Design of PSS Revenue Models

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Abstract

Often practitioners react deprecatingly to PSS and point out risks in financing and investing. This deviates greatly from the academic perception of PSS. This paper aims at assessing PSS revenue model design to contribute to close this gap. It starts with discussing common PSS that can be found in industrial application. Considering PAT, a PSS revenue model proposed by Kim et al. [4] is used to identify fundamental mechanisms to coordinate the behaviour of PSS-supplier and PSS-customer. Generally applicable findings will be compared to another PSS revenue model which is used in industrial application, namely outsourcing.

Keywords

Revenue model, performance measure, PSS, outsourcing

1 INTRODUCTION

1.1 Motivation

In scientific publications on the issue of bundling technical products and services, the fact that value creation can be increased through new business models is frequently discussed [1, 2]. The combination of products and services reaches from product after sales services (e.g. maintenance) up to Product Service Systems (PSS). PSS are characterized by an integrated and mutually determined process of planning, developing, delivering and using of products and services containing immanent software components.

In doing so, added value of PSS for PSS-supplier and PSS-customer is based on new revenue models. These serve substantially for dividing costs of delivery and revenue of use between PSS-supplier and PSS-customer and therefore steer the behaviour of the contracting parties. Thus, the strategic design of revenue models gains in importance [3]. With the aim of increasing total value creation by means of PSS, innovative revenue models are discussed especially in academic publications. With that, providing value instead of technical products or service processes as a basis for PSS pricing is often discussed.

People from industry frequently react sceptically with regard to these revenue models being innovative. They argue that PSS is not a new approach to increase value in general. They refer PSS to be a novel marketing strategy to increase sales of service and to hide weaknesses of technical products. Moreover, they frequently refer to outsourcing or to performance-based contracting which are “PSS in industrial application” for many years.

In particular with regard to the design of revenue models, optimistic academics and sceptical practitioners collide. Among others, the differing appraisement of PSS revenue models can be a result of an insufficient knowledge transfer between theory and practice. Thus, there is a lack of information on both sides which needs to be eliminated.

1.2 Scope

It is the aim of this article to contribute to the examination of PSS revenue model design. Focussing on business models which target increasing customer value is a first step towards eliminating the mentioned information deficit between academics and practitioners. In order to achieve the stipulated aim, this article is divided into the following sections:

Based on the introduction, section 2 presents the basic understanding of PSS in academia. Additionally, section 2 introduces two PSS, namely “outsourcing” and “performance-based contracting”, to link PSS to its common industrial applications.

Section 3 includes the theoretical contemplation of PSS revenue model design. This section starts with a brief explanation of the underlying understanding of “PSS revenue models”. This is taken as a basis for the following discussions. The analysis of the PSS revenue model proposed by Kim et al. [4] which focuses on performance based contracting in after-sales service supply chains forms the basis for a theoretical discussion of PSS revenue model’s architecture. As the design of PSS revenue models is closely linked to the design of incentives for contractual parties, the analysis is carried out by taking the Principal Agency Theory [5] into account.

A PSS which is commonly used in practice, namely outsourcing of production processes, serves as an example to be assessed in section 4. Particular focus is placed on analysing the revenue model’s architecture of a real example which has been abstracted for data protection reasons. The objective is to reveal the effect of the PSS revenue model design on decision making and risk sharing between PSS-supplier and PSS-customer.

The article concludes in section 5.

2 PSS

Already since the beginning of the 1990s, the combination of products and services is marketed as PSS in scientific literature [6]. Especially at the beginning the focus has been placed on endeavouring to comprehend technical products and attending services as integral problem solutions. Thus, products and services are no longer regarded as separate sales objects but as a bundle (PSS) which can be offered to the customer. PSS can be differentiated, inter alia, subject to the sales market (B2B or B2C) that is targeted.

2.1 Outsourcing (OS) und Performance Based Contracting (PBC)

In industry, the existing manifold combinations of products and services are, however, less known as PSS but rather under terms like outsourcing (OS) [7], performance-based contracting (PBC) [8], etc..

The bundling of products and services to PSS is reflected, in particular, in the widely spread principle of **OS**. Legally binding cooperation agreements between OS-supplier and OS-customer are used to regulate the outsourcing of processes which are initially performed by the OS-customer himself. Shifting processes from one company to another frequently also includes shifting its required resources. These comprise both technical products and the staff. Through the strategic OS of production processes the extent of the economic value chain of the outsourcing company can be reduced. The motivation for OS can be manifold and reaches from focussing on core competences up to reducing investment risks and capital lockup. Moreover, the principle of OS usually promises more flexibility due to the scalability of the outsourced production processes. In OS, various revenue models have been established. For example “pay on demand” or “pay per use”.

