendly innovation' Italian prize. *Journal of Cleaner Production*, *11*(8), 851–857.

Marceau, J., Cook, N., Dalton, B., & Wixted, B. (2002). Selling solutions: Emerging patterns of product-service linkage in the Australian economy. Tech. rep., University of Wollongong.

Markeset, T., & Kumar, U. (2005). Product support strategy: conventional versus functional products. *Journal of Quality in Maintenance Engineering*, *11*(1), 53–67.

Martín-Peña, M. L., & Ziaee Bigdeli, A. (2016). Servitization: academic research and business practice. *Universia Business Review*, (49), 18–31.

Mathieu, V. (2001a). Product services: from a service supporting the product to a service supporting the client. *Journal of Business & Industrial Marketing*, *16*(1), 39–61.

Mathieu, V. (2001b). Service strategies within the manufacturing sector: benefits, costs and partnership. *International Journal of Service Industry Management*, *12*(5), 451–475.

Matthyssens, P., & Vandenbempt, K. (2008). Moving from basic offerings to value-added solutions: Strategies, barriers and alignment. *Industrial Marketing Management*, *37*(3), 316–328.

Matthyssens, P., & Vandenbempt, K. (2010). Service addition as business market strategy: identification of transition trajectories. *Journal of Service Management*, *21*(5), 693–714.

Matthyssens, P., Vandenbempt, K., & Berghman, L. (2006). Value innovation in business markets: Breaking the industry recipe. *Industrial Marketing Management*, *35*(6), 751–761.

Matthyssens, P., Vandenbempt, K., & Weyns, S. (2009). Transitioning and co-evolving to upgrade value offerings: A competence-based marketing view. *Industrial Marketing Management*, *38*(5), 504–512.

Matzen, D. (2009). *A systematic approach to service oriented product development*. Doctoral thesis, Technical University of Denmark.

Matzler, K., Hinterhuber, H. H., Bailom, F., & Sauerwein, E. (1996). How to delight your customers. *Journal of Product & Brand Management*, *5*(2), 6–18.

McCutcheon, D. M., & Meredith, J. (1993). Conducting case study research in operations management. *Journal of Operations Management*, *11*(3), 239–256.

McFadden, M., & Worrells, D. S. (2012). Global outsourcing of aircraft maintenance. *Journal of Aviation Technology and Engineering*, *1*(2), 4.

McGahan, A. M., & Porter, M. E. (1997). How much does industry matter, really? *Strategic Management Journal*, *18*, 15–30.

Meier, H., Lagemann, H., Morlock, F., & Rathmann, C. (2013). Key performance indicators for assessing the planning and delivery of industrial services. *Procedia Cirp*, *11*, 99–104.

Meier, H., & Massberg, W. (2004). Life Cycle-Based Service Design for Innovative Business Models. *CIRP Annals - Manufacturing Technology*, *53*(1), 393–396.

Meier, H., Roy, R., & Seliger, G. (2010). Industrial Product-Service Systems—IPS2. *CIRP Annals - Manufacturing Technology*, *59*(2), 607–627.

Meyer, A. D., Tsui, A. S., & Hinings, C. R. (1993). Configurational approaches to organizational analysis. *Academy of Management journal*, *36*(6), 1175–1195.

Michaels, K. (2013). OEMs Increase Production, Squeeze Suppliers.
URL http://aviationweek.com/awin/oems-increase-production-squeeze-suppliers (Accessed at 2017-12-21)

Michaels, K. (2017a). Beware, OEM -supplier Relations Are Changing.
URL http://aviationweek.com/commercial-aviation/beware-oem-supplier-relations-are-changing (Accessed at 2017-05-24)

Michaels, K. (2017b). Europe's Super Supplier: Reasons To Cheer The Safran-Zodiac Deal.
URL https://www.linkedin.com/pulse/europes-super-supplier-reasons-cheer-safran-zodiac-deal-michaels/ (Accessed at 2017-12-21)

Michaels, K. (2017c). Opinion: How Airbus C Series Deal Will Change Aerospace.
URL http://aviationweek.com/commercial-aviation/opinion-how-airbus-c-series-deal-will-change-aerospace (Accessed at 2017-10-27)

Michaels, K. (2017d). Post-Tier 1: The next era in aerospace supply chain evolution?
URL https://www.linkedin.com/pulse/post-tier-1-next-era-supply-chain-evolution-kevin-michaels/ (Accessed at 2017-12-21)

Michaels, K. (2017e). Why The Rockwell Collins - B/E Aerospace Merger Could Work.
URL https://www.linkedin.com/pulse/why-rockwell-collins-be-aerospace-merger-could-work-kevin-michaels/ (Accessed at 2017-12-21)

Miles, M. B., & Huberman, A. M. (1984). *Qualitative data analysis: A sourcebook of new methods*. Newbury Park, London, New Delhi: Sage Publications.

Miller, D. (1986). Configurations of strategy and structure: Towards a synthesis. *Strategic management journal*, *7*(3), 233–249.

Miller, D., & Friesen, P. H. (1984). *Organizations: A quantum view*. Englewood Cliffs: Prentice Hall.

Miller, D., Hope, Q., Eisenstat, R., Foote, N., & Galbraith, J. (2002). The problem of solutions: balancing clients and capabilities. *Business Horizons*, *45*(2), 3–12.

Mintzberg, H. (1979). *The structuring of organizations*. Upper Saddle River: Prentice Hall.

Möller, K. E. K., & Törrönen, P. (2003). Business suppliers' value creation potential: A capability-based analysis. *Industrial Marketing Management*, *32*(2), 109–118.

Mont, O. (2002). Clarifying the concept of product–service system. *Journal of Cleaner Production*, *10*(3), 237–245.

Morgan, N. A. (2012). Marketing and business performance. *Journal of the Academy of Marketing Science*, *40*(1), 102–119.

Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model: Toward a unified perspective. *Journal of Business Research*, *58*(6), 726–735.

Mountney, S., Asthana, A., Mohammed, K., & Almond, M. (2016). A preliminary investigation of the reserve service continuum. *Universia Business Review*, *1*(49), 116–131.

Müller, P., & Sakao, T. (2010). Toward Consolidation on Product-Service-Systems Design. In *CIRP IPS2 Conference 2010*, (pp. 1–8).

Nair, S., Paulose, H., Palacios, M., & Tafur, J. (2013). Service orientation: effectuating business model innovation. *The Service Industries Journal*, *33*(9-10), 958–975.

Nalebuff, B. (2004). Bundling as an Entry Barrier. *The Quarterly Journal of Economics*, *119*(1), 159–187.

Namukasa, J. (2013). The influence of airline service quality on passenger satisfaction and loyalty: The case of Uganda airline industry. *The TQM Journal*, *25*(5), 520–532.

