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Performance-based contracting in military supply chains and the willingness to bear risks

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Abstract

Purpose – Performance-based contracting (PBC) plays an increasingly important role in the defense industry. This paper aims to investigate factors that influence service provider's willingness to accept PBC-induced risks. It also shows how these risks could be managed in a military service supply chain.

Design/methodology/approach – The case study focused on the relationship between a service provider and a customer that acted on behalf of other users in the defense sector. The contract involved the sustainment of a military engine in a complex supply chain.

Findings – The service provider's performance attributability appeared to have a strong impact on its willingness to take PBC-induced risks. For the parts where the service provider did not have full control over the service performance, exclusions and Service Level Agreements (SLAs) were used to manage and mitigate the risks associated with uncontrolled performance. The service provider's willingness to accept PBC-induced risks was also affected by its ability to make accurate forecasts, the applied growth path and the length of the contract.

Research limitations/implications – This case has specific characteristics, unique by time (maturity of the technical system and supply chain) and place (market). It is recommended that results are tested in other research settings.

Practical implications – Organizations should be aware of the factors that influence a service provider's willingness to bear PBC-induced risks. Customers should limit PBC to those parts of a contract where risks are of an acceptable level. Also, it is recommended to follow a phased growth path when it is not possible to make accurate forecasts in a PBC context.

Originality/value – This study is the first to address critical issues concerning the identification and management of risks under PBC in the defense industry.

Keywords Service supply chains, Agency theory, Risk management, Defense, Performance-based contracting (PBC), Service industries

Paper type Research paper

1. Introduction

During the past four decades, a shift in importance can be observed from a goods and or manufacturing oriented industry towards a service-oriented industry (Ellram *et al.*, 2004; Vargo and Lusch, 2004). Business services can be complex, entailing a high level of risk and

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uncertainty for the customer (Homburg and Stebel, 2009). For electronics and automobiles, maintenance services usually involve fixed payments for warranties. Complex systems, however, require a more sophisticated relationship between the customer and the service supplier. It is a managerial challenge to design contracts that can cope with the pitfalls associated with uncertainty, transaction costs and opportunism that are typically involved in complex procurement projects (Caniëls *et al.*, 2012; Williamson, 1991). In capital-intensive industries, like aerospace and defense, significant uncertainties in cost and repair make it very hard to guarantee a predetermined service level or quote a price for providing it (Kim *et al.*, 2007). Therefore, maintenance support in these industries typically involves cost-sharing arrangements, which include fixed-price and cost-plus contracts.

In performance-based contracting (PBC), the service provider's payment is tied to performance, rather than to input, activities and tasks (Kim *et al.*, 2007). PBC has gained a renewed interest and adoption in practice and in academic literature (Nullmeier *et al.*, 2016). In the past decade, PBC is playing an increasingly important role in the defense industry. Faced with sustainment costs up to two or three times the development and production costs of the weapon systems, a new sustainment strategy was needed (Randall *et al.*, 2010). The Department of Defense (DoD) introduced this new strategy in 2003 under the name of performance-based logistics (PBL) ((DAU, 2005, pp. 2-4): "the essence of PBC is buying performance, instead of the traditional approach of buying individual parts or repair action". Ever since its introduction, PBC is reshaping service support supply chains in capital-intensive industries such as aerospace and defense (Kim *et al.*, 2007).

Risk plays an important role in PBC as it changes the nature of the risk and its allocation. Risk can be defined as "the extent to which there is uncertainty about whether potentially significant and/or disappointing outcomes of decisions will be realized." (Sitkin and Pablo, 1992, p. 10). In PBC the risk is shifted away from the customer and on to the contractor (Kleemann and Essig, 2013). This shift raises important questions concerning the identification and management of risks under PBC. To date, little empirical research has been carried out on the management of this risk (Gruneberg *et al.*, 2007). Allocating and managing risk through PBC is a critical issue. It remains unclear which factors impact the contractor's willingness to bear PBC induced risks and how these risks are or should be handled in practice (Selviaridis and Norrman, 2014). This study aims to provide a better understanding of the handling of risks under PBC, more specifically:

Q1. What factors influence the service provider's willingness to take PBC-induced risks and how are these risks managed in a service supply chain?

This case study is about the relationship between a customer and a service provider with an aim to develop in-depth understanding and build on existing theory (Voss *et al.*, 2002) regarding the risk attitudes and the management of risk in PBC. The service provider is an Original Equipment Manufacturer (OEM) in the defense industry. The customer represents several users. A single case design is adopted and deemed appropriate as the case represents a typical revelatory case (Yin, 2003). Data are collected through semi-structured interviews and review of organizational documents. The open-ended designed questions allowed interviewees to develop their own views (Denscombe, 2014) on PBC and its risk implications.

2. Theoretical background

The previous section introduced the problem statement of the study. This section explores the current literature on the main aspects of the problem statement, namely, PBC in combination with service supply chain, the principal-agent model and risk management. This section shows how this study fits in the current literature landscape.

2.1 Performance-based contracting in the service supply chain

A service supply chain (SSC) consists of a network of suppliers, service providers, consumers and other supporting units. Parties in a SSC perform the functions of the transaction of resources required to produce service, the transformation of resources into services and the delivery of these services to customers (Baltacioglu *et al.*, 2007). In the beginning of this century, it was noted that the traditional view of (manufacturing-oriented) supply chain management is not entirely applicable to SSC (Kathawala and Abdou, 2003; Sampson, 2000; Sampson and Spring, 2012b). The customer has an important role in the SSC covering different characters, amongst others: the supplier, design engineer, production manager, quality assurance manager and competitor (Sampson and Spring (2012a). This phenomenon is called: *customer-supplier duality*. The customer also has an important role in the specification of the expected performance (Oflaç *et al.*, 2012). Kim *et al.* (2007) were among the first to study the use of PBC in an SSC. They analyzed two important issues of contracting in SSCs: the performance requirement allocation and risk sharing.

PBC is as a contractual approach of tying the service provider's payment to specified performance, rather than merely paying for its activities and tasks (Kim *et al.*, 2007). Characteristic of PBC is the emphasis on specification and evaluation of outcomes rather than required inputs, activities or processes of the supplier (Martin, 2007). At the core of PBC lies the contracting mechanism that the payments of buyers depend on the actual performance of suppliers. This results-oriented contracting method focuses on the outputs, quality or outcomes that are tied to (at least partially) suppliers' payments (Selviaridis and Norrman, 2014; Liinamaa *et al.*, 2016). Typical for PBC is the use of financial incentives and penalties which are linked to specified outputs or outcomes (Selviaridis and Wynstra, 2014).

