Performance-based logistics: a portfolio for contracting military supply

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Abstract
Purpose – The purpose of this research is to analyse military logistics providing a decision support instrument for contracting in defence supply chains.

Design/methodology/approach – This instrument – the Performance-Based Logistics (PBL) portfolio – is developed following the contingency approach. Qualitative interviews and illustrative examples from Germany, Austria and Switzerland are used to validate the portfolio.

Findings – The proposed portfolio examines a military demand in respect of its required effectiveness (robustness and resilience), and the suppliers’ ability to influence efficiency (forecast and supply risk). In combination, the contingencies are used to recommend three alternative types of PBL contracting.

Research limitations/implications – This paper is based on conceptual work with illustrative case examples. Therefore, although the authors believe that the PBL portfolio provides useful guidance for further research, the empirical applicability of this instrument must be proven.

Originality/value – The research on PBL is gaining importance, but still there remains a deficiency of theoretical grounding and management instruments. This study is a first approach to use the contingency framework for developing such an instrument. The value of the PBL portfolio lies in supporting normative decision making for contracting military supply.

Keywords Defence supply chains, Security logistics, Outsourcing, Performance management, Pay for performance

Paper type Research paper

Introduction
Support expenditures of a weapon system, including logistics, exceed the costs of development and production by two or three times (Flint, 2007). In total, the US Department of Defense (DoD) spends more money on repairing weapon systems than on buying new ones with a comparable situation in other nations, such as Germany (Geary and Vitasek, 2008; Huber and Schmidt, 2004). Therefore, a new strategic initiative is needed (Grineberg et al., 2007), and performance-based logistics (PBL) is addressing the problem of extraordinary support costs for complex product systems such as aircraft, infrastructures and weapon systems in defence supply chains (Randall et al., 2010).
Despite increasing research in the PBL field (Selviaridis, 2011), there are still deficiencies relating to the theoretical grounding and empirical backing for the approach (Randall et al., 2010), and there is a surprising scarcity of academic publications on this subject (Buchanan and Klingner, 2007). Simultaneously, practitioners lack appropriate instruments for PBL management, and this study seeks to provide a decision support tool for contracting military supply.

Military logistics is the art of planning, coordinating, and conducting the movement and maintenance of forces (NSA, 2009). In contrast to commercial logistics, military logistics include all the processes used to enable deployed armed forces to continuously maintain their readiness to accomplish missions (Tuttle, 2006). Often, the definition also encompasses the transport of personnel and medical health services (NSA, 2009), but as the transport of material goods and health services follow different rules, this study focuses on logistics as the process of planning, implementing, and controlling the efficient and effective flow of goods, services, and related information (CLM/CSCMP, 2010).

Military equipment is often in use for decades, therefore it is essential to consider the total costs (Ellram and Siferd, 1993). Approximately 70 percent of the money spent on a weapon system is used for logistics and maintenance (Berkowitz et al., 2004). The high cost of supporting existing equipment results in a lack of funds for new material or the modernisation of aging systems. Therefore, military logistics is subject to numerous cost-reducing activities. Outsourcing, the transfer of tasks to suppliers (Dirlewanger, 1991), promises to be a “painless alternative” for costly in-house military logistics due to the expected higher efficiency of private companies (Moore, 1987). Outsourcing of logistics services is generally of high importance in both theory and practice (Randell, 1991; Hofmann, 2009). However, commercial outsourcing approaches act in relatively secure conditions, whereas military logistics face numerous challenges from damaged infrastructure to enemy attacks. Whereas the “first mile” of military logistics is very similar to private-sector logistics, the “last mile” is completely different. The consideration of outsourcing in the military context and the possible use of PBL lead to the first research question of this study:

RQ1. Which logistics tasks may be outsourced using PBL? (demand aptitude).

Outsourcing necessitates the integration of private and military logistics. Close inter-organisational cooperation can positively influence performance (Carr and Pearson, 1999). However, the private sector acts in market conditions that orient all parties toward one major objective: profitability. By contrast, the military acts in unstable and dangerous (e.g. combat or frontline) conditions while simultaneously trying to reach several military, political, and economic objectives. Economy and efficiency are, thus, somewhat secondary or side conditions of military tasks – the objective of which can be simply stated as “mission success”.