PBC does exist in manifold forms. Despite the customization of PBC solutions, similarities can be detected. In general, PBC solutions are based on products, machines, equipment or entire systems which are no longer sold to the customer, but which are made available to him. With that, the compensation of the PBC-supplier is typically based on a performance-related user fee. Thus, the PBC-customer pays a fee which is primarily charged according to the utility provided by the PBC-supplier. Thus, no service no cash. Analogously to the basic understanding of PSS, products and services are only offered as bundles. As with OC, PBS also results in the responsibility to maintain the functionality of an infrastructure being shifted from the customer to a PBC-supplier. As the underlying revenue model refers either to “pay-per-performance” or “pay on production”, the PBC-supplier bears the financial risk and therefore the costs for a system failure or inadequate production quality.

OS and PBC are dominated by the shift of ownership of tangible and intangible assets from one party to another. The result is a reallocation of risks between supplier and customer. But, reallocating risks creates incentives and has got an immanent influence on human behaviour. As a major consequence, this needs to be taken into account for designing PSS revenue models.

2.2 PSS in industrial application

A well-established PSS can be found in the field of hard-copy document management [9, 10]. As Xerox and Océ are manufacturers of photocopying machines and, hence have best knowledge about their technical products, they have specialized in providing integral printing and document management solutions to companies, public authorities and universities. The PSS approach consists of transferring the operation of photocopying machines and printers to the manufacturer. Providing a high degree of process flexibility as well as ensuring a certain level of quality and availability are integral aspects of their offer. Thus, the corresponding revenue model is based on the output quantity of the copying machines and the flexibility to adapt to increasing or decreasing quantities of copies or prints.

Another example for PSS originates from the field of aviation and is offered by Rolls Royce, namely “Power By The Hour” and “Rolls Royce Total Care” [11]. Here, the jet engine manufacturer no longer only sells jet engines including after-sales services. Instead, he offers jet engine’s availability. The remuneration of the PSS-supplier is based on actual flight hours which are done by an aircraft containing the available jet engine power.

Both examples, outsourcing of document management on the one hand and performance based contracting of jet engines on the other hand, have at least one thing in common. A PSS-customer’s decision has shifted from MAKE to BUY. This basically results from coordination of external markets being more efficient than the internal coordination within the company. Especially taking into account the shift from make to buy can have a big influence on PSS revenue model design, as it will be shown in the following section.

3 THEORETICAL CONTRIBUTIONS TO PSS REVENUE MODEL DESIGN

3.1 Revenue model – definition and classification

The application of PSS in industry is based on contracts which generally contain three aspects. According to Burianek et al. [3], a contract defines i) the distribution of generated value among the contractual parties, ii) the allocation of rights for decision-making and iii) risk allocation. The distribution of generated value is determined by selection and design of a revenue model. Based on the preliminary work of Hünerberg and Hüttmann [12], the term “revenue model” can thus be defined as follows:

“A revenue model is defined as a heuristic model which addresses the measurable performance parameters for pricing and is therefore decisive for pricing. According to the basic understanding of revenue, there is a mutual dependency between price and quantity.”

In the relevant literature on PSS, various approaches to classify revenue models can be found. Tucker and Tischner [13] identify three types of revenue models. The authors differentiate between i) functional, ii) usage-based and iii) performance-based revenue models. Burianek et al. [3] present an extended classification which uses the measurable output of a value-adding process (e.g. costs, frequency of utilization or availability) as a classification criterion.

3.2 PAT and PSS revenue model design

The design of PSS revenue models is based on designing incentive mechanisms. Taking into account a fundamental theory of economics, namely the principal agency theory (PAT) [5], effects of incentives on human or organisational behaviour can be modelled and assessed. In PAT a principal commissions one or more agents to carry out an activity, whereby it is assumed that the principal and the agent have various pieces of information, for example about the system or the system’s environment. Both influence their actions and behaviour respectively. As gathering information causes costs, the principal is not able neither to observe all actions of the agent nor the current state of system’s environment. Thus, he can often only observe the result of the agent’s actions. Therefore, it is the principal’s aim to abolish the information dissymmetry between him and the agent. For this purpose, the principal offers a certain remuneration to compensate the effort of the agent. Basically, this can be regarded as a revenue model, whereby the remuneration shall, on the one hand, offer an incentive to the agent to use his information advantage and, on the other hand, contribute towards reducing or abolishing any dysfunctional behaviour of the agent.