Narasimhan, R., Nair, A., Griffith, D. A., Arlbjørn, J. S., & Bendoly, E. (2009). Lock-in situations in supply chains: A social exchange theoretic study of sourcing arrangements in buyer–supplier relationships. *Journal of Operations Management*, *27*(5), 374–389.

Neely, A. (2008). Exploring the Financial Consequences of the Servitization of Manufacturing. *Operations Management Research*, *1*(2), 103–118.

Neely, A., Benedettini, O., & Visnjic, I. (2011). The servitization of manufacturing: Further evidence. In *18th European Operations Management Association Conference*.

Nenonen, S., Ahvenniemi, O., & Martinsuo, M. (2014). Image risks of servitization in collaborative service deliveries. *Service Industries Journal*, *34*(16), 1307–1329.

Ng, I., Ding, D. X., & Yip, N. (2013). Outcome-based contracts as new business model: The role of partnership and value-driven relational assets. *Industrial Marketing Management*, *42*(5), 730–743.

Ng, I., Maull, R., & Yip, N. (2009). Outcome-based contracts as a driver for systems thinking and service-dominant logic in service science: Evidence from the defence industry. *European Management Journal*, *27*(6), 377–387.

Ng, I., Parry, G., Smith, L., Maull, R., & Briscoe, G. (2012). Transitioning from a goods-dominant to a service-dominant logic: Visualising the value proposition of Rolls-Royce. *Journal of Service Management*, *23*(3), 416–439.

Niehues, A., Berlin, S., Hansson, T., Hauser, R., Mostajo, M., & Richter, J. (2001). Punctuality: How Airlines Can Improve On-Time Performance.
URL http://www.boozallen.com/media/file/aero{_}punctuality.pdf (Accessed at 2016-06-13)

Nijssen, E. J., Hillebrand, B., Vermeulen, P. A. M., & Kemp, R. G. M. (2006). Exploring product and service innovation similarities and differences. *International Journal of Research in Marketing*, *23*(3), 241–251.

Niosi, J., & Zhegu, M. (2005). Aerospace clusters: local or global knowledge spillovers? *Industry & Innovation*, *12*(1), 5–29.

N.N. (2009). Lufthansa Technik Brussels Provides Line Maintenance for Ryanair Lufthansa Technik Brussels Provides Line Maintenance for Ryanair.

URL http://www.aviationpros.com/press{_}release/10397957/lufthansa-technik-brussels-provides-line-maintenance-for-ryanair (Accessed at 2017-04-18)

N.N. (2012). Boeing Expands GoldCare to 747s.
URL http://aviationweek.com/awin/boeing-expands-goldcare-747s (Accessed at 2015-04-30)

N.N. (2014a). Airbus unter Druck: Emirates fordert sparsameren A380.
URL http://www.airliners.de/airbus-druck-emirates-a380-spirtsparen/34138 (Accessed at 2014-11-17)

N.N. (2014b). Engine MROs Gearing Up For New Models.
URL http://www.mro-network.com/maintenance-repair-overhaul/engine-mros-gearing-new-models (Accessed at 2017-06-29)

Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. Oxford university press.

Nordin, F., & Kowalkowski, C. (2010). Solutions offerings: a critical review and reconceptualisation. *Journal of Service Management*, *21*(4), 441–459.

O'Halloran, B. (2017). Ryanair to offer connecting flights via Porto from January.
URL https://www.irishtimes.com/business/transport-and-tourism/ryanair-to-offer-connecting-flights-via-porto-from-january-1.3282933 (Accessed at 2017-12-22)

Oinonen, M., & Jalkala, A. (2013). What Actually Constitutes A Solution? –Scrutinizing The Concept Of Solution Through A Systematic Literature Review. In *Proceedings of the 29th IMP conference, Atlanta, Georgia*.

Oliva, R., & Kallenberg, R. (2003). Managing the transition from products to services. *International Journal of Service Industry Management*, *14*(2), 160–172.

Olsson, R., Gadde, L.-E., & Hulthén, K. (2013). The changing role of middlemen—Strategic responses to distribution dynamics. *Industrial Marketing Management*, *42*(7), 1131–1140.

O'Reilly 3rd, C. A., & Tushman, M. L. (2004). The ambidextrous organization. *Harvard business review*, *82*(4), 74.

Osterwalder, A. (2004). *The Business Model Ontology - A Proposition in a Design Science Approach*. Ph.D. thesis, L'Université de Lausanne.

Osterwalder, A., & Pigneur, Y. (2013). *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons.

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the association for Information Systems*, *16*, 1–25.

O'Toole, K. (1996). Fokker bankrupt.
URL https://www.flightglobal.com/news/articles/fokker-bankrupt-17617/ (Accessed at 2016-02-08)

Paiola, M., Saccani, N., Perona, M., & Gebauer, H. (2013). Moving from products to solutions: Strategic approaches for developing capabilities. *European Management Journal*, *31*(4), 390–409.

Parida, V., Sjödin, D. R., Wincent, J., & Kohtamäki, M. (2014a). A survey study of the transitioning towards high-value industrial product-services. *Procedia CIRP*, *16*, 176–180.

Parida, V., Sjödin, D. R., Wincent, J., & Kohtamäki, M. (2014b). Mastering the transition to product-service provision: Insights into business models, Learning activities, and capabilities. *Research Technology Management*, *57*(3).

Park, Y., & Lee, H. (2009). Towards Integration of Products and Services: Literature Review and Phraseology. In *Management and Service Science*, (pp. 1–4).

Pawar, K. S., Beltagui, A., & Riedel, J. C. K. H. (2009). The PSO triangle: designing product, service and organisation to create value. *International Journal of Operations & Production Management*, *29*(5), 468–493.

Pearce, B. (2013). Profitability and the air transport value chain.
URL https://www.iata.org/whatwedo/Documents/economics/profitability-and-the-air-transport-valuechain.pdf (Accessed at 2014-07-01)

Penttinen, E., & Palmer, J. (2007). Improving firm positioning through enhanced offerings and buyer–seller relationships. *Industrial Marketing Management*, *36*(5), 552–564.

Perret, B. (2015a). Comac Rolls Out C919.
URL http://aviationweek.com/C919Rollout{#}slide-0-field{_}images-1372431 (Accessed at 2016-02-08)

Perret, B. (2015b). Mitsubishi Aircraft Flies The MRJ.
URL http://aviationweek.com/MRJFirstFlight{#}slide-0-field{_}images-1375421 (Accessed at 2016-02-08)

Perrett, B. (2017). Source: COMAC C919 targets first delivery for 2020.
URL http://atwonline.com/manufacturers/source-comac-c919-targets-first-delivery-202 (Accessed at 2017-12-08)

Peteraf, M. A. (1993). The cornerstones of competitive advantage: a resource-based view. *Strategic management journal*, *14*(3), 179–191.

Peterson, K. (2011). A Wing and a Prayer: Outsourcing at Boeing.
URL http://www.reuters.com/article/2011/01/20/us-boeing-dreamliner-idUSTRE70J2UX20110120 (Accessed at 2015-06-26)

Pfeffer, J., & Salancik, G. (1978). *The external control of organizations: A resource dependence perspective*. New York: Harper & Row.