In a defence supply chain it is necessary to align profit-oriented enterprises with military organisations focused on their mission. PBL is an approach that promises to combine both sides by improving performance and simultaneously reducing costs by linking the providers’ compensation to the outcome value of products rendered (Fowler, 2008; Kim et al., 2007). However, even the – more or less private – defence industry is reluctant to take over military support tasks without having enough control on costs and performance. This leads to the second research question:
**RQ2.** To what extent is a private-sector provider willing to agree to a PBL-contract?
(supply aptitude).

To answer both research questions, this work provides a PBL portfolio which can be used to describe and explain logistical service-contracting types with reference to the particularities of the defence context. We use the contingency approach to develop the portfolio (Fiedler, 1967). The analysis of contingency factors provides insights into the demand requirements of military decision makers as well as the business risks of the defence industry, which are then combined to explain the most applicable PBL contract type.

The remainder of the paper is structured as follows. In the following section we provide a review of the literature on the contingency approach and PBL followed, by a discussion of our methodology. Next, we present the PBL portfolio and describe how military logistics can be evaluated; this is followed by a section in which we use case examples from Germany, Austria and Switzerland to illustrate our findings. Finally, we discuss the results and conclude with an outlook for future research.

**Literature review**

*Contingency approach literature*

The contingency approach assumes that the optimal course of action for an organisation depends on its internal or external situation (Fiedler, 1967; Ashour, 1973). The contingency approach originated with the explanation of organisational forms or structures with respect to particular circumstances (Lawrence and Lorsch, 1967; Drazin and Van de Ven, 1985; Donaldson, 2001). According to Sousa and Voss (2008, p. 698), it reasons “[…] that organisations adapt their structures to maintain a fit with changing contextual factors, so as to attain high performance”.

The contingency approach has been adapted to numerous management problems such as the dynamics in strategic alliances (Birkinshaw et al., 2002; Nasrallah et al., 2003) or supply chain collaborations (Fawcett et al., 2008; Guide et al., 2003). In general, a contingency framework helps to explore the interrelationships of corporate or supply chain structures within a specific environment reflecting the strategy-structure-performance paradigm (Chandler, 1962).

For the analysis of military logistics, contingency factors such as political-military tasks, capabilities, weapon systems and the size and deployment of the armed forces can be used to identify structural differences. However, contingency factors influence the design only to a certain extent. It is a strategy that modifies the design of an organisation, and this refers back to the “strategic choice approach” (Child, 1972). This approach argues that an organisational structure can only be partly explained by contingencies. Decision makers choose structures that coincide with their cognitive and motivational orientations (Bobbitt and Ford, 1980).

For military logistics, this means that supply structures will depend on how the contingency factors have been assessed. This sounds like common sense for every logistics problem, but it opens the discussion to the analysis of specific contingency factors and their appropriate assessment. In the military context, the assessment of contingencies can lead to (in) appropriate supply structures, including the use or non-use of PBL.

*PBL literature*

PBL is often sold as a breakthrough shift to a collaborative long-term approach (Geary and Vitasek, 2008; Honore et al., 2004). However, especially in the defence context,
similar approaches can be traced back to the 1960s with early publications focusing on how a customer might incentivize the supplier to provide good performance (Marcus, 1964; Anderson, 1969; Hiller and Tollison, 1978). Since then, there has been a stream of research discussing the topic which is also known as “performance contracting”, “outcome-based contracting”, or “availability contracting” (Selviaridis, 2011; Kim et al., 2007; Hansen, 2006; Pagonis, 2004; Kumar et al., 2007; Ng and Nudurupati, 2010). Given that the content is not limited to logistics, other terms such as “pay for performance”, “performance-based contracting” or “performance-based service acquisition” have been suggested (Buchanan and Klingner, 2007) but, in the defence sector, PBL is the common term (DoD, 2001) and will, therefore, be used in this paper.

Sols et al. (2007) examined PBL in different industries. Randall et al. (2010) linked the concept with the service-dominant logic. Some authors have dealt with the pricing mechanisms in operations-research oriented papers (Kim et al., 2007; Plambeck and Zenios, 2000). Berkowitz et al. (2004) identified drivers of PBL while other contributions have focused on manufacturing (Hypko et al., 2010) and the defence sector (Ng and Nudurupati, 2010). Selviaridis (2011) is one of the most recent authors to review the PBL literature and developed a conceptual framework for PBC research.