3.3 PSS revenue model design according to Kim et al.

One article dealing with the design of PSS revenue models and taking PAT into account has been published by Kim et al. in 2007 [4]. The PSS regarded by Kim et al. refers to the performance based contracting in after-sales service supply chains for jet engines.

Underlying PSS

In the example used by Kim et al. [4], the owner of an aircraft is regarded as the principal. The technical system "aircraft" consists, inter alia, of the subsystem "jet engine" which is produced and serviced by a specific supplier (agent). In contrary to a classic jet engine sale and the conclusion of an after-sales service agreement with the agent, Kim et al. now contemplate a PSS. With this the agent remains owner of the jet engine. Thus, the agent does no longer sell a technical product to the owner of the aircraft (principal) but instead the functionality of the subsystem jet engine. Accordingly, the technical availability of the engine becomes a scarce, tradable commodity.

Kim et al. focus in particular on the technical availability of the PSS and define an appropriate performance measure to model the technical availability, whereby they do not directly refer to successfully completed flight hours but define an indirect measure to quantify jet engine's availability. This indirect measure is referred to as "backorder" and describes the number of malfunctions in which an engine cannot be immediately substituted by a functioning replacement system (also see figure 1).

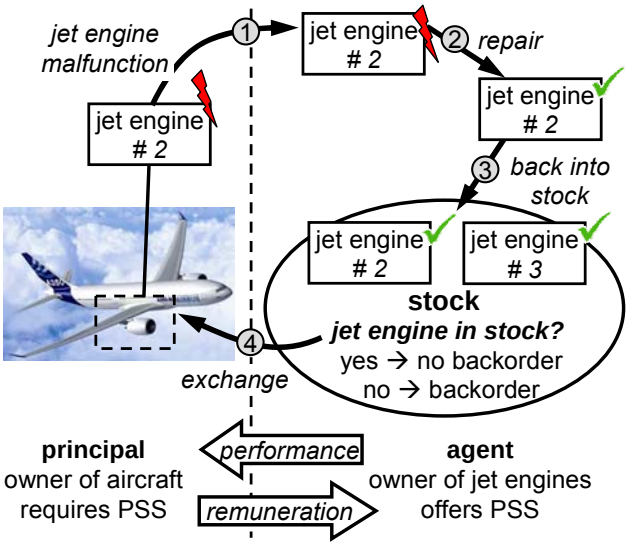

Figure 1: Interrelationship between principal and agent

On the one hand, the availability of the PSS is determined by the statistical failure probability of the technical product itself. On the other hand, the agent's decision regarding the stock quantity of replacement jet engines has just as much influence on the availability of the PSS.

The stipulated performance measure, namely the backorder, serves as an incentive for the agent to keep a sufficient quantity of replacement jet engines in stock. A large stock on the one hand lowers the risk of a backorder, but on the other hand does cause costs. Hence, the agent can spend additional effort for cost reduction. This is possible, if he changes the design of the technical product to make it more robust. Thus, the availability of the PSS from the agent's point of view is determined by two adverse parameters, namely stock quantity and cost reduction.

Discussion of the PSS revenue model

The analysis of PSS revenue model design proposed by Kim et al. [4] results in the fact that a revenue model for an availability-oriented PSS is, in principle, composed of the following three revenue components (see figure 2)

PSS revenue model:

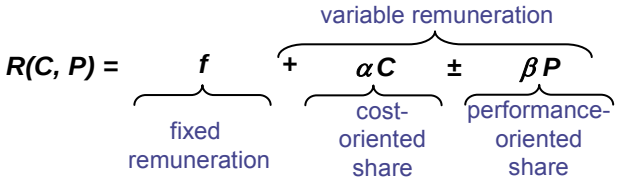

Figure 2: revenue model according to Kim et al. 2007 [4]

Besides a component for fixed remuneration (f), the variable remuneration is devided into a cost-oriented share (C) and a performance-oriented share (P). The variable remuneration components are integrated into the PSS revenue model with specific weighting factors. The cost-related weighting factor ($0 \leq \alpha \leq 1$) serves for dividing resulting costs for keeping a certain stock quantity between the principal and the agent. In contrast, the penalty for not delivering an available jet engine is included by the last term summand. Here the number of backorders is multiplied by a performance-related weighting factor ($0 \leq \beta \leq 1$). As the performance is indirectly measured in the example described by Kim et al., in this case the third term leads to the agent's remuneration being decreased ($-\beta P$). Determining f, α and β is part of the negotiation between PSS-supplier and PSS-customer and will end up in the PSS contract.