Pfeifer, S., & Kerr, S. (2019). Airbus to end A380 line after Emirates slashes order. URL https://www.ft.com/content/bee5699c-3017-11e9-8744-e7016697f225

Pompl, W. (2007). *Luftverkehr: Eine ökonomische und politische Einführung*. Berlin, Heidelberg: Springer, 5. ed.

Porter, M. E. (1979). How Competitive Forces Shape Strategy. *Harvard Business Review*, *March-Apri*, 137–145.

Porter, M. E. (1985a). *Competitive advantage: creating and sustaining superior performance*. New York: Free Press.

Porter, M. E. (1985b). Technology and Competitive Advantage. *Journal of Business Strategy*, *5*(3), 60–78.

Porter, M. E. (1996). What is Strategy? *Harvard business review*, (November-December), 1–20.

Porter, M. E. (1998). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: The free press.

Porter, M. E. (2001). Strategy and the Internet. *Harvard Business Review*, *79*(3), 62–78, 164.

Potter, A., Al-kaabi, H., & Naim, M. (2015). Aircraft maintenance, repair and overhaul. In S. Eriksson, & H.-J. Stenhuis (Eds.) *The Global Commercial Aviation Industry*, vol. 8, (pp. 170–189). Routledge.

Pozzi, J. (2015). Ryanair COO discusses its MRO plans. URL http://www.mro-network.com/operations/ryanair-coo-discusses-its-mro-plans (Accessed at 2017-12-26)

Pozzi, J. (2016). Firms look to develop capabilities in competitive aftermarket. In *AP&M Europe*.

Pozzi, J. (2017a). FL Technics Lands CAMO Support Contract With Russian Airline. URL http://www.mro-network.com/maintenance-repair-overhaul/fl-technics-lands-camo-support-contract-russian-airline (Accessed at 2016-05-25)

Pozzi, J. (2017b). GE , SIAEC Announce Engine Repair JV At Paris. URL http://www.mro-network.com/maintenance-repair-overhaul/ge-siaec-announce-engine-repair-jv-paris (Accessed at 2017-06-21)

Pozzi, J. (2017c). Magnetic MRO Joins Boeing GoldCare Network. URL http://www.mro-network.com/maintenance-repair-overhaul/magnetic-mro-joins-boeing-goldcare-network (Accessed at 2017-06-01)

Pratt, M. G. (2009). For the lack of a boilerplate: tips on writing up (and reviewing) qualitative research. *Academy of Management Journal*, *52*(5), 856–862.

Preiss, H. (2012). Freie oder Vertragswerkstatt?
URL http://www.n-tv.de/auto/Freie-oder-Vertragswerkstatt-article5959591.html (Accessed at 2016-03-11)

Preuß, O. (2017). Lufthansa Technik macht Flugzeugwartung dicht.
URL https://www.welt.de/regionales/hamburg/article163089216/Lufthansa-Technik-macht-Flugzeugwartung-dicht.html (Accessed at 2017-07-06)

Pritchard, D. J. (2002). *The global decentralization of commercial aircraft production: Implications for United States-based manufacturing activity*. Ph.D. thesis, State University of New York at Buffalo.

Quinn, J. B., Doorley, T. L., & Paquette, P. C. (1989). Beyond products: services-based strategy. *Harvard Business Review*, *68*(2), 58–60.

Rabetino, R., Kohtamäki, M., Lehtonen, H., & Kostama, H. (2015). Developing the concept of life-cycle service offering. *Industrial Marketing Management*, *49*, 53–66.

Raddats, C., & Easingwood, C. (2010). Services growth options for B2B product-centric businesses. *Industrial Marketing Management*, *39*(8), 1334–1345.

Raddats, C., Kowalkowski, C., Benedettini, O., Burton, J., & Gebauer, H. (2019). Servitization: A contemporary thematic review of four major research streams. *Industrial Marketing Management*.

Ramirez, R. (1999). Value co-production: intellectual origins and implications for practice and research. *Strategic Management Journal*, (pp. 49–65).

Raynor, M. E. (2007). Strategic options: a new tool for managing in turbulent environments. *Business Strategy Series*, *9*(1), 21–29.

Reim, W., Parida, V., & Örtqvist, D. (2015). Product–Service Systems (PSS) business models and tactics – a systematic literature review. *Journal of Cleaner Production*, *97*(2015), 61–75.

Rentmeister, J., & Klein, S. (2003). Geschäftsmodelle—ein Modebegriff auf der Waagschale. In *Die Zukunft des Electronic Business*, (pp. 17–30). Springer.

Rexroth, A. (2018). Mitsubishi Progresses on MRJ Testing.
URL https://www.ainonline.com/aviation-news/air-transport/2018-07-16/mitsubishi-progresses-mrj-testing (Accessed at 2018-07-31)

Rieple, A., & Helm, C. (2008). Outsourcing for competitive advantage: An examination of seven legacy airlines. *Journal of Air Transport Management*, *14*(5), 280–285.

Rockwell Collins (2013). Intertrade adds engines to its surplus aircraft parts offerings. URL https://www.rockwellcollins.com/Data/News/2013{_}Cal{_}Yr/Feature{_}Stories/Intertrade-adds-engines.aspx (Accessed at 2017-07-06)

Rojo, F. R., & Roy, R. (2009). Obsolescence challenges for product-service systems in aerospace and defence industry. In *Proceedings of the 1st CIRP Industrial Product-Service Systems (IPS2) Conference*.

Rojo, F. R., Roy, R., & Shehab, E. (2010). Obsolescence management for long-life contracts: state of the art and future trends. *The International Journal of Advanced Manufacturing Technology*, *49*(9-12), 1235–1250.

Rolls-Royce (2017). Aftermarket Services.
URL https://www.rolls-royce.com/products-and-services/civil-aerospace.aspx (Accessed at 2017-04-28)

Rose-Anderssen, C., Ridgway, K., Baldwin, J., Allen, P., Varga, L., & Strathern, M. (2015). The evolution of commercial aerospace supply chains and the facilitation of innovation. *International Journal of Electronic Customer Relationship Management*.

Ross, J. W., Weill, P., & Robertson, D. (2006). *Enterprise architecture as strategy: Creating a foundation for business execution*. Harvard Business Press.

Rossetti, C. L., & Choi, T. Y. (2008). Supply Management Under High Goal Incongruence: An Empirical Examination of Disintermediation in the Aerospace Supply Chain. *Decision Sciences*, *39*(3), 507–540.

Rumelt, R. P. (1991). How much does industry matter? *Strategic Management Journal*, *12*, 167–185.

Sahay, A. (2012). *Leveraging information technology for optimal aircraft maintenance, repair and overhaul (MRO)*. Philadelphia: Woodhead Publishing.