While there have been numerous practical descriptive papers contributed to the PBL literature (Claiborne, 2004; Beggs et al., 2005) there are relatively few scientific contributions given its prevalence in practice (Selviaridis, 2011; Randall et al., 2010; Kumar et al., 2007). However, there is still no coherent understanding of PBL (Geary and Vitasek, 2008; Kim et al., 2010; Berkowitz et al., 2004; Kotlanger and Giuntini, 2008; A-DoD, 2007; DoD, 2001; Beggs et al., 2005; Hypko et al., 2010).

The basic idea of PBL is to pay only for performance that has been rendered. A PBL contract explicitly identifies what performance is required, but the provider determines how to fulfill the requirement with payments linked to performance results (Macfarlan and Mansir, 2004; Kim et al., 2007). In a defence context, PBL reflects contracting performance outcomes such as the availability of supplies, subsystems or systems when required, although payments for the operational readiness or even mission success are conceivable. The performance outcome of the weapon system is the driving objective of any PBL initiative, while the inputs – such as spare parts, inventory or services – are merely elements of providing the outcome (Sols et al., 2007).

However, there are many other aspects of PBL besides contracting performance outcomes. Hypko et al. (2010) presented a framework with eight perspectives on PBL, ranging from the provider’s background to the asset ownership. However, some of the perspectives such as the responsibility for personnel, are somehow subordinate to perspectives which constitute the relationship. Therefore, we address four perspectives of PBL for this literature review, which we derived from the papers mainly used for this work (Table I).

**PBL core.** Activity-based contracts are based on inputs and their quality specifications. Such contracts link payments to inputs (e.g. tariffs per man-hour or for materials used) or intensity factors (tariffs related to product quantities). In a performance-based contract, payments have no direct relation to inputs; instead, the supplier is paid when the desired outcome is achieved (Straub and van Mossel, 2005). The outcome is evaluated with performance indicators, defined either process-related (e.g. service time), potential-related (e.g. availability) or result-related (e.g. operating time, mission success) (Sols et al., 2007). In addition, the literature suggests that there
are at least four other perspectives of importance for PBL: life-cycle, cooperation, implementation, and pricing (Figure 1).

**Life-cycle.** As the initial investment costs of a weapon system are only a fraction of the operating costs over its lifetime, the life-cycle perspective is a key perspective on PBL. A lifetime of 25 years is not uncommon in defence (MoD, 2001). The focus on the total costs of ownership allows for strategic thinking about how to link private suppliers and service providers to military needs (Camm *et al.*, 2004).

**Cooperation.** The challenging part of PBL is not the performance description but rather its application. Barriers such as defence funding instability can hinder cooperation (Tremaine, 2007). Additionally there are open questions about the limits of supplier involvement near the “battle zone”. Nevertheless, some initiatives integrate service providers in the support of weapon systems while they are deployed in the field. The maintenance of an aircraft in Iraq is one example of the integration of contractors alongside their military counterparts (Lewis, 2005). As a first step PBL cooperation can rest upon a contractual basis whereas, at least in Europe, PBL can also be associated with strategic partnerships (public private partnership-organizations). Examples include fleet management, helicopter training and long distance transport to air refuelling tankers (NAO, 2008).

**Implementation.** Another focus is on the implementation of PBL, stressing the need to differentiate PBL application at the system, subsystem, and component levels

<table>
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**Notes:** X – content/perspective explicit named and discussed in the paper; (X) – content/perspective implicit regarded in the paper; “–” – content/perspective of minor relevance for the paper

Table I. Overview of the content and perspectives addressed in the PBL literature
(DeVries, 2004; Essig et al., 2009) as it has been pointed out that each PBL project is unique and “one size does not fit all” (Geary and Vitasek, 2008). Consequently, a case-specific PBL approach that reflects the life-cycle phase of the system, the existing military and industrial capabilities and legislative constraints, is often required (Claiborne, 2004).

**Pricing.** Whereas contracts for products are normally based on fixed payments, many instances of military logistics require more sophisticated approaches. We follow Straub and van Mossel (2005) who differentiated activity-based from performance-based contracts and also Kim et al. (2007) who examined cost-plus, fixed-price and performance-based contracts. Combining these two approaches on PBL pricing, a cost-plus contract is activity-based as it covers all input costs of a supplier. In a cost-plus contract, the risk allocation is mainly on the buyer (Bajari and Tadelis, 2001). It provides few incentives to reduce costs or improve performance. Rather, suppliers try to inflate costs to increase their profit margins (Glas and Essig, 2010).