The analysis of the PSS revenue model proposed by Kim et al. leads to the following four findings regarding PSS revenue model design:

- A **pure fixed-price revenue model** ($\alpha=0$ and $\beta=0$), transfers the entire risk of costs from the PSS-customer (principal) to the PSS-supplier (agent). This results in a great incentive for the agent to reduce costs. Cost reduction can be achieved by optimizing the technical product or by improving service processes. All this is steered by setting the agent's work input to decrease costs.
- A **pure cost-plus revenue model** ($\alpha=1$ and $\beta=0$) serves for transferring the entire risk of costs to provide the PSS from the PSS-supplier (agent) to the PSS-customer (principal). This results from the fact that the principal is contractually forced to compensate any arising expenses of the agent. Thus, there is no incentive for the agent to reduce costs by optimizing the system. Additionally, the agent will only put in minor efforts to strive to increase PSS's availability.
- Fixed-price and Cost-plus revenue models normally do not provide any incentives for the PSS-supplier (agent) to improve the availability of the PSS. Both revenue models do only serve to shift all risks either to the PSS-customer or to the PSS-supplier.
- A **complete PSS revenue model** taking all three summands ($f \neq 0$, $\alpha \neq 0$ and $\beta \neq 0$) into account can, however, contribute towards efficiently dividing the costs for ensuring the availability, the risk of failure and the financial benefits resulting from PSS availability between the PSS-supplier (agent) and the PSS-customer (principal). In particular, the third summand generates incentives for the agent to behave in the interest of the principal.

Intermediate conclusion

In summary, a combined remuneration consisting of a fixed-price, cost-plus and performance-oriented share constitutes the basis for an availability-oriented PSS. Taking all three summands into account can lead to a win-win situation for the PSS-supplier and PSS-customer. This is based on sharing costs and financial benefits of availability of a PSS between both of them. Thus, the combined PSS revenue model constitutes, at least from a theoretical point of view, an effective alternative to a classic input/cost-oriented remuneration of the agent. An important issue is always the stipulation of an adequate performance measure to align PSS-suppliers and PSS-customers objectives.

4 REVENUE MODEL ANALYSIS OF AN AVAILABILITY-ORIENTED PSS FOR PROCESS OUTSOURCING

The outsourcing of a process which can be regarded as a PSS (see section 2.2) serves as a basis to assess a PSS in industrial application. In order to maintain secrecy the following case study has been constructed to represent all relevant aspects of the availability-oriented PSS.

4.1 Underlying case study

As shown in figure 3, in the initial situation a **company (C)** offers a product on a B2B sales market consisting of individualised and non-individualised components.

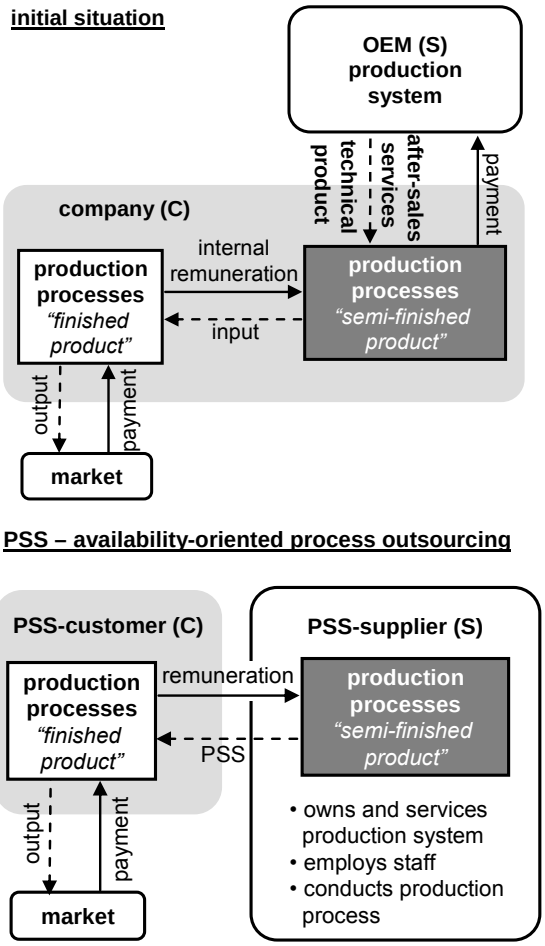

Figure 3: Underlying case study – initial situation and PSS

While the non-individualised components can be purchased on an external market, the production of individualised components requires company-internal resources. In the initial situation all necessary production facilities are property of C and are operated by employees of C. The raw materials required for producing the semi-finished product are available on the market. As not all of the processes required for producing the final product are core competencies of C, C has the possibility of outsourcing certain processes. An **OEM (S)** which has so far only delivered the production system and after-sales services to produce the semi-finished product to C, now offers C to take over the entire process up to the production of semi-finished products. By means of an adequate PSS, S now integrates itself into the production process of C. As shown in figure 3 the production of the semi-finished product is now provided by S to C.