Sakao, T., Sandström, G. Ö., & Matzen, D. (2009). Framing research for service orientation of manufacturers through PSS approaches. *Journal of Manufacturing Technology Management*, *20*(5), 754–778.

Salonen, A. (2011). Service transition strategies of industrial manufacturers. *Industrial Marketing Management*, *40*(5), 683–690.

Salonen, A., & Jaakkola, E. (2015). Firm boundary decisions in solution business: Examining internal vs. external resource integration. *Industrial Marketing Management*, *51*(2015), 171–183.

Santamaría, L., Nieto, M. J., & Miles, I. (2012). Service innovation in manufacturing firms: Evidence from Spain. *Technovation*, *32*(2), 144–155.

Santos, F. M., & Eisenhardt, K. (2005). Organizational boundaries and theories of organization. *Organization science*, *16*(5), 491–508.

Sato, C. E. Y., & de Freitas Chagas Jr, M. (2014). When do megaprojects start and finish? Redefining project lead time for megaproject success. *International Journal of Managing Projects in Business*, *7*(4), 624–637.

Sawhney, M., Balasubramanian, S., & Krishnan, V. V. (2004). Creating Growth with Services. *MIT Sloan Management Review. Winter2004*, *45*(2), 34–44.

Saxon, S., & Weber, M. (2017). A better approach to airline costs. URL https://www.mckinsey.com/industries/travel-transport-and-logistics/our-insights/a-better-approach-to-airline-costs (Accessed at 2018-10-07)

Schallmo, D. (2013). *Geschäftsmodell-Innovation: Grundlagen, bestehende Ansätze, methodisches Vorgehen und B2B-Geschäftsmodelle*. Wiesbaden: Springer-Verlag.

Scherm, E., & Borowicz, F. (2001). Standardisierungsstrategien: eine erweiterte Betrachtung des Wettbewerbs auf Netzeffektm{ä}rkten. *Zeitschrift f{ü}r betriebswirtschaftliche Forschungür betriebswirtschaftliche Forschung*, *53*(6), 391–416.

Scheuffelen, S. C. (2017). *Evaluating Different Types of Segmentation Bases Towards Their Link to Consumer Behavior in E-commerce*. Ph.D. thesis, Rheinisch-Westfälische Technische Hochschule Aachen.

Schilke, O. (2014). On the contingent value of dynamic capabilities for competitive advantage: The nonlinear moderating effect of environmental dynamism. *Strategic Management Journal*, *35*(2), 179–203.

Schmalensee, R. (1989). *Inter-industry studies of structure and performance*. Amsterdam: Elsevier, 2 ed.

Schmenner, R. W. (2009). Manufacturing, service, and their integration: some history and theory. *International Journal of Operations & Production Management*, *29*(5), 431–443.

Schneider, S., Spieth, P., & Clauss, T. (2013). Business model innovation in the aviation industry. *International Journal of Product Development*, *18*(3/4), 286–310.

Schofield, A. (2018). Engine Makers Share Views on The Role of Independent MRO. URL http://www.mro-network.com/engines-engine-systems/engine-makers-share-views-role-independent-mro (Accessed at 2018-04-02)

Schreyögg, G., & Kliesch-Eberl, M. (2007). How dynamic can organizational capabilities be? Towards a dual-process model of capability dynamization. *Strategic management journal*, *28*(9), 913–933.

Schuh, G., Gudergan, G., Feige, B. A., Buschmeyer, A., & Krechting, D. (2015). Business Transformation in the Manufacturing Industry - How Information Acquisition, Analysis, usage and Distribution Affects the Success of Lifecycle-Product-Service-Systems. *Procedia CIRP*, *30*, 335–340.

Scott, D., Hedenryd, E., & Buxton, D. (2005). Current Aero-Industry Business Models.

Seidenman, P., & Spanovich, D. (2016a). OEMs in the Aftermarket: Good, Bad And Ugly.
URL http://www.mro-network.com/maintenance-repair-overhaul/oems-aftermarket-good-bad-and-ugly (Accessed at 2017-06-29)

Seidenman, P., & Spanovich, D. J. (2005). Leveraging line maintenance. *Overhaul & Maintenance*, *12*(December).

Seidenman, P., & Spanovich, D. J. (2016b). Narrowbody Engines Drive Biggest MRO Growth In 2016.
URL http://aviationweek.com/mro/narrowbody-engines-drive-biggest-mro-growth-2016 (Accessed at 2016-02-12)

Shafer, S. M., Smith, H. J., & Linder, J. C. (2005). The power of business models. *Business Horizons*, *48*(3), 199–207.

Shankar, V., Berry, L. L., & Dotzel, T. (2007). Creating and managing hybrid innovations. In *Presentation at AMA Winter Educators' Conference, San Diego, CA*. Citeseer.

Shay, L. A. (2015a). Fleet Modernization Big Factor In 2016 MRO Trends.
URL http://aviationweek.com/mro/fleet-modernization-big-factor-2016-mro-trends (Accessed at 2016-02-12)

Shay, L. A. (2015b). Roll-Royce changes aftermarket support to foster competition.
URL http://aviationweek.com/mro/rolls-royce-changes-aftermarket-support-foster-competition (Accessed at 2015-11-26)

Shay, L. A. (2016). Boeing Encourages Industry Cooperation On Big Data.
URL http://aviationweek.com/mro-europe-2016/boeing-encourages-industry-cooperation-big-data (Accessed at 2016-10-21)

Shay, L. A. (2017a). Details of Boeing's Revamped service business.
URL http://www.mro-network.com/print/12665 (Accessed at 2017-09-01)

Shay, L. A. (2017b). Digital Analytics for MRO Progressing On Several Fronts.
URL http://www.mro-network.com/maintenance-repair-overhaul/digital-analytics-mro-progressing-several-fronts (Accessed at 2017-07-24)

Shay, L. A. (2017c). One-Stop OEM Shopping?
URL http://www.mro-network.com/maintenance-repair-overhaul/one-stop-oem-shopping (Accessed at 2017-08-15)

Shay, L. A. (2017d). Top 10 MROs Worldwide Unveiled.
URL http://www.mro-network.com/print/12106 (Accessed at 2017-05-23)

Shay, L. A. (2017e). Top-Performing MRO Buck Trends , Invest In New Technologies. URL http://www.mro-network.com/airframes/top-performing-mros-buck-trends-invest-new-technologies (Accessed at 2017-05-23)

Shay, L. A., & Anselmo, J. (2017). Will MRO + Boeing = $50 billion? URL http://www.mro-network.com/maintenance-repair-overhaul/will-mro-boeing-50-billion (Accessed at 2017-06-26)

Sinkula, J. M. (2002). Market-based success, organizational routines, and unlearning. *Journal of Business & Industrial Marketing*, *17*(4), 253–269.

Sirdeshmukh, D., Singh, J., & Sabol, B. (2002). Consumer trust, value, and loyalty in relational exchanges. *Journal of marketing*, *66*(1), 15–37.