Fixed payments are activity-based or performance-based. The first links payments to defined product or service specifications (activity-based). This transfer poses a risk for providers without giving them the latitude to influence costs or performance (Jones, 2003). Risk-averse providers will not accept fixed-price contracts with low margins in cases with great uncertainties as must be expected in the defence context. In contrast the second contract links fixed payments to performance indicators. Thus, the affiliated costs can be seen as an independent variable (Sols et al., 2007). The supplier is able to become more profitable by reducing costs as long as the specified performance is provided.

PBL contracts link payments to performance indicators. It is conceivable that all payments fully relate to the performance indicator, but parts of the payment can also form an incentive. A “cost-plus-incentive-fee” contract covers all costs and provides
additional incentives. Similarly, a “fixed-price incentive” contract provides a fixed payment and offers additional incentives (Sols et al., 2007).

The linkage of payments directly with a performance indicator commits the service provider to performance objectives. As contracting based on outcome has the ability to evoke desired behaviours arising from the incentives, this can motivate the provider to invest in the relationship. These investments are rewarded when the provider achieves the agreed-upon performance while reducing costs (Randall et al., 2010). PBL clearly emphasises a reward for performance, rather than simply complying with narrowly defined contractual provisions (Doerr et al., 2004; Lewis, 2005).

This becomes more interesting as the defence industry receives an average profit of only 3-6 percent (Storey, 2001; Anwar, 2011). Compared to business-to-business services which have at minimum twice this margin (Monitor Group, 2004), this is relatively low. Therefore, the defence industry may become more profitable when using PBL, while the military may benefit from higher performance (Randall et al., 2010; Ng and Nudurupati, 2010). The following types of PBL can be distinguished (Figure 2).

Whereas cost-plus and activity-based contracts are not PBL, we identified four alternatives as PBL (Types A-D). In the narrower sense, PBL directly links payments with performance (PBL Type A). All other types lack full alignment of performance and payments. Therefore, we call these PBL “in the wider sense”. Such contracts have either a cost-plus basis with additional incentives (PBL Type B) or fixed prices with incentives (PBL Type C). In the widest sense, even a fixed-price agreement is one alternative (PBL Type D). We focus the analysis on these four PBL contract types.

**Methodology**

The military context is, from its political setting of a defence strategy to tactical front-line decisions, significantly different from its business counterpart. This calls for a situation-specific contingency approach. Our framework follows that of Berkowitz et al. (2004) who discuss the decision of PBL responsibility assignment. We assume that the application of PBL is dependent on the willingness of political and military leaders to use such contracts and to transfer responsibilities to private industry, and that industry must, of course, agree with the terms and conditions. Therefore, the contingencies must integrate both viewpoints (RQ1, demand aptitude and RQ2, supply aptitude for PBL).

<table>
<thead>
<tr>
<th>Demand definition</th>
<th>Contract pricing</th>
<th>Pay for performance (variable price)</th>
<th>Fixed price incentive</th>
<th>Fixed price</th>
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<td>Activity-based demand definition</td>
<td>Cost-plus</td>
<td>Cost-plus incentive fee</td>
<td>Non-PBL</td>
<td>Fixed price</td>
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<td>“Consumption-based contracting” (Kim et al., 2010)</td>
<td>“Input-based pricing” (Hümerberg and Hüttmann, 2003)</td>
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<tr>
<td>Performance-based demand definition</td>
<td>Non-PBL</td>
<td>PBL in the wider sense (Type B)</td>
<td>PBL in the narrower sense (Type A)</td>
<td>PBL in the wider sense (Type C)</td>
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<td>Distribution of risk in the defense supply chain</td>
<td>Customer (military) covers risks</td>
<td>Contractor (service provider) covers risks</td>
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**Figure 2.** The PBL contract types
For this purpose we use the conceptual portfolio approach as portfolios are generally employed to support decision-making in supply and logistics management (Cox, 1996; Kraljic, 1983; Nellore and Söderquist, 2000; Gelderman and Van Wheele, 2005). Portfolios are appropriate when there is no single best method but rather several alternatives exist; for example, portfolios are suggested for decisions between partnership and adversarial supplier relationships (Tucker and Jones, 2000). Our approach applies one portfolio for the military demand side and another one to the supply side. Finally, we blend both points of view to develop recommendations for the selection of appropriate PBL types.