For the official definition and specification of the PSS a contract is concluded between the **PSS-supplier (S)** and the **PSS-customer (C)**. This contract includes aspects which contribute towards the implicit or explicit determination of the revenue model. The implicit aspects include, for example, the specification of the machines to be used, the staff or the service-level agreement. In contrast, aspects such as the stipulation of production prices and the commitment of the PSS-customer to purchase certain quantities explicitly influence the design of a PSS revenue model.

4.2 Analysis – Different stages of the PSS revenue model

In the following, due to different contract variations different stages of PSS revenue models are analysed in order to reveal the influence of cost-plus, fixed-price and performance based components of remuneration.

1st stage: Mere Pay-On-Production (MPOP)

In the 1st stage of the PSS revenue model, C remunerates S based on the quantity of semi-finished products manufactured by S. C's motivation to conclude such a PSS contract based on a **Mere Pay-On-Production (MPOP)** remuneration could, for example, result from an insecure situation on the sales market. In this market the quantity of the final product demanded is fraught with risk. C therefore pursues the aim of making his production more flexible. Through concluding the contract with the PSS supplier S, C gains the possibility of transferring part of the market risk to S. At the same time, C achieves maximum cost flexibility by converting his fixed production costs into costs which are variable for him. Prerequisite for the unit-based remuneration of S is C's requirement regarding a guaranteed trouble-free operation of the PSS. In this sense, S will only receive a unit-based remuneration if the produced semi-finished products correspond to an agreed quality standard. If S does not provide sufficient capacity to produce the quantity of semi-finished product required by C, C reserves the right to procure the difference in quantity on the external market.

From PSS-supplier's point of view, this risk transfer is to be regarded differently. In particular, the calculation of the unit-based prices which have to refer to a predictable production quantity turns out to be problematic. In order to determine the underlying production quantity, S has to use an appropriate forecasting method. Under the prerequisite that the outsourcing concerns a production unit of C which already exists, S could, for example, use historical data for predicting future production quantities. Alternatively, the result of surveying the PSS-customer could be used as an input parameter for S's price calculation. But it has to be taken into account that C who is acting rationally and opportunistically will always indicate production quantities which are too high to realize unit-based prices which are as low as possible (Remark: this is only valid for the 1st stage of the PSS revenue model).