Although PBC has received much attention in the last decade, it is not a new phenomenon. As the 1960s initiatives were taken with academic publications focusing on incentivizing the supplier to provide good performance for the customer. An often-mentioned example of PBC in the aerospace industry is the Roll Royce's Power-by-the-Hour™ business model where the company is compensated for engine availability[1] (flight hours) rather than the cost of labor and spare parts (Neely, 2009; Ng *et al.*, 2009; Selviaridis and Wynstra, 2014; Voss *et al.*, 2002). Inherent inefficiencies and strained relations between the customer and service provider have driven a recent move away from the traditional sustainment contracts. PBS aims to improve this by linking the service provider's profit to the amount of post-production support services they sell. The more parts break down, the more service or parts the service provider is able to sell. This return on sales model demonstrates a negativity associated with a transactional arrangement where the majority of the risk is absorbed by the customer (Sols *et al.*, 2007). The customer ends up bearing the financial burden associated with the uncertainties in reliability. The aim of PBC is to align the customer's and the service provider's objectives. PBC transfers financial risks to suppliers (Selviaridis and Norrman, 2014) and can lead to improved service and reduced costs (Kim *et al.*, 2007).

2.2 Principal-agency theory

To better understand the relationship between the service provider and customer, we take a look at the principal-agency theory (PAT). PAT analyzes problems where one party (the principal) delegates work to another party (the agent) to perform a certain task (Eisenhardt, 1989). In the case, which we will describe in the next section, the principle is the customer and the agent is the service provider. When the principal contracts an agent to perform a service on his behalf (and delegates some decision-making authority to the agent in the process) (Jensen and Meckling, 1976), the principal allows the agent's actions to directly

affect his own well-being (Toivonen and Toivonen, 2014). This addresses two specific problems that can occur in agency relationship (Eisenhardt, 1989). The first is the agency problem that arises when the desires or goals of the principal and agent conflict, and it is difficult or expensive for the principal to verify what the agent is actually doing. The latter is the problem of risk sharing that arises when the principal and agent have different attitudes toward risk. The problem is that the principal, and the agent may prefer different actions because of the different risk preferences. Eisenhardt (1989) studied goal misalignment in relation to outcome-based contracts. She concluded that with an outcome-based contract the agent is more likely to behave in the interests of the principal. For the customer, this would reduce the risk of opportunistic behavior by the service provider. Essentially, whenever the agent's actions deviate from the principal's interest/goals, there is lost agency. The degree of that deviation determines the amount of agency lost. The ultimate goal is to align interests/goals of both parties. Agencies can do that (or come close to doing that) with outcome-based contracts and performance incentives.

2.3 Risks associated with performance-based contracting

Activity-based or transactional contracts are very different from performance-based contracts. A simple cost-plus contract is activity based as it covers the costs of a supplier, providing no incentives for cost reduction or improved performance (Kim *et al.*, 2007). The Federal Acquisition Regulation (FAR) outlines three variants of a cost-plus contract: a cost-plus-incentive-fee, cost-plus-award-fee and a cost-plus-fixed-fee contract. These are all cost-reimbursement types of contracts and provide payment to the contractor of allowable incurred costs, to the extent prescribed in the contract (FAR subpart 16.3. A fixed-price contract is defined by the FAR as a contract that provides for a price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract. It places upon the contractor maximum risk and full responsibility for all costs and resulting profit or loss. And it provides maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon the contracting parties (FAR subpart 16.2 (Administration GS, 2018). Performance-based contracts link payments to performance indicators. All payments can fully relate to the performance indicator and also parts of the payment can form an incentive (Glas *et al.*, 2013). For instance, a fixed-price incentive contract provides a fixed payment, but also offers additional incentives (Sols *et al.*, 2007). We follow Glas *et al.* (2013) who identified alternatives as performance-based contracts (types A-D in Figure 1). A performance-based contract in the narrow sense fully links payments with performance (Type A, pay for performance). Performance-based contracts in

Contract pricing		Cost-plus	Cost-plus incentive fee	Pay for performance - variable price	Fixed price incentive	Fixed price
Contracts		Activity based	Performance based in the wider sense (Type B)	Performance based in the narrow sense (Type A)	Performance based in the wider sense (Type C)	Performance based in the wider sense (Type D)
Distribution of risks		Customer covers risks				Service provider covers risks

Source: Adapted from Glas *et al.*, (2013, p. 103)

Figure 1.
Activity and performance-based contract types

the wider sense have either a cost-plus basis with additional incentives (Type B, cost-plus incentive fee) of fixed prices with incentives (Type C, fixed price incentive). Even a fixed price contract is considered performance-based, whenever the contract is not activity-based (Type D, fixed price).

PBCs alter the allocation and degree of financial risks and operational risks between the service provider and the customer in the SSC (Doerr *et al.*, 2004; Ekström and Selviaridis, 2014; Selviaridis and Norrman, 2015). For most service providers the primary concern in PBC is the financial risk (Gardner, 2008). For the customer, there is also the operational risk of not being able to produce the desired effects (Doerr *et al.*, 2004; Ekström and Selviaridis, 2014). Kim *et al.* (2007) studied which contracts (Cost-plus, Fixed Price or PBC) provided the best results depending on the risk appetite of the SSC members, using a principal-agent model.

In Figure 1, moving from the left with the cost-plus contract to the right with the fixed-price contract, the amount of risk is gradually transferred from the customer to the service provider (Gruneberg *et al.*, 2007). In a cost-plus contract, the customer owns most of the risks while in a fixed-price contract, the service provider owns most of the risk. There are several other contract possibilities between these extremes, characterized by moderate distributions of risks between customer and supplier. The most commonly performance-based contracts are: cost-plus incentive fee (CPIF, type B), cost-plus fixed fee (CPFF, type D) and fixed price incentive (FPI, type C) (Berends, 2000; Glas *et al.*, 2013; Roels *et al.*, 2010; Sols *et al.*, 2007). Cost-plus-award-fee (CPAF) contracts are frequently used incentive contracts in DoD and other agencies. Especially in cases where it is difficult to establish pre-negotiated targets to cost, schedule or technical performance (for instance service acquisitions).

2.4 Management of risk associated with performance-based contracting

Risk management in PBC is about risk identification and allocation (Gruneberg *et al.*, 2007) and sequentially developing strategies for managing the probabilities of negative events and/or their consequences should they occur (Cohen and Kunreuther, 2007). Little is known about the real-world implications of how PBC changes risk (Gruneberg *et al.*, 2007). Incentives are normally used in industrial service contracts to transfer risks and to measure compliance with performance measures (Datta and Roy, 2011). Furthermore, Prendergast (2000) considered the tradeoff between risk and incentives as a central principle of agency theory. Cohen and Kunreuther (2007) state that in risk management, providing incentive plays an important role to assure an appropriate level of investment.

In PBC, both parties, the service provider and the customer, assume a certain amount of risk that is different in nature for each. For most service providers, the primary concern is financial risk; providers want to ensure that the customer will give them sufficient business with an adequate return on investment. One of the best ways for service providers to ensure profitability and reduce financial risk is to secure longer contracts. They must also carefully weigh their (operational) risks in determining the level of service they are willing/able to provide (Gardner, 2008). In this study, the willingness to bear PBC-induced risks refers to the extent that the service provider will agree on and accept terms and conditions in the contract within service supply chains.