Smith, D. J. (2013). Power-by-the-hour: the role of technology in reshaping business strategy at Rolls-Royce. *Technology Analysis & Strategic Management*, *25*(8), 987–1007.

Spafford, C., Hoyland, T., & Medland, A. (2015). Turning the Tide: A Wave of New Aviation Technology Will Soon Hit the MRO Industry. URL http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2015/apr/MRO-Survey-2015-digital.pdf (Accessed at 2015-12-28)

Spafford, C., & Rose, D. (2013). Thrive Rather than Survive. It's time for MROs to act. URL https://www.oliverwyman.com/content/dam/oliver-wyman/global/en/files/archive/2013/MRO{_}Survey{_}2013.pdf (Accessed at 2018-10-07)

Spafford, C., & Rose, D. (2014). Signs of new life. URL http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2014/apr/MROSurvey2014-digital.pdf (Accessed at 2016-02-08)

Spring, M., & Araujo, L. (2009). Service, services and products: rethinking operations strategy. *International Journal of Operations & Production Management*, *29*(5), 444–467.

SR Technics (2016). SR Technics signs a range of maintenance agreements with easyJet. URL http://www.srtechnics.com/news/press-releases/2016/10/sr-technics-signs-a-range-of-maintenance-agreements-with-easyjet/ (Accessed at 2017-12-26)

Stabell, C. B., & Fjeldstad, Ø. D. (1998). Configuring value for competitive advantage: on chains, shops, and networks. *Strategic management journal*, (pp. 413–437).

Stalnaker, T., Usman, K., & Taylor, A. (2016). Airline economic analysis. URL http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2016/jan/oliver-wyman-airline-economic-analysis-2015-2016.pdf (Accessed at 2017-05-02)

Steiner, M., Eggert, A., Ulaga, W., & Backhaus, K. (2016). Do customized service packages impede value capture in industrial markets? *Journal of the Academy of marketing Science*, *44*(2), 151–165.

Storbacka, K. (2011). A solution business model: Capabilities and management practices for integrated solutions. *Industrial Marketing Management*, *40*(5), 699–711.

Storbacka, K., Windahl, C., Nenonen, S., & Salonen, A. (2013). Solution business models: Transformation along four continua. *Industrial Marketing Management*, *42*(5), 705–716.

Story, V. M., Raddats, C., Burton, J., Zolkiewski, J., & Baines, T. (2017). Capabilities for advanced services: A multi-actor perspective. *Industrial Marketing Management*, *60*, 54–68.

Strauss, A., & Corbin, J. (1998). *Basics of Qualitative Research*. Thousand Oaks, London, New Delhi: SAGE Publications, 2nd ed.

Stremersch, S., & Tellis, G. J. (2002). Strategic bundling of products and prices: A new synthesis for marketing. *Journal of Marketing*, *66*(1), 55–72.

Stremersch, S., Wuyts, S., & Frambach, R. T. (2001). The Purchasing of Full-Service Contracts: An Exploratory Study within the Industrial Maintenance Market. *Industrial Marketing Management*, *30*(1), 1–12.

Sundin, E., Öhlund Sandström, G., Lindahl, M., Öhrwall Rönnbäck, A., Sakao, T., & Larsson, T. (2009). Challenges for industrial product/service systems-Experiences from a learning network of large companies. In *CIRP IPS2 Conference 2009-Industrial product-service systems (IPS2)*. Cranfield University.

Tanaka, Y., Nagai, S., Ushida, M., & Usui, T. (2003). Large Engine Maintenance Technique to Support Flight Operation for Commercial Airlines. *Mitsubishi Heavy Industries Technical Review*, *40*(2), 102–109.

TeamSai (2014). Global MRO Market Economic Assessment.
URL http://arsa.org/wp-content/uploads/2014/03/ARSA-TeamSAI-EconomicReport-20140307.pdf (Accessed at 2018-10-07)

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350.

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2-3), 172–194.

Teece, D. J. (2012). Dynamic Capabilities: Routines versus Entrepreneurial Action. *Journal of Management Studies*, *49*(8), 1395–1401.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533.

Tegtmeier, L. A. (2009). Balancing Competition in MRO. *Aviation Week & Space Technology*, *170*(16), 58–61.

The Boeing Company (2017). Boeing Company Annual Report 2016.
URL http://investors.boeing.com/investors/financial-reports/default.aspx (Accessed at 2017-12-20)

The Economist (2015). *Style Guide*. Economist Books. PublicAffairs.

Thomas, A., Byard, P., & Henry, P. (2008). Self-maintenance works for repair firm [aerospace industry]. *Engineering & Technology*, *3*(7), 69–71.

Toh, M. (2017). Mitsubishi delays MRJ deliveries by a year.
URL https://www.flightglobal.com/news/articles/mitsubishi-delays-mrj-deliveries-by-two-years-433402 (Accessed at 2017-12-08)

Toossi, A., Lockett, H., Raja, J. Z., & Martinez, V. (2013). Assessing the value dimensions of outsourced maintenance services. *Journal of Quality in Maintenance Engineering*, *19*(4), 348–363.

Tovey, A. (2016). Airbus to cut production of A380 in fresh blow for 'superjumbo'.
URL http://www.telegraph.co.uk/business/2016/12/28/airbus-cut-production-a380-fresh-blow-superjumbo/ (Accessed at 2017-12-07)

Tovey, A. (2017). Airbus replaces 'legendary' John Leahy as sales chief with Rolls-Royce's Eric Schulz.
URL http://www.telegraph.co.uk/business/2017/11/28/airbus-replaces-legendary-john-leahy-sales-chief-rolls-royces/ (Accessed at 2017-12-19)

Tranfield, D. R., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, *14*, 207–222.

Treleven, M., & Schweikhart, S. B. (1988). A risk/benefit analysis of sourcing strategies: single vs. multiple sourcing. *Journal of operations management*, *7*(3-4), 93–114.

Trimble, S. (2013). IN FOCUS: How to power A320neo is tough choice for airlines.
URL https://www.flightglobal.com/news/articles/in-focus-how-to-power-a320neo-is-tough-choice-for-airlines-383733/ (Accessed at 2017-12-18)

Trimble, S. (2017). ANALYSIS: Why the next Airbus MRO vendor is Boeing.
URL https://www.flightglobal.com/news/articles/analysis-why-the-next-airbus-mro-vendor-is-boeing-436736 (Accessed at 2017-09-25)

Tsang, A. H. C. (1998). A strategic approach to managing maintenance performance. *Journal of Quality in Maintenance Engineering*, *4*(2), 87–94.

Tsang, A. H. C. (2002). Strategic dimensions of maintenance management. *Journal of Quality in Maintenance Engineering*, *8*(1), 7–39.

Tukker, A. (2004). Eight types of product – service system: eight ways to sustainability? Experiences from SusProNet. *Business strategy and the environment*, *13*(4), 246–260.