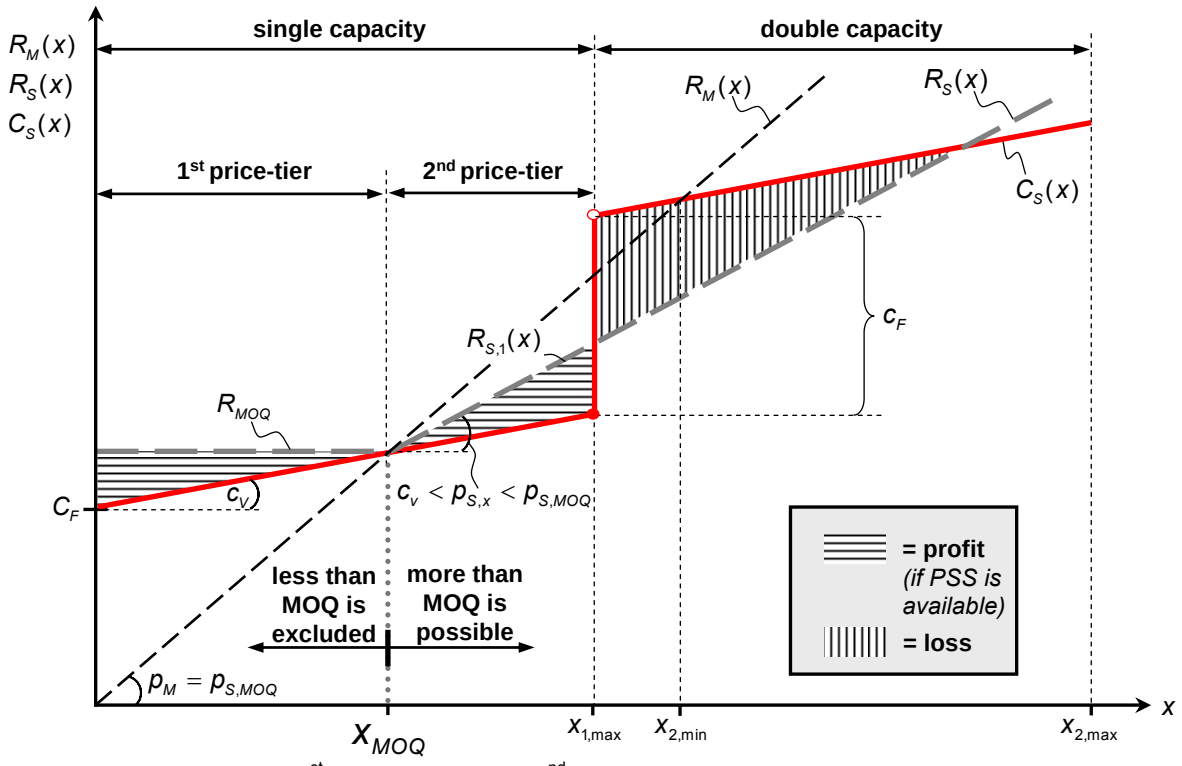

Figure 4: 1st stage (MPOP) and 2nd stage (BOQ) of the PSS revenue model

As the market risk is almost entirely transferred from C to S by applying the 1st stage of the PSS revenue model, the revenue situation is dissatisfactory for S. To generate a distribution of risks between S and C which is more advantageous, this revenue model needs to be adjusted. With this it also has to be taken into account that S can so far only react to quantity changes in the production of C. This needs to be regarded all the more critically as there are no incentives for C to forfeit his information advantage regarding a certain production quantity predicted by him.

2nd stage: Minimum Ordered Quantity (MOQ)

In order to reduce the risk to be born by S resulting from the uncertain estimation of a **production quantity which is not capable to cover his expenses**, the 1st stage of the PSS revenue model is extended by introducing a **Minimum Ordered Quantity (MOQ).** Due to this, C assures to remunerate S for delivering a certain production quantity x_{MOQ}. This is stipulated in a contract, whereby S is not only remunerated for MOQ, but is still remunerated depending on the quantity of semi-finished products x exceeding MOQ. A visualisation of this revenue model including MOQ is presented in figure 4.

The revenue function $R_M(x)$ depicted in figure 4 reflects the maximum revenue which can be achieved with the PSS. This is based on the market price p_M and on a given production quantity x. This basically corresponds to the 1st stage of the PSS revenue model and coincides with the assumption that process outsourcing provided by S can be traded on an external market. In this sense, p_M can be regarded as a reference price.

Moreover, the cost function of S, namely $C_S(x)$, has been depicted in figure 4 depending on the production quantity of the semi-finished product. $C_S(x)$ contains fixed costs C_F, step costs c_F and variable costs $c_V \cdot x$. Step costs c_F take into account that endless resource capacity cannot be assumed in general so that an increase of the production capacity is linked with a volatile increase of costs. In order to make this coherence clear by means of an example, double capacity represented by double manufacturing facility and associated staff, is depicted in figure 4.

The extension of the 1st stage of the PSS revenue model essentially consists of the introduction of a two-tiered price system. Whereas the price calculation of the first tier is based on the committed MOQ x_{MOQ}. The price for MOQ is determined by the market price p_M. Taking the PSS-supplier's perspective into account, first of all C_F is to be covered by the commitment. Besides the fixed costs, the additionally incurring variable costs are included to determine the price of the second tier. As fixed costs are already covered by MOQ, **the price in the second tier is always lower than that of the first tier.**

For using only single capacity, the revenue model's two-tier price system is reflected in the revenue function of S. Here, a differentiation is made between two levels of remuneration depending on the committed MOQ and the maximum production output $x_{1,max}$ which can be achieved by means of only one machine and associated staff. Resulting revenues to remunerate MOQ on the one hand and additional production quantity on the other hand are represented by R_{MOQ} and $R_{S,1}(x)$. The fixed remuneration R_{MOQ} of S is always carried out subject to the committed quantity, whereas the production output exceeding x_{MOQ} is remunerated on a variable basis.

Assuming both that S is initially seeking cost coverage of C_F plus $c_V \cdot x_{MOQ}$ and the intended price $p_{S,MOQ}$ is determined by the market price p_M ($p_{S,MOQ} = p_M$), S stipulates the production quantity x_{MOQ} as shown in figure

4. Based on this, S chooses a price $p_{S,x}$ in the interval $[c_V ; p_{S,MOQ} = p_M]$ for the second price-tier which targets variable remuneration. The lower interval limit of this price, namely c_V, results from the coverage of the additional variable costs $c_V \cdot (x - x_{MOQ})$, whereby the upper limit is given through the market price. By stipulating the price $p_{S,x} < p_{S,MOQ}$ for the variable remuneration, S generates an incentive for C to increase his production quantity.