In addition to the negotiated price, performance-based contracts often include financial penalties and incentives to promote performance. Contractual incentives are mechanisms that produce compliance with performance measures (Datta and Roy, 2013). In order to be effective, the incentives must be aligned to the overall project objectives, and not just the risk involved. Moreover, incentives should be attractive to the contractor over the entire contract duration to meet the desired performance. The design of incentive mechanisms depends

upon the type of inter-organizational governance approach used for managing buyer–supplier relationships (Datta and Roy, 2013). Factors influencing incentive design for government contracts are: develop services (quality and quantity), minimize costs and minimize budget uncertainty (Hooper, 2008). Wiseman and Gomez-Mejia (1998) studied the alignment of incentives. They noticed that aligning incentives generally involved four issues: the allocation of compensation between base and variable; the design of variable pay forms of compensation; the setting of performance targets for the awarding of variable pay and the selection of measures used in evaluating performance.

Economists use the term *risk preferences* to describe risk tolerance (Wu, 2007).This risk preference can be stated in a degree of risk aversion. Firms or individuals who are risk averse are willing to give up some possible positive outcomes to avoid risk (March and Shapira, 1987). Risk preference is studied on numerous subjects: students, animals, individuals and organizations. Principals will tend to be risk-seeking while dealing with risky options whose outcomes are generally poor. In contrast, principals will generally be risk averse when dealing with risky options whose outcomes are generally good (Kahneman and Tversky, 1979). When a service provider is risk averse, it might be an inhibitor of PBC (Selviaridis and Wynstra, 2014). Selviaridis and Norrman (2014) found four influencing factors: the ability of the service provider to:

(1) measure and control the service performance ("attributability");
(2) balance risk and reward across the SSC;
(3) transfer risk to subcontractors; and
(4) the importance of relational governance in SSC relationships.

Attributability in this study consists of two dimensions of the service provider's ability to measure, control, and influence the service output. First, the measurability of the service (performance) output and second the service provider's (lack of) control over input and behavior of the customer and the subcontractors (Selviaridis and Norrman, 2014)). Low attributability means that the service provider cannot be held responsible and accountable. Performance measurement is one of the key elements in PBC (Datta and Roy, 2011). A problem could occur when the customer lacks the necessary information to specify the decision-making activities. According to Selviaridis and Norrman (2014) and Oflaç *et al.* (2012), the ability to attribute service performance seems to depend on the measurability of the performance. The ability to control the service performance reduces the service provider's risk (Fearnley *et al.*, 2004; Selviaridis and Norrman, 2014), with more control translating to less risk for the service provider.

Incentives and penalties can be used to balance and mitigate risks. Selviaridis and Norrman (2014) state that the incentives should reflect a good balance of risk and reward for buyers and suppliers. In addition, risk sharing can be considered an important risk mitigation mechanism in PBC (Cohen and Kunreuther, 2007; Heinrich and Choi, 2007; Li *et al.*, 2015; Towse and Garrison, 2010). As a critical note however, Agrell *et al.* (2004) noticed that the problem with risk sharing/balancing is that companies might place their own interest above the SSC's and consequently leading to opportunistic behavior. In this study, balancing of risk refers to the extent that both the service provider and the customer are able to balance risks and rewards in their service supply chain, including subcontractors (Selviaridis and Norrman, 2014). Critical dimensions are the customer views on performance-based incentives (for instance, a customer can be primarily price focused and not be willing to pay performance bonus), and the sharing of risks and rewards by the service provider with the subcontractors. Subcontractors play an important part in PBC in

the SSC. In most cases, the service provider is not able to deliver the service performance alone and depends on subcontracters for significant share of the performance delivery. Datta and Roy (2013) consider uncertainty sharing between the service provider and the subcontractors the basis for sustainable PBC. However, Selviaridis and Norrman (2014) question the added value of the service provider if the risk transferred from the customer will be passed on to the subcontractors. In this study, the transfer of risk is operationalized as the transfer of (financial) risks from the customer to the service provider and on to the subcontractors.

Relational governance can reduce the risk associated with low performance attributability. The importance of relational governance is confirmed by Lu *et al.* (2015). They concluded that relational governance is important for improving project performance and mitigating opportunism. Zheng *et al.* (2008) found evidence that contractual governance should be seen as crucial but not sufficient "qualifier" for effective exchange and therefore needs to be complemented with pro-active relational governance. In this study, relational governance refers to the interfirm exchange relationships, including specific assets in combination with high levels of inter-organizational trust. Relational governance implies trust-based, flexible collaboration wherein the work is monitored while relying on social norms and personal relationships, rather than on formal governance mechanisms (contracts and authority). Building on the model presented by Selviaridis and Norrman (2014), we entered the study with the following conceptual model (Figure 2).

3. Methodology

The previous section presented the relevant literature to the problem statement. To answer the problem statement, data needed to be collected and analyzed. This section describes the process and techniques which were used to collect and analyze the data. It also shows how the reliability and validity of the case study are assured.

The case study methodology has a lot to contribute to the development of disciplines such as purchasing and supply management (Dubois and Araujo, 2007). We adopted a case study approach to gain insights in the handling of risks induced by PBC. Ketokivi and Choi (2014) discuss three different methodological approaches to case research: theory generation, theory testing and theory elaboration. Theory elaboration is not aimed at generating new theories or testing existing theories. This approach can be used to introduce new concepts,

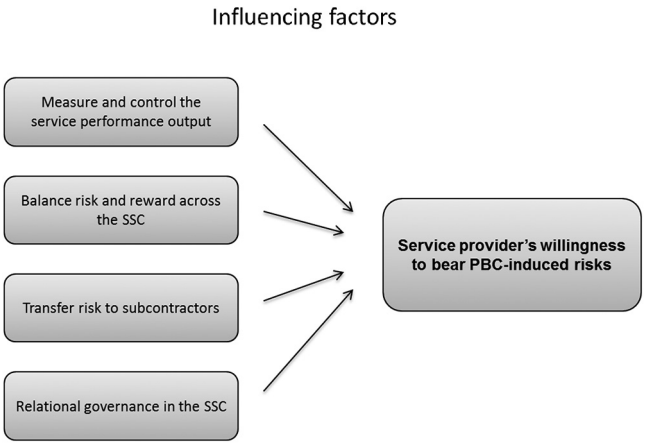

Figure 2. Conceptual model of factors influencing service provider's willingness to bear PBC-induced risks

examine boundary conditions or investigate relationships between concepts. Unlike in theory-testing, we did not anticipate the additional empirical findings by a priori formulation of propositions (Ketokivi and Choi, 2014). Our study aims to elaborate on the theory by analyzing empirical data collected through the use of a single case study (Nullmeier *et al.*, 2016). In line with Ketokivi and Choi (2014), the used process of deriving propositions from theory is considered deductive, additionally the data analysis process and the drawing of empirical conclusions exhibit inductive characteristics.