Tukker, A., & Tischner, U. (2006). Product-services as a research field: past, present and future. Reflections from a decade of research. *Journal of Cleaner Production*, *14*(17), 1552–1556.

Tuli, K. R., Kohli, A. K., & Bharadwaj, S. G. (2007). Rethinking Customer Solutions: From Product Bundles to Relational Processes. *Journal of Marketing*, *71*(3), 1–17.

Turunen, T. (2011). *Users as a development driver in manufacturing: the case of reverse servitization*. Cheltenham, UK: Edvard Elgar.

Turunen, T., & Finne, M. (2014). The organisational environment's impact on the servitization of manufacturers. *European Management Journal*, *32*(4), 603–615.

Turunen, T., & Toivonen, M. (2011). Organizing customer-oriented service business in manufacturing. *Operations Management Research*, *4*(1-2), 74–84.

Uhlmann, E., Bilz, M., & Baumgarten, J. (2013). MRO - Challenge and chance for sustainable enterprises. In *Procedia CIRP*, vol. 11.

Ulaga, W., & Eggert, A. (2006). Value-Based Differentiation in Business Relationships: Gaining and Sustaining Key Supplier Status. *Journal of Marketing*, *70*(January), 119–136.

Ulaga, W., & Reinartz, W. J. (2011). Hybrid Offerings: How Manufacturing Firms Combine Goods and Services Successfully. *Journal of Marketing*, *75*(6), 5–23.

Ulrich, D., & Barney, J. B. (1984). Perspectives in organizations: resource dependence, efficiency, and population. *Academy of Management Review*, *9*(3), 471–481.

Valeika, R. (2015). Opinion: 'Big Data' From Aircraft? Great. But For What? URL http://aviationweek.com/print/mro-enterprise-software/opinion-big-data-aircraft-great-what (Accessed at 2015-12-18)

Valtakoski, A. (2017). Explaining servitization failure and deservitization: A knowledge-based perspective. *Industrial Marketing Management*, *60*, 138–150.

van Hinte, E. (2015). The Unexpected Success of the Boeing 747. URL https://worksthatwork.com/2/boeing-747 (Accessed at 2017-12-20)

Vandermerwe, S. (2000). How increasing value to customers improves business results. *MIT Sloan Management Review*, *42*(1), 27.

Vandermerwe, S., & Rada, J. (1988). Servitization of business: Adding value by adding services. *European Management Journal*, *6*(4), 314–324.

Vargo, S. L. (2011). From Micro to Macro: Stakeholders. *Journal of Macromarketing*, *31*(2), 125–128.

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of marketing*, *68*, 1–17.

Vasantha, G. V. A., Roy, R., Lelah, A., & Brissaud, D. (2012). A review of product–service systems design methodologies. *Journal of Engineering Design*, *23*(9), 635–659.

Velamuri, V., Neyer, A.-K., & Möslein, K. (2011). Hybrid value creation: a systematic review of an evolving research area. *Journal für Betriebswirtschaft*, *61*(1), 3–35.

Vendrell-Herrero, F., & Wilson, J. R. (2017). Servitization for territorial competitiveness: Taxonomy and research agenda. *Competitiveness Review: An International Business Journal*, *27*(1), 2–11.

Vezzoli, C., & Ceschin, F. (2008). Product Service Systems in the automotive industry: an alternative business model for a sustainable satisfaction system. In *The 6th International Conference on Manufacturing Research*. Brunel University.

Vieira, D. R., & Loures, P. L. (2016). Maintenance, Repair and Overhaul (MRO) Fundamentals and Strategies: An Aeronautical Industry Overview Holds the research chair in Management of Aeronautical Projects Université du Québec à Trois Rivières -Canada. *International Journal of Computer Applications*, *135*(12), 975–8887.

Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management*, *22*(2), 195–219.

Walker, K. (2018). CFM , GE To Adopt MRO 'Conduct Policies' As IATA Signs CFM Agreement.
URL https://www.mro-network.com/engines-engine-systems/cfm-ge-adopt-mro-conduct-policies-iata-signs-cfm-agreement (Accessed at 3.7.2019)

Wall, R. (2015). Europe Mulls Aircraft-Parts Competition Investigation Amid Airline Complaints.
URL http://www.wsj.com/articles/europe-mulls-aircraft-parts-competition-investigation-amid-airline-complaints-1444919179 (Accessed at 2016-02-16)

Wallin, J. (2013a). *Developing Capability for Product-Service System Innovation: An Empirical Study in the Aerospace Industry*. Ph.D. thesis, Chalmers University of Technology.

Wallin, J. (2013b). The Servitization of the Aerospace Industry and the effects on product development. In *Proceedings of the 4th CEAS Air and Space Conference*.

Wang, P. P., Ming, X. G., Li, D., Kong, F. B., Wang, L., & Wu, Z. Y. (2011). Status review and research strategies on product-service systems. *International Journal of Production Research*, *49*(22), 6863–6883.

Ward, Y., & Graves, A. (2005). Through-life management: The provision of total customer solutions in the aerospace industry.

Weeks, R., & Benade, S. (2015). The development of a generic servitization systems framework. *Technology in Society*, *43*, 97–104.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic management journal*, *5*(2), 171–180.

Whyte, T., & Von Oertzen, T. (2001). Strategic Agenda For Aircraft Maintenance. In *Travel and Tourism PIG*. Boston Consulting Group.

Wild, J. (2014). Airlines turn to outsourcing to keep lid on costs.
URL https://www.ft.com/content/4a6ead0e-c54f-11e3-89a9-00144feabdc0 (Accessed at 2017-12-26)

Wilden, R., Devinney, T. M., & Dowling, G. R. (2016). The Architecture of Dynamic Capability Research. *The Academy of Management Annals*.

Wilden, R., Gudergan, S., & Lings, I. (2018). The interplay and growth implications of dynamic capabilities and market orientation. *Industrial Marketing Management*.

Wilhelm, H., Schlömer, M., & Maurer, I. (2015). How dynamic capabilities affect the effectiveness and efficiency of operating routines under high and low levels of environmental dynamism. *British Journal of Management*, *26*(2), 327–345.

Williamson, O. E. (1981). The economics of organization: The transaction cost approach. *American journal of sociology*, *87*(3), 548–577.

Williamson, O. E. (1985). *The economic institutions of capitalism*. London: Free Press.

Wilson, D. T. (1995). An integrated model of buyer-seller relationships. *Journal of the academy of marketing science*, *23*(4), 335–345.

Windahl, C., Andersson, P., Berggren, C., & Nehler, C. (2004). Manufacturing firms and integrated solutions: characteristics and implications. *European Journal of Innovation Management*, *7*(3), 218–228.

Windahl, C., & Lakemond, N. (2006). Developing integrated solutions: The importance of relationships within the network. *Industrial Marketing Management*, *35*(7), 806–818.