A particularity of this two-tier price system is that the PSS supplier is only able to realize a profit if the actual production quantity x deviates from MOQ . This applies both for a positive and a negative deviation in quantity. It must, however, be taken into account that for a positive deviation the production quantity $x_{1,\max}$ may not be exceeded, as otherwise additional resources are required. In turn, this generates step costs.

If, however, C and S do not commit to MOQ but to the maximum quantity $x_{1,\max}$ which is producible with single capacity, S can contractually stipulate the maximum revenue. This results from choosing market price for the entire production quantity to be delivered by S. But only a minimal exceedance of $x_{1,\max}$ already requires additional capacity and additional step cost, thus S will suffer a loss. As $p_{S,x} \leq p_M$ always applies, the maximum loss resulting from exceeding single capacity is depicted in figure 4.

If $R_M(x)$ equals $C_S(x)$ both minimum quantities for single and double capacity can be defined by S. Hence, S will choose at least a minimum quantity $x_{2,\min}$ if double capacity is needed. As presented in figure 4, $x_{2,\min}$ represents the lower production limit if double capacity is offered to C. The upper production limit is defined by additional step costs for triple capacity.

Basically, the commitment of MOQ is substantially affected by the risk preference of S and C as well as by the existing information dissymmetry. There are various approaches and academic theories to determine MOQ. But, as industry is striving for cost coverage MOQ is determined by opposing revenues, resulting from different ways of pricing, to upcoming costs. Apart from break-even analysis, contract theory including negotiations between S and C should be taken into account from an academic perspective. But as observations reveal, break-even analyses are industries pricing approach number one.

In general, it can be taken from assessing the PSS in its industrial application that S will require an excessive MOQ as soon as S is more risk avers than C. The reason for this originates from the PSS-supplier's striving to minimize risk transferred to him. At the same time, the PSS-customer strives to achieve a **maximum risk transfer** to S in order to unfold production flexibility. As this dilemma substantially is caused by the information dissymmetry between the two parties, unequal distribution of information needs to be eliminated. This, however, can only be done if C is given an incentive to forfeit his knowledge advantage towards S. Such an incentive results from the PSS revenue model and its two-tier price system. With this, S is paying C to forfeit his information advantage by reducing MOQ. Committing a lower MOQ unfolds the opportunity that C can reach the revenue model's second price tier early and thus profit from a lower price than in the first price-tier.

In summary, it can be observed that risk of costs to be borne by S due to a **production quantity which is too low** to cover his expenses is covered with the 2nd stage of the PSS revenue model including a commitment of MOQ. The risk of step costs resulting from a **production quantity which is too high** still remains and will not be covered by the 2nd stage of the PSS revenue model.

3rd stage: Assured Minimum Capability (AMC)

In order to abolish the risk of **step costs arising from a production quantity which exceeds a predetermined manufacturing capacity**, the 2nd stage of the PSS revenue model is expanded once more. This is carried out by introducing an **Assured Minimum Capability (AMC)** offered by S to C to ensure a "certain level of performance" (see figure 5). AMC can be regarded as a quantitative performance measure as well as an insurance against production downtimes. Thus, C can rely on a guaranteed capability of the PSS provided by S to produce a certain quantity of semi-finished products.

Thus, S has to compensate all incurring costs resulting from non-performance. To deliver the assured quantity of semi-finished products S has to procure them from the external market. The incurring costs are composed of the production costs of external suppliers which are at least $p_M \cdot x_{non-performance}$ plus all required transaction costs, such as extra costs for transport etc.

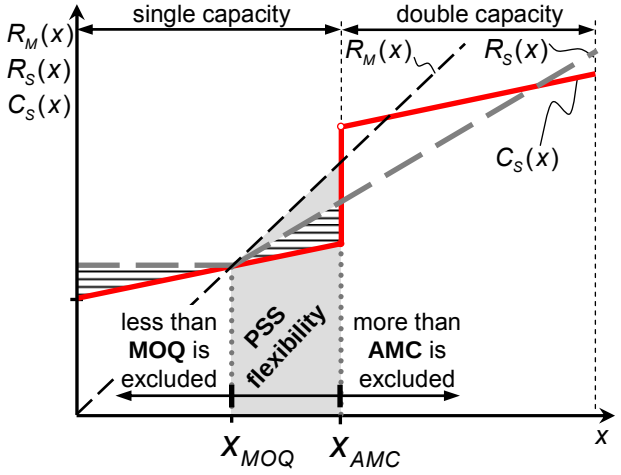

Figure 5: MOQ and AMC defining flexibility of PSS

As AMC is introduced by S to abolish the risk of uncovered step costs he defines AMC depending on the maximum quantity that can be achieved with a certain level of capacity. As depicted in figure 5, the quantity contracted in combination with AMC to ensure single production capacity equals $x_{AMC} = x_{1,\max}$. Furthermore, the maximum flexibility of a PSS is contracted. And as depicted in figure 5, it is defined by a quantity ranging from x_{MOQ} to x_{AMC}.