According to Yin (2003), a single case study is an appropriate design under several circumstances. He provided five rationales: it concerns a critical, extreme and unique, representative or typical, revelatory and or a longitudinal case. The selection of the case was based on the consideration that we wanted to investigate the risk handling in an information-rich PBC context. The case is part of a large PBC project (Randall *et al.*, 2010) and a complex supply chain (Fayezi *et al.*, 2012). We examined the relationship between a major OEM (service provider) and a Program Office (customer) that acts on behalf of other units (users) in the defense industry (Figure 3). The performance-based contract involved the sustainment of a military jet engine. In an activity-based contract, the demands are elaborated in a Statement of Work (SoW), in our investigated case, the performance-based demand was elaborated in a Performance Work Statement (PWS). The required performance is the (Non) Mission Capable rate of the system which is specified in a fixed price incentive contract. In terms of the PBC-categories that we described in Section 2.1, the studied contract is a performance-based contract of the type C (fixed price incentive-contracts) (Figure 1) (Glas *et al.*, 2013). This case has specific characteristics unique by time (maturity of the technical system and developing the supply chain CONUS and OCONUS) and place (market). Simultaneously developing, producing and sustaining a major component as a jet engine on this scale is unprecedented and is accompanied with a unique risk pattern. The huge financial magnitude and the fact that this is not accessible for outsiders add to the uniqueness of the studied case.

3.1 Data collection and data processing

Different sources of complimentary evidence were used, and several measures were taken to strengthen the validity of the study (Yin, 2014) (Table I). The case study involved in-depth semi-structured interviews with key informants of the service provider and the customer, as well as an analysis of documentation. These documents included the contract between the service provider and the customer and supporting documents as there were among others the performance-based logistics plan (including PWS), incentive fee plan, performance measurement process document and the metric taxonomy and calculations documents. These

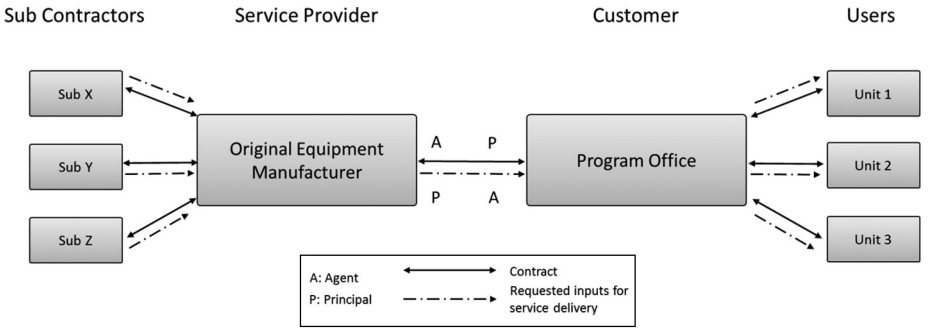

Figure 3.
Relation between the subcontractors, service provider, customer and units/users

Case study quality criteria	Measures taken
Internal validity	Several measures were taken to insure the internal validity of this study. First and utmost, pattern-matching was applied. In this case, empirical based patterns from the derived research data are compared with the propositions. These propositions are based on literature and established concepts as service supply chain management, PBC and the agency theory (Gibbert *et al.*, 2008). The data was displayed in NVivo code overviews in a way that the data could be examined for cross-analysis (conform Yin, 2003)
Construct validity	Several measures were taken to insure the construct validity of this study. One measure is using multiple sources of evidence. Several persons per unit of analysis were interviewed. Huber and Power (1985) conclude that interviewing more than one person per unit of analysis increases the level of understanding of that unit by offsetting the biases or by reducing errors through reconciling responses. Moreover, data triangulation is applied, entailing data from interviews and data from organizational documents. An additional applied measure is maintaining the chain of evidence, from source to report. NVivo is used to maintain this chain of evidence from recordings, to transcripts to codes. The final measure to insure the construct validity is to verify the operational measures before the research commenced (Flick, 2009)
External validity	The use of a single case study has the advantage of greater depth, but obviously limits the external validity of the results. The selection of the case was based on the consideration that we wanted to investigate the handling or risks in an information-rich PBC environment. In relation to the external validity it's important to take in to account the context of this case study (Gibbert and Ruigrok, 2010)
Reliability	Several measures were taken to insure the reliability of this study. One measure is using the case study database, which includes interview recordings, transcripts, quotations, codes, memos and related documents. Another measure to insure the reliability is the development and use of the interview guide (Appendix) (Voss *et al.*, 2002)

Table I. Case study criteria and quality measures

documents were an important source of data as the contract content could be related and compared to the data gained from the interviews. The interview questions covered several themes such as the (actual) risk transfer to the service provider, the incentives, and the factors that influence the willingness to bear PBC induced risk by the service provider. The interview process was conducted as described in Figure 4. After identifying the candidates to provide the essential case study data, an interview date was set. During each interview the same structured interview protocol was used to safeguard the reliability of the study (see Appendix Interview Guide with the structured interview protocol). After the interview, the data were processed and the draft report was adjudicated by the interviewee. Depending on the comments, the report was either adjusted and sent back to the interviewee for endorsement or made final and stored in the case study database. The interviews were conducted following the guidelines stated in Interviewing as Qualitative Research (Seidman, 2013).

Interviews were held with key managers spanning several positions in the PBC process: procurement officers, contracting officers, account managers and business development managers. Four managers from the customer side were interviewed and three managers from the service provider side, together they formed the group that worked the PBL construct from the customer and service provider side. The other sources of data were organizational documents, such as the PBL plan and the PWS of the contract. These documents describe the essence of the contract, namely, the required performance, measurement of the performance and incentive structure.