Windahl, C., & Lakemond, N. (2010). Integrated solutions from a service-centered perspective: Applicability and limitations in the capital goods industry. *Industrial Marketing Management*, *39*(8), 1278–1290.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic management journal*, *24*(10), 991–995.

Winter, S. G., & Szulanski, G. (2001). Replication as strategy. *Organization science*, *12*(6), 730–743.

Wirtz, B. W. (2011). *Business model management*. Wiesbaden: Gabler.

Wise, R., & Baumgartner, P. (1999). Go Downstream: The New Profit Imperative in Manufacturing. *Harvard Business Review*, *77*(5), 133–141.

Wittmer, A., Bieger, T., & Müller, R. (2011). *Aviation systems: management of the integrated aviation value chain*. Heidelberg u.a.: Springer.

Wizz Air (2015). Wizz Air Renews Maintenance Contracts with Lufthansa Technik Group for Hungary, Romania and Slovakia.
URL https://wizzair.com/en-gb/information-and-services/about-us/news/shownews/2015/11/19/wizz-air-renews-maintenance-contracts-with-lufthansa-technik-group-for-hungary-romania-and-slovakia-{#}/ (Accessed at 2017-05-25)

Xerox (2015). Document Management Solutions.
URL http://www.services.xerox.com/document-management-solutions/enus.html (Accessed at 2015-07-28)

Yin, R. K. (2009). *Case Study Research: Design and Methods*, vol. 5. London: SAGE Publications.

Yin, R. K. (2011). *Qualitative research from start to finish*. Newbury Park, London, New Delhi: SAGE Publications.

Young-Ybarra, C., & Wiersema, M. (1999). Strategic flexibility in information technology alliances: The influence of transaction cost economics and social exchange theory. *Organization science*, *10*(4), 439–459.

Zaheer, A., Gulati, R., & Nohria, N. (2000). Strategic networks. *Strategic management journal*.

Zahra, S. A., Sapienza, H. J., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: A review, model and research agenda. *Journal of Management studies*, *43*(4), 917–955.

Zhang, W., & Banerji, S. (2017). Challenges of servitization: A systematic literature review. *Industrial Marketing Management*, *65*(March), 217–227.

Zollo, M., Reuer, J. J., & Singh, H. (2002). Interorganizational routines and performance in strategic alliances. *Organization Science*, *13*(6), 701–713.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization science*, *13*(3), 339–351.

Zott, C., & Amit, R. (2008). The fit between product market strategy and business model: Implications for firm performance. *Strategic Management Journal*, *29*(1), 1–26.

Zott, C., & Amit, R. (2010). Business Model Innovation: Creating Value in Times of Change. *Long Range Planning*, *3*(2-3), 216–226.

Zott, C., Amit, R., & Massa, L. (2011). The business model: Recent developments and future research. *Journal of Management*, *37*(4), 1019–1042.

Annex

1 Costs of Aircraft Non-availability

The costs of non-availability (CNA) are calculated using an average contribution margin (ACM), which is defined as the selling price per ticket minus the variable costs per ticket. The ACM ranges for most passenger airlines between 40% and 45%.

$$CNA = \Delta_{\text{days not available}} \times \text{Revenue per pax per leg} \times \text{Earning Capacity}$$
$$\times \text{Seat Load Factor} \times \text{Legs per Day} \times \text{ACM}$$

The exemplary calculation using the values of Table 1 of costs of non-availability for an A320 operated on a short haul flight, shows that approximately $30,000 lack of contribution margin occur.

Factors	Values
Average revenue per PAX per leg	$70,00
Seat capacity A320	180
Average seat load factor	85%
Average legs per day	6,5
ACM margin	45%
$D_{\text{days not available}}$	1
Costs of non-availability	$31,326.75

Table 1: Exemplary Calculation of Costs of Non-availability (Based on Internal Sources)

This calculation is simplified, since it does not take other factors, such as cargo, the availability of replacement aircraft, and the airline's staff, supervising the base maintenance event, into account.

2 Costs for Aircraft Ferry Flights

Total costs of ownership (TCO) for ferry flights can be approximated through the following formula:

$$TCO_{\text{ferry flight}} = \text{BH}\times(\text{Aircraft Ownership Costs per BH + Maintenance Costs per BH})+$$
$$\text{Navigation Fees + Landing Fees + Crew Costs + Fuel Consumption }\times\text{Fuel Price}$$

The exemplary calculation using the Values in Table 2 of ferry costs results in approximately $14,000 total cost of ownership incurred for an intra-European ferry flight. It is simplified, since it does not take other factors, such as cargo into account.

Factors	Values
Block hours (BH) needed	3
Aircraft ownership cost / BH	$670
Maintenance cost / BH	$800
Landing fees	$500
Navigation fees	$1,800
Fuel consumption in gal	2,800
Fuel price/ gal (03/13/17)	$1.5
Crew Cost	$3,300
Sum inner-European Ferry Flight	$14,210

Table 2: Exemplary Calculation of Ferry Flight Costs (Based on Internal Sources)

3 Additional Case Material

Category	Initial Questions	Follow up Questions
Introduction, Servitization, Business Model Innovation	• what touchpoints have you had with OEMs' service offers? • what has changed with the OEMs' entry in the aftermarket? • What changes have you made to your business model?	• how does offering solutions differ from traditional offerings/pure service offerings? • how do customer requirements change and what will be the requirements of the future? • how do requirement between the different customer groups differ (e.g., airlines and lessors)
BMI 1: Developing Solutions	• Describe the solution business model [of the specific case]?	Categories of business model canvas: • Value Proposition • Key Resources • Key Activities • Key Partners • Cost Structure • Channels • Relationships • Customer Segments • Revenue Structure
	• What are the factors that determine in [interviewee's case] that you can [/ cannot] provide solutions?	• are these factors generalizable? • how important are these factors?
	To provide solutions: • which resources and capabilities did you need to develop? • which resources and capabilities did you acquire from external partners?	• how and why are these resourced developed internally/externally?
	• how did you develop solutions? which [dynamic] capabilities did you require to develop solutions?	• which sensing capabilities? • which seizing capabilities? • which reconfiguring capabilities?
Competitive Advantage	Strengths and weaknesses: • What are strengths and weaknesses of MROs? • What are strengths and weaknesses of OEMs?	• how can the strengths of MROs be leveraged into a cost- or differentiation leadership? • how can the strengths of OEMs be leveraged into a cost- or differentiation leadership?
BMI 2: Alliancing with Manufacturers	• how does your business model differ being an OEM network partner compared to your traditional business model?	Categories of business model canvas: • Value Proposition • Key Resources • Key Activities • Key Partners • Cost Structure • Channels • Relationships • Customer Segments • Revenue Structure
	• What are the factors that determined that you became a network partner of the OEM?	• why did you chose to collaborate? • in what case would you chose to compete?
	• how did you become an OEM Network Partner? • which [dynamic] capabilities did/do you require to become OEM network partner?	• which sensing capabilities? • which seizing capabilities? • which reconfiguring capabilities?