First we analyse the military tasks of Germany, Austria, and Switzerland to extract relevant contingency factors. At the end of this process we condense the demand requirements into two assessable characteristics to form the portfolio axes according to comparable approaches (Kovács and Tatham, 2009; Kaufmann and Germer, 2001). Second we analyse the supply risks. As several portfolios address such risks, we set up our supply contingencies accordingly (Kraljic, 1983; Gelderman and Van Wheele, 2005). Each of the four axes of the PBL portfolio is operationalised in this paper by a number of proposed factors. Questionnaires with ordinal scales allow practical handling of the portfolio and the usage for an introspective and external application. Every factor may be weighted and used for calculating a score for each portfolio axis.

Our conclusions are illustrated using three case examples. We use these for the introspective and participant application of the portfolio on military demand objects. All cases are concerned with Air Force product-support contracts. We analysed the projects with partners from the departments of defence, acquisition agencies and defence-industry and conducted several in-depth interviews with decision makers in leading positions within their organisations (minimum three in each case). Due to nondisclosure agreements, we cannot name the specific project content as, as a result, the cases are portrayed in a slightly modified form. Although the cases have been very useful for the application of the PBL portfolio, there are necessarily limitations especially those relating to the regional focus. Nevertheless, we observed accepted methods and quality criteria for case-study design and research (Eisenhardt, 1989; Yin, 2009).

### Contingency factors for military logistics

In this section, we condense the demand and supply characteristics of military logistics into four key contingencies. We use the Austrian, German and Swiss contexts as a starting point, because it is anticipated that the requirements differ from nation to nation as military logistics is linked with national defence strategy (Tuttle, 2006).

The political status of the three nations differs significantly, from neutrality (Switzerland), “everlasting neutrality” but EU participation (Austria); to full EU and NATO membership (Germany). Basic structures also differ fundamentally – for example between a conscription-based militia (Switzerland), conscription army (Austria) and a professional army (Germany). Despite these differences, the military tasks are quite similar, for example, each nation is engaged in missions in host or foreign countries, and all three also use some items of similar equipment such as the Leopard tank and Typhoon jet.

Therefore, the basic logistics requirements are quite similar, even for missions abroad where the Swiss Armed Forces have 22 military observers and approximately 250 soldiers involved in the peace support operation in Kosovo, whilst Austria currently has 1,182 soldiers engaged in observer missions, e.g. Golan, or peace support operations.
(Bosnia and Kosovo), and Germany participates in internationally assigned missions with over 7,000 soldiers, most of them in Afghanistan. Despite the difference in absolute numbers, the percentage of deployed troops is, at least in the case of Austria and Germany, quite comparable at some 3-4 percent of their respective military forces. Therefore, all three armed forces face the same logistical problems: the effective allocation of mission-ready equipment and its supply. Thus, the military logistics needs of these nations are basically comparable and can be summarised as follows: every nation must:

- supply its domestic bases;
- sustain (aging) equipment;
- keep forces ready for (quick, crisis) deployments; and
- supply deployed troops.

To understand military logistics more generally, we use a framework presented by Anderson (2002). Input (effort, costs, etc.) enables the logistic conversion process which consists of several levels: the basic core components (command, capabilities, and infrastructure) followed by the national, mission theatre and unit levels of military operation. Private companies may act at all levels of the logistics system, but the coordination of the military-private interface remains an important consideration. At the end of the conversion, the logistics output arrives in form of mission capabilities. This is key to understanding military logistics. It is not intended to ensure an effective and efficient flow of goods as in the private industry (CLM/CSCMP, 2010); rather, military logistics has to ensure mission capabilities when required.

Effectiveness is the predominant objective to ensure mission success. Mission success and the lives of those for whom the military logistics support is being provided must not be put at unnecessary risk. Thus, military logistics must guarantee the performance of desired outcomes. Based on the objectives of logistics services, this means that the right goods (ammunition, spare parts, and weapon systems) must be delivered to the right place (i.e. the mission theatre) at the right time (strategically and tactically scheduled) in the right quality (mission operable or mission ready).

However, in times of significant shortfalls in defence expenditure (Shanker, 2010), efficiency and economy gain importance as low