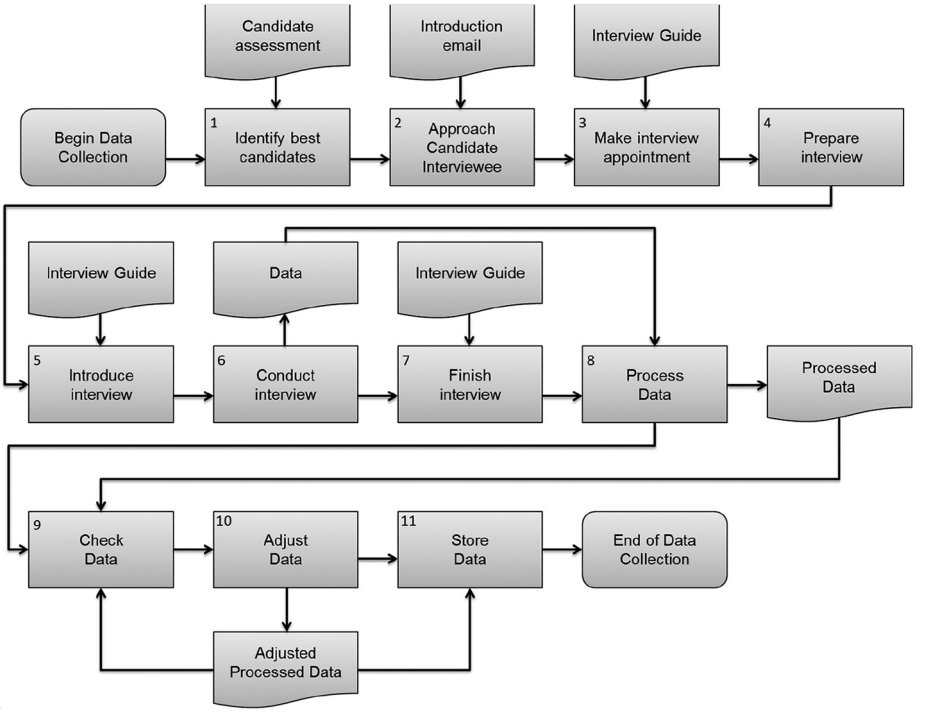

Figure 4.
Interview data collection process

Coding was used for data reduction to make the analysis of the large amount of data more efficient. Codes have been assigned to the fully transcribed interviews and documents. The qualitative data analysis software program NVivo was used for this coding process to label and index-related data. NVivo allows you to add codes (or nodes as they are called in NVivo) before, during and after processing the data. For the first cycle of coding, a provisional and descriptive coding process was used followed by structural and sub-coding (conform Saldaña, 2009). Pattern coding was used as a second cycle. In line with the coding process presented by Miles and Huberman (1994), the initial codes were related to the factors that influence the service provider's willingness to bear PBC induced risks, such as *control of the service performance* and *balancing risk*. As new insights emerged and part of progressive refinement of the codes, sub-codes and new codes were added to new findings and observations, like the *uncertainty due to accurate forecasts* and the *length of the contract*. NVivo was also used as the database to store all the used data, namely, recordings, transcripts, articles, etc., to maintain an evidence trail. Afterwards all the coded material was presented in one clear overview, allowing better and easier pattern matching. Following the three concurrent stages of Miles and Huberman (1994) after the data reduction and data display the next step was analysis.

During the interviews and after transcription attempts were made to recognize patterns between the different interviewees and organizational documents. According to Almutairi *et al.* (2014), pattern matching techniques can be used to reconcile the multiple perspectives of knowledge in case-study research. Pattern matching also helped to insure the internal validity of this research (Yin, 2003). We have applied within-case analysis. The codes helped

with a within-case reliability check as the codes had a large number of agreements in relation to total number of agreements (Miles and Huberman, 1994). According to Eisenhardt (1989, p. 533): "within-case analysis gains familiarity with data and preliminary theory generation". Within-case analysis was applied within the unit of analysis and between the unit of analysis and the documents.

4. Results

The previous section showed how the data to answer the problem statement was gathered and analyzed. This section presents the findings of this analysis. We begin with a description of the relationship between the service provider and the customer and the characteristics of the case. In the following paragraphs, the findings related to the factors obtained from literature are discussed. This section concludes with three new found factors which influence the service provider's willingness to bear PBC-related risks.

4.1 The PBC case and characteristics

The study consisted of conducting a single case study that exemplifies the PBC construct. The customer and service provider in this case study worked together for a considerable amount of time on this PBC construct. The service provider is the OEM of the engine with a long-standing relationship with the customer. This is the first performance contract between the two parties and is considered a transition PBL contract. The PBL plan contains the PWS, considered as the working end of the contract describing specifics who, what and how of the required service performance. The case is part of one of the biggest US military development and sustainment projects in history (Vucetic, 2013), with a total expected program cost of US $1.5tn (through 2070 in then-year dollars).

In Firm Fixed Price contracts and in performance-based contracts, financial risks are primarily transferred to the service provider. However, the studied documents do not mention any transfer of financial risk. It appeared that the service provider was only partly paid on a performance basis for his sustainment activities. The interviewees agreed that a limited *financial risk* was transferred to the service provider in this contract. The operational risk however, is supposed to remain the customer's responsibility. The discussions tended to get a more philosophical as to whether one (governmental) organization can contract another organization to be responsible for its own core business. According to a manager of the customer:

> You can hold the service provider financially accountable for financial risks but if he fails, the customer is still responsible for the operational risk. The operational risk of not being able to conduct the (fighter/bomber) mission is still on the customer.

In PBC, the customer is supposed to incentivize the performance of the service provider, while balancing the risks with these incentives. The contract shows two incentivized metrics, one on performance and one on costs. The performance metric is the non-mission capable (NMC) rate. The costs metric is on the total cost of the contract. The contract does not literally state risk is transferred to the service provider and incentives are used to balance this. The interviewees provided similar answers:

> There are financial incentives in place to balance the change in allocation of the risks. We have one incentivized metric on performance. The incentive is fee or profit.

> As a service provider, we are willing to accept an increased amount with risk, but you need to be able to control at least a portion of the performance outcome. And it needs to be rewarded.

The service provider is supposed to behave in the interest of the customer in accordance with the number of PBC constituents in the contract. The case study provided evidence to support this assumption. A manager of the service provider:

> [. . .] [red. on another contract] we improve the reliability of the parts that resulted in an improved Time on Wing. For the service provider this meant fewer parts to be repaired (equals less costs), for the customer this meant higher serviceability of the engines (aircraft) and significantly improved readiness.

Still, there was a critical note from the side of the customer:

> Right now, we have a cost-plus incentive fee, so the contractor has to give us insight in their spending (amount of man-hours). Once you move to a fixed price, you will not have that insight. So you're paying for certainty. But you might be paying too much, which is not in the best of our interest.

4.2 Factors influencing the service provider's willingness

The model showed four factors that influence the service provider's willingness to bear PBC induced risks. These factors and the extent to which the data from this study supported these factors will be discussed below.

4.2.1 The ability to measure and control the service performance. There are clear definitions in the PBL plan describing how the service performance is calculated. There is also a procedure to adjudicate and reconcile the data derived from the monitoring systems. However, *control* on the service performance is considered a major factor. Neither the service provider nor the customer has complete control over the service performance. Two examples of area where the service provider does not have performance control to a great degree are the maintenance performed by third party and foreign object damage (FOD). The latter refers to any damage or incident attributed to a foreign object that can be expressed in physical or economic terms which may or may not degrade the product's required safety and/or performance characteristics (Technologies NCFAT, 2009). Exclusions and service level agreements (SLAs) on uncontrolled performance output are a way of managing and mitigating the risks associated to not having full control over the performance. As a customer put it:

> As the service provider has more control of his destiny the more willing he is to sign up for PBL. For certain activities that the service provider does not control (to a great extent) the service provider will want to put a box around if (define exclusions).

And the service provider:

> We are willing to accept more risk when we're able to control our destiny. A good example would be Non-Mission Capable Supply which we control and Non-Mission Capable Maintenance which we don't (directly). We will take on risks that are acceptable for both parties. If we go (full) PBL we will have to put a box around it. So certain events will be out of scope.

All respondents consider the ability of the service provider to measure and control the service performance an important factor influencing the willingness to bear PBC induced risks. The exclusions and SLAs in the PBL plan reflect this need to manage and mitigate this factor. The interview and document data support the impact of the measurement and control on the willingness to bear PBC risks.

4.2.2 Balance risk and reward and transfer risk to subcontractors. The service provider is assumed to be willing to bear more risks to the extent that he is able to transfer risk to subcontractors. According to the data derived from the interviews, balancing risk and

rewarding takes place between the customer and the service provider and between the service provider and the subcontractors. A customer:

> We balance change in risk by stating what is included and excluded in the contract. For instance, with FOD we incorporate risk sharing. The idea behind risks sharing is that the service provider does not have to calculate or price for all risks. As a customer we are recommending the service provider to flow the same amount of risk down to the subcontractors, as they are being transferred from the customer.