Table 3: Interview Protocol

For analytical purposes, a Business Model Canvas that describes the focal company's business model in each Case has been developed. The individual Business Model Canvases are configuration-agnostic, meaning that all elements of the business model are summarized, irrespective of in which configuration they are utilized.

Key Partners
- Affiliated Airline with sourcing campaign
- Engine OEMs

Key Activities
- Engine Disassembly, Assembly, Test
- Engine Parts Repair
- Workscoping
- Mobile services
- Dynamic Feedback Loops

Key Resources
- Discounted Material, Repair Manuals, Mechanics, Engineers, Plants & equipment
- Mobile maintenance network

Key Capabilities
- Engine Repair Capability
- Engineering Capability

Value Proposition
- Sharing risk and investment
- Decrease of engine repair costs
- Delivering local support
- Improving OEM's engineering capabilities

Customer Relationship

OEM:
- Long-term cooperation on equal footing

Airline:
- Relationship restricted in closed network configuration

Channels

Network Configurations:
- Open: direct channel with airline
- Closed: channel only with OEM, no direct customer channels

Customer Segments
- Engine OEMs
- Airlines

Cost Structure
- One-off investment in license
- Material at varying discount rates
- Labor
- Plants and equipment

Revenue Streams
- Fixed-price for performing work packages
- Gain-sharing models for cost reductions

Figure 1: Engine Network Partner Business Model

Key Partners
- Alliance with OES on the A350 aircraft program

Key Activities
- Dynamic Feedback Loops: Engineering Council
- Alliance Management

Key Resources
- (Joint) worldwide asset supply system
- Serviced fleet
- Workshops and mechanics
- Material
- Worldwide sales force
- Workshops and mechanics

Key Capabilities
- Integration and multi-vendor capability
- Operational capabilities (asset management, engineering, repair)

Value Proposition

VP developed for OES:
- Focus on core business manufacturing
- reduction of investments, costs, assets and risks associated with aftermarket support
- Participation in aftermarket revenues
- Engineering and customer feedback to benefit new product development

Customer Relationship
- OES-Alliance: incentive-alignment and high mutual dependency
- Multifaceted relationship: supplier and competitor on other aircraft types
- Unchanged relationship with airline

Channels
- Direct Channel to airline remains
- Dynamic Feedback Loops and Alliance Management with OES

Customer Segments
- All types of Airlines operating the A350 aircraft
- Access to customers preferring service by OES

Cost Structure
- Risk and Revenue-sharing mechanism: Material discounts offset by revenue-dependent license fee

Revenue Streams
- Revenues incurred from maintenance contracts with airlines and third-party MRO
- Risk and Revenue-sharing mechanism: sharing of revenues via license fee

Figure 2: Components Network Partner Business Model

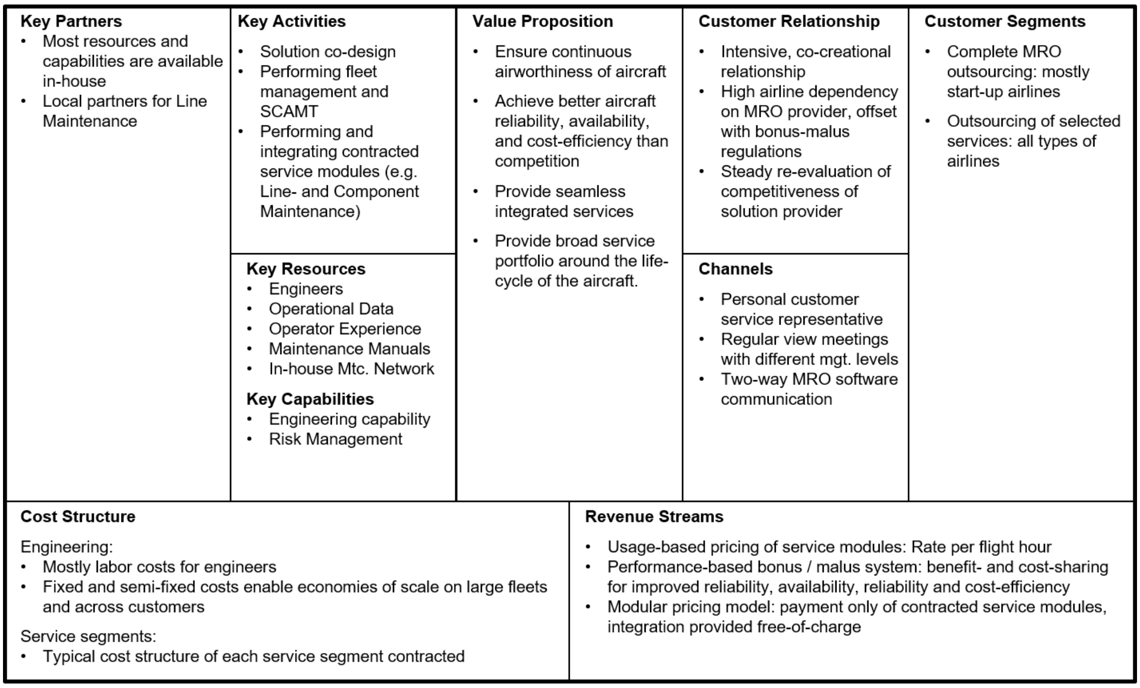


Figure 3: Aircraft Solutions Business Model

Eidesstattliche Erklärung

Hiermit versichere ich an Eides Statt, dass ich die vorgelegte Dissertation selbstständig und ohne die Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Die aus anderen Quellen direkt oder indirekt übernommenen Aussagen, Daten und Konzepte sind unter Angabe der Quelle gekennzeichnet. Bei der Auswahl und Auswertung folgenden Materials haben mir die nachstehend aufgeführten Personen in der jeweils beschriebenen Weise unentgeltlich geholfen:

Christine Heitmann — Transkription von Interviews

Weitere Personen neben den in der Einleitung der Dissertation aufgeführten Koautorinnen und Koautoren waren an der inhaltlich-materiellen Erstellung der vorliegenden Dissertation nicht beteiligt. Insbesondere habe ich hierfür nicht die entgeltliche Hilfe von Vermittlungs- bzw. Beratungsdiensten in Anspruch genommen. Mit Ausnahme des im Methodikkapitel aufgeführten professionellen Transkriptionsservices hat niemand von mir unmittelbar oder mittelbar geldwerte Leistungen für Arbeiten erhalten, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen. Die Dissertation wurde bisher weder im In- noch im Ausland in gleicher oder ähnlicher Form einer anderen Prüfungsbehörde vorgelegt. Ich versichere, dass ich nach bestem Wissen die reine Wahrheit gesagt und nichts verschwiegen habe.

Oliver Wirths
Zurich
July 4, 2019