The benefit for S resulting from the introduction of AMC depends on the elimination of information advantages of C regarding his forecasted production quantity. This advantage will be opened up, if C discloses his maximum production quantity in order to be ensured by stipulating AMC. As PSS-customers are not just anonymous companies but human beings who decide to or decide not to reveal their intension smart wording can be extremely helpful to implicate a certain intension. In case of real world process outsourcing, especially the smart wording of "Assured Minimum Capability" generates a positive notion. But apart from a nice marketing phrase it implies that the outsourced production flexibility of C is substantially restricted by means of its underlying implication. This,

however, entails a loss of flexibility for C, because S simply contracts to be able to generate the defined quantity. Anything else is just obliging.

By extending the PSS revenue model to the 3rd stage, a quantitative corridor is defined by MOQ and AMC (see figure 5). Basically, this corridor serves for covering fixed and variable costs of S and enables S to exclude or at least reduce the risk of unforeseeable step costs. Thus, the negotiation regarding the stipulation of this corridor should be substantially steered by S as S obtains an information advantage with regard to the capacity of his production system, staff and production processes.

4.3 Concluding Remarks

It could have been shown that an unequal risk distribution between PSS-supplier and PSS-customer can, in particular, result from inefficient PSS revenue model design. In this case, risks originating from outsourcing of production processes can, however, be limited by stipulating a Minimum Ordered Quantity (MOQ) and an Assured Minimum Capability (AMC).

The necessity of limiting risks shows that mere remuneration based on production quantity combined with maximum production flexibility is probably suitable for the PSS-customer, but doesn't generate a win-win-situation for both parties. In order to realize the basic idea of PSS which can be ascribed as generating a win-win situation by integrating product and service an elimination of information dissymmetry is needed.

The comparison of findings of section 3 and the analysis of the case study of section 4 leads to the following conclusions:

- Both PSS revenue models are composed of remuneration mechanisms which comprise fixed-price, cost-plus and performance-orientieted components.
- Regarding this case study a **fixed-price-oriented remuneration** does exist if S and C do commit to a certain Minimum Ordered Quantity (x_{MOQ}) and if x_{MOQ} won't be exceeded.
- A **cost-plus-oriented remuneration** is, however, effected for a production quantity of semi-finished products which exceeds the committed Minimum Ordered Quantity ($x > x_{MOQ}$).
- A **performance-oriented component** for remuneration is achieved with the introduction of an Assured Minimum Capability. It is integrated into the PSS revenue model through the stipulation of the maximum production quantity $x_{1,\max}$ that can be ensured with single production capacity. (**Remark:** The choice of a performance measure substantially depends on the PSS characteristics. In this case study, the availability of a certain production quantity has been chosen to be the performance measure. This was necessary as there is no discrete subsystem, as with the jet engine example, but a continuous production quantity).
- Applying these remuneration mechanisms separately may lead to a one-sided distribution of risks, but combining all three of these mechanisms can end up in an equitable sharing of risks between both partners.

5 SUMMARY

A substantial effect on the exploitation of PSS potentials is determined by the design of PSS revenue models. The aim of this article was to analyse PSS revenue models with regard to their components and effects.

On the basis of the clarification of vital aspects underlying this article (e.g. revenue model, PAT etc.), the fact that PSS are in principle relevant in practice could initially be demonstrated by means of characterising "outsourcing" and "performance-based contracting". The discussion of the PSS revenue model proposed by Kim et al. [4] has led to the conclusion that a combined remuneration, consisting of fixed-price, cost-plus and a performance-oriented proportion, must always be sought for availability-oriented PSS. Only the combination of all of these components of remuneration can lead to a win-win situation for both the PSS-supplier and the PSS-customer. These findings have been confronted with a PSS revenue model which is widely used in practice, namely the outsourcing of production processes. Among others, it has been shown that this revenue model also consist of different revenue components. Here, a win-win situation for the PSS-supplier and the PSS-customer has been generated by committing a certain Minimum Ordered Quantity and an Assured Minimum Capability.

Besides, it has been discussed that PSS revenue model design should not only focus on functionality of incentive mechanisms for risk allocation and cost reduction but sometimes should also take clever wording into account.

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