The responses from the respondents were all in line, both from the customer and the service provider. A customer manager stated:

> An example is with a particular subsystem where the service provider has a PBL contract with the subcontractor. And I think there is no other way around that. Service provider flows down the risk, and the incentives as well.

The actual contracts between the service provider and its subcontractor(*s*) were not made available due to confidentiality reasons. However, the interview data show a consistent image, where the willingness of the service provider to bear the PBC induced risks is positively influenced by the service provider ability to transfer risk to the subcontractor.

4.2.3 Importance of relational governance. Based on the literature review, relational governance is generally thought to have a positive impact on the willingness of the service provider to bear PBC-induced risks. In the interviews, the relation between the customer and service provider is consistently described as good. Regarding trust, all interviewees underlined the importance of trust in a PBC relationship. Obviously, it does not make sense to negotiate with a service provider without a limited level of trust. However, during the interviews, it became clear that relational governance was not a factor of major importance during the development of this PBC contract. As a service provider manager put it:

> Trust is good in the working environment, but when it comes to payment, I think it's better to have it written out in a contract. And it's important to have clear inclusions, exclusions, calculations and boundaries.

In the proposed PBC contract, the service provider is not given much autonomy for making his own decisions:

> Then there is the "mother may I" factor, where in some cases the service provider has to ask permission to take certain actions. I would say that we have medium control on this value stream. For instance, we are still not able to decide where we sent engines [the location of spare engines can influence the down time of an aircraft and thus the NMC rate, the service performance].

Both parties emphasize the importance of trust and relational governance and trust in PBC. However, the propulsion performance based logistics (PBL) Plan and PWS give the service provider limited freedom of movement and control.

4.3 Additional factors influencing the service provider's willingness

During the interviews, coding and pattern matching process, three additional major factors emerged. These factors were supported by the interview data from both, the service provider and the customer and the documents. These three additional major factors are ability to make accurate forecasts in relation to the maturity of the system, the growth path toward full PBC and the length of the contract.

4.3.1 Ability to make accurate forecasts in relation to the maturity of the system. At the time of the interviews, the equipment was technically not fully mature. The data gathered on reliability, maintainability and serviceability might not be representative for future

sustainment costs and performance, thus generating uncertainty. The same is true considering the service supply chain. The fleet consisted of 150+ aircraft stationed in the USA, spread over 12 sites. The coming years, the fleet projected to grow considerably, and the service supply chain is expected to keep pace. In 2020, the fleet is projected to grow to 650+ aircraft stationed across 11 different countries and spread over 40+ sites. This growth will be accompanied with uncertainty, as there are no figures or experience to build a reliable forecasting model for this venture. The inability to make accurate forecasts creates risks that have to be managed. In this study, two mitigation measures were recognized: the length of the contract and a phased growth toward full PBC.

Although it has not been expressed as formal strategy by the customer, the studied document and previous contracts show a similar and consistent picture. The immaturity of the system and the subsequent inability to make accurate forecasts are related to the amount of risk that is being transferred to the service provider. The more immature the system, the more risks are involved, the higher the price to transfer the risks to the service provider. This was deemed to be the primary reason for the contracts to be cost-plus with incentive fee.

4.3.2 The growth path toward full performance-based contracting. A way of handling uncertainty in a maturing environment is to take small incremental contract steps toward full PBC. By only transferring the sustainment activities where the service provider is comfortable in providing, the customer is likely to receive better value. In the current contract, just the sustainment activities related to engineering and support labor is on PBC. The sustainment activities related to the repair of parts is still on Cost-plus Incentive Fee. Because the system is not fully mature small steps are taken to limit risk. This factor is closely related to the ability to make accurate forecasts and could be considered a way of handling the uncertainty of the immaturity of the technical system and service supply chain.

4.3.3 Length of the contract. All interviewees agreed that the length of the contract influences the service provider's willingness to bear the risk. It influences the willingness in different ways and has a relation with the maturity of the system and supply chain, the behavior of the service provider, the trust relationship and uncertainty concerning contract renewal. The looked-for length of the contract depends on the uncertainty related to the maturity of the system and supply chain. A manager of the customer stated:

> The length of the contract is another way in which the financial risks are managed. In the beginning the contractor is not interested in setting up a five-year contract. The costs of a flying hour are too uncertain. Getting real representative data of the maturity of the system is a way to manage risk. With a one-year contract the contractor does not have enough time to improve the parts. So in that case to PBC construct doesn't work.

For the sustainment activities where the data are representative and where there is less uncertainty for the service provider, the service provider would like to have longer-term contracts. In these instances, the service provider can invest in service performance and see a return on investment:

> The one-year contract prevents us from buying a large amount of parts for the coming years based on the forecasted utilization. This prevents us from negotiating a lower price for the parts. For us an optimum contract length is five years (Figure 5).

5. Discussion and recommendations

PBC plays an increasingly important role in the defense industry. In PBC, risk is an essential consideration as PBC changes the nature of the risk and its allocation. This shift in risk

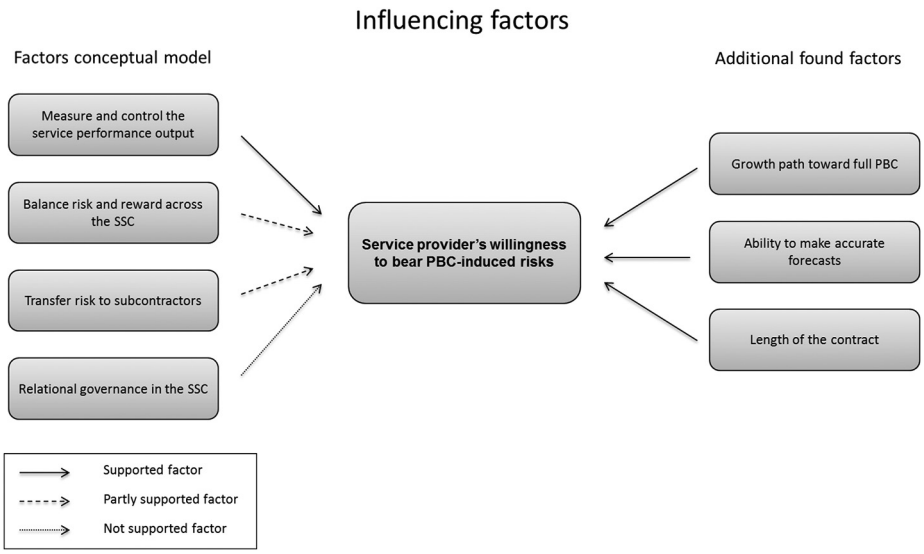

Figure 5. Factors influencing the willingness of the service provider to bear PBC induced risks

raises important questions concerning the identification and management of risks under PBC. To date, little empirical research has been carried out on the management of risk under PBC. This study was aimed at shedding light on factors that impact a service provider's willingness to bear PBC-induced risks and how these risks are or could be managed in practice. In their 2014 study Selviaridis and Norrman (2014) identified four factors influencing this willingness, these are: performance attributability, balancing risk and reward across the SSC, transferring risk to subcontractors, and the importance of relational governance in SSC relationships. These factors served as the basis of our model. At the end of our study three additional factors were identified: utilization of a growth path toward full PBC, the ability to make accurate forecasts and the length of the contract. Additionally, two ways of managing the lack of total performance attributability were identified. The investigated case is a typical example of a large PBC project in the defense industry

5.1 Discussion of main findings

In this section, we will describe the significance of the main findings in light of what was already known and discuss the impact of our new insights. This insight consists of the three additional factors that were found that strongly influence the willingness: the chosen growth path towards full PBC, the ability to make accurate forecasts and the length of the contract. The other new insight that was found is the way a lack of total performance attributability can be managed.

5.1.1 Performance attributability. In this study, two ways were identified on how the risk of not having total *performance attributability* (total control of the service performance) are managed, by exclusions and SLAs. Where the service provider is not completely in control of the service performance, the service provider wants to exclude (some of these) risks or share risks with the customer. These exclusions can be addressed during a reconciliation process between the service provider and the customer. The SLAs are beneficial when the service provider is dependent on another entity to perform part of the service performance for example the maintenance performed by the customer. The service provider only accepts

this lack of performance control when the customer performs above a certain service level. When the customer fails to live up to these SLAs, the service provider will have to be compensated for loss of service performance. This is a case of *customer-supplier duality*; besides being one of the primary supplies of process inputs, the customer is also actively responsible for delivering part of the service performance.

5.1.2 Ability to transfer risk. In PBC, risks are likely to be transferred from the contractor to his subcontractors. In our study we found evidence for this mechanism. As a result, the *ability to transfer risk* down the service supply chain positively impacted the willingness of the service provider to bear PBC induced risk (Selviaridis and Norrman, 2014).

5.1.3 Relational governance. Relational governance is generally considered critical for improving performance and mitigating opportunism (Lu *et al.*, 2015). In our study too, it was found that relational governance played an important role in the PBC relationship. However, there was still a strong emphasis on the contractual governance. The service provider is not given more control, which one would expect when moving toward a performance-based contract. The findings of this study are in line with Zheng *et al.* (2008) who found that contractual governance should be seen as crucial but not sufficient "qualifier" and therefore should be complemented with pro-active relational governance.

5.1.4 Growth path toward full performance-based contracting. PBC literature emphasizes that risks are *gradually* transferred from the customer to the service provider (Gruneberg *et al.*, 2007). Our study also identified a *growth path*, including several dimensions or ways to move toward full PBC. One of the ways is to progress on the PBC continuum, from cost-plus contracts to full PBC (Glas *et al.*, 2013). Alternatively, this can be achieved through the scope of the performance contract. The study revealed that the parts where the service provider is confident in achieving the service performance (low risk) are managed on a performance basis. In case of higher uncertainty and risk, that part of the contract remains on a transactional basis. This last dimension is not prominently addressed in the literature as a factor influencing the willingness of the service provider to bear PBC risks, particularly its management.

5.1.5 Ability to make accurate forecasts. The results indicate that the *ability to make accurate forecasts* positively impacts the service provider's willingness to bear PBC-induced risks. If a risk cannot be managed (well), the service provider is less willing to bear that risk. This is especially true for the uncertainty related to the technical performance and growing (global) sustainment footprint. This is closely related to what Brown and Burke (2000) concluded, that accurate historical data records are critical to effectively manage performance risks. Our study gives an example on how performance risks caused by the inability to make accurate forecasts are managed in practice. A more mature system would improve the accuracy of forecasts. The inability to make accurate forecasts creates risks. Obviously, there is a price tag on transferring risks to service providers. We cannot indicate which level of maturity is necessary to switch to PBC, although there is a clear need for a system capable of providing reliable forecasts.

5.1.6 Length of the contract. In this study, it was found that one of the best ways for service providers to ensure profitability and reduce (financial) risk is to extend the *length of the contract*. This is in line with formal guidelines of the Defense Acquisition University (DAU, 2005). The service provider wants to be confident that they will receive an adequate return on investment and cash flow. With Cohen and Kunreuther (2007), we conclude that the length of the contract is a factor influencing the service provider's willingness to bear PBC induced risks. In addition, it became clear that federal law sometimes restricts the use of multi-year contracts, which makes it more difficult to persuade service providers to invest in a long-term relationship.

5.2 Managerial and theoretical implications

This study has managerial implications for entities operating in a PBC environment. Managing risks induced by PBC is a complex matter. Companies should be aware of the investigated factors that might influence a service provider's willingness to bear PBC induced risk. Awareness of these factors could improve the ability to align the goals of the customer and service provider, one of the aims of PBC.

Particularly, the service provider's performance attributability is a factor to take in to account in PBC relationships. This study provides two methods to manage this factor: exclusions and SLA's. Exclusions take area's where the service provider has (very) limited control over required performance, out of the scope of the contract. SLA's with third party providers (or in some cases the customer himself) gives the service provider a greater level of certainty that he will able to provide the desired performance. This limits the amount of risk to the service provider, which should translate in a more affordable contract for the customer. Although more study on this subject is recommended, these methods can be taken in consideration when performance attributability is an issue in the PBC relationship.

Our study confirmed the importance of collecting and analyzing accurate historical data necessary for making reliable forecasts. Accurate historical data and corresponding accurate forecasts are critical to manage performance risks. Customers should have sufficient data to accurately forecast future costs, as these are a considerable risk factor in PBC. A stepped or phased growth path could be selected to manage the risk of not being able to make accurate forecasts.

A stepped of phased growth path can be taken in several dimensions. Perhaps the most common approach is to gradually move from a transactional contract to the full PBC contract (Figure 1): gradually moving from the left (transactional) to the right (full PBC). Another (hybrid) approach is to contract those sustainment activities where the risk is acceptable under a PBC. Sustainment activities which still pose a significant risk are better to keep on a transactional contract, as high risk will translate in a high price for the customer. The amount of incentive fee could be considered another dimension of the growth path. Particularly in the beginning of a PBC relationship there could be uncertainty on both sides whether the desired performance is achievable and to what effort. Keeping the incentive fee relatively small in the beginning of the PBC relationship allows both parties to get familiar with new construct without high financial risks. The same can be said about the objective value of the incentivized metric. When the sustainment activities are in a more mature and steady state and thus risk is reduced, the incentivized metric and the incentive fee may be adjusted.

5.3 Limitations and future research

This study has limitations which could be addressed in further research. The use of a single case study limits the external validity of the results. This case has specific characteristics unique by time (maturity of the technical system and supply chain) and place (market). The results should therefore be interpreted with caution. The results could be tested in another research setting. Another recommendation would be to perform a similar study when both the technical system and the supply chain are in a stable, full grown state. It will be interesting to see how this case changes over time, particularly the growth path in relation to the maturity of the technical system and the global service supply chain. Further research is needed to extend the knowledge in this field and to identify whether findings can be generalized to other PBC projects in the defense industry.

6. Conclusions

The aim of this study was to identify the factors influencing the service provider to bear PBC induced risks. For our model we used four factors obtained from previous literature:

(1) measure and control the service performance ("attributability");
(2) balance risk and reward across the SSC;
(3) transfer risk to subcontractors; and
(4) the importance of relational governance in SSC relationships.

The service provider's performance attributability was indeed found to be a strong factor influencing the service provider's willingness. In this study, the service provider did not have total control over the performance outcome. This study showed two methods on how this can be managed by the customer and service provider, namely, Service Level Agreements and exclusions.

The other factors obtained from literature were not deemed prominent based on the observations of this case study. In our study, three additional factors were found that strongly influence the willingness: the chosen growth path toward full PBC, the ability to make accurate forecasts and the length of the contract. Awareness of these factors and managing them could help to align the goals of the customer and service provider, achieving one of the primary aims of PBC.

Note

1. Time on wing.

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Appendix. The interview guide

Performance-based contracting/logistics

This research is about PBC and is defined as: a product support/sustainment strategy used to achieve measurable performance outcomes for a weapon system or subsystem. A PBC approach focuses on developing strategic performance metrics and directly relating contracting payment to performance against these metrics.

General questions

(1) Can you describe the organization you work for (core business, products/services, key customers/suppliers)? [information is given, there is an opportunity to correct and add]

(2) What does your job entail?

(3) Can you tell something about what your tasks, authority and responsibilities are in relation to PBC?

PBC-induced risk

It has been shown that PBC alters the (allocation of) risk in the service supply chain.

(4) Which risks are associated with the PBC?
- Which financial risks are identified (please describe)? How severe are these? In what extent are these risks are transferred to the service provider? How are the financial risks managed? How did that work out?
- Which operational risks are identified (please describe)? How severe are these? In what extent are these risks are transferred to the customer? How are the operational risks managed? How did that work out?

(5) Were there any mechanisms in the contract to balance the (possible) change in allocation of the risks? (Ask for examples). For service providers: how was this the case in the contract with the subcontractor?

(6) In PBC risk is transferred to the service provider, wherein the customer builds in incentives for the realization of the performance. Which incentives are applied? What results have been achieved? Does it help to align incentives and goals? For service providers: how was this the case in the contract with the subcontractor?

(7) What is the customers view on the use of incentives (willingness to pay performance bonuses or risk premium)?

There is wide range for PBC contract ranging from cost-plus incentive fee to full PBC. PBC constituents in this research are defined as PBC components in the contract, where the cost-plus incentive fee has limited PBC constituents and full PBC has a maximum of PBC constituents.

(8) In case of PBC it is said that: "the more PBC constituents, the more the service provider will behave in the interests of the customer". Do you agree with this statement? What PBC constituents have been applied in your case? Can you give examples and explain how they affect performance?

(9) Which performance metric is agreed upon in the contract? Is this metric being met? If yes, how? If not, why not? What can you tell me on the cooperation and commitment of the service provider on reaching the desired performance? Did the PBC contribute to this performance and in what way? How did that work in practice?

(10) How does the payment/incentive structure impact on customer/supplier behavior?

Willingness to bear PBC-induced risk

Willingness to bear PBC induced risk denotes the service provider accepts the terms (e.g. allocation of risk) in the contract and commits to successful execution.

(11) Are you as service provider prepared to accept an increased amount of risk in this specific customer/supplier contract? Under what conditions?

(12) What factors *positively* influence the service provider willingness to bear PBC induced risk? Please elaborate. (Ask for specific examples. Relation with paragraphs in current or future contract?)

(13) What factors *negatively* influence the service provider willingness to bear PBC induced risk? Please elaborate. (Ask for specific examples. Relation with paragraphs in current or future contract?)

(14) In case of PBC it is said that: "as the service provider is better able to measure and control the service performance, the more willing the service provider is to bear PBC induced risks". Do you agree with this statement? How is the performance measured in your case? What can you tell me on the extent of control the service provider has on the service performance (are there many exclusions)? How does this influence the willingness? Can you give examples and explain how this affects performance?

(15) In case of PBC it is said that: "as there is more control based on trust and relational governance (and not on the basis of contracts), the more willing the service provider is to bear PBC induced risks". Do you agree with this statement? How would you describe the relationship in terms of collaboration, thrust and flexibility? How is the relationship between service provider and customer regulated? For service providers, and with the subcontractors? Can you give examples and explain how this affect performance?

(16) On relational governance, how would you describe the relationship between the service provider and the subcontractor in terms of collaboration, thrust and flexibility?

(17) In case of PBC it is said that: "as the service provider is better able to pass on risks to subcontractors, the more willing the service provider is to bear PBC induced risks". Do you agree with this statement? In your case, are the risks transferred to subcontractors (are there any PBC constituents in the contract between the service provider and the subcontractor)? How is the subcontractor rewarded for this risk taking? Can you give examples and explain how this affects performance?

(18) How would you describe the subcontractor willingness to bear PBC induced risks? In this respect, how would you describe the subcontract ability to influence the end customer performance?

(19) In case of PBC it is said that: "as the service provider is better able to balance risks and rewards, the more willing the service provider is to bear PBC induced risks". Do you agree with this statement? How are risks and rewards balanced in your case? Can you give examples and explain how this affects performance? What is the service providers' view on risk and reward sharing with the subcontractor?

Closing questions

(21) Access to complementary documents (e.g. contracts)?
(22) Suggestions for other interviewees and/or research issues?
(23) OK to come back for supplementary questions?

Interview process

The flowchart on the data collection process, including the interview process, is attached in Appendix. The data collection process consists of 11 steps. Each step will be clarified below. Figure 4 shows the flowchart of these steps. Also see Figure 4.

(1) The first step is to identify the best candidates for the interviews. The "best candidate" in this context is considered the person and or official who can contribute the most to get a clear understanding of factors influencing the service provider's willingness to take PBC-induced risks and how are these risks managed in a service supply chain.
(2) After the candidates are identified, they will be approached either direct or through their supervisor, depending on the situation. The candidate will receive the elementary information of the interview, as there are the goal of the research, the goal the interviews, anonymity and what will happen with the derived data.
(3) Up next will be setting the actual appointment. A copy of this interview guide will be send to the interviewee so he or she knows what to expect.
(4) The preparation of the interview includes reserving a suitable location to conduct the interview and preparing al necessary paperwork and equipment.
(5) During the introduction the following topics will be addressed: goal of the research, the goal the interview, the interview process, agreements on privacy (anonymity), the use of voice recorder, the use of data and data security.
(6) During the interview, the information will recorded on a voice recorder and written on paper.
(7) At the end of the interview, the next steps (8 to 12) will be explained.
(8) The information/data from the interview will be processed. This involves writing an interview report based on data from the voice recorder and notes and recollections.
(9) When the draft interview report is finished, it will be send to the interviewee for adjudication.
(10) Depending on the comments, the report will adjusted and send back to the interviewee for confirmation or the final interview report will be stored.
(11) The data will be stored in the interview report and in the case study database. The data will serve as input for the research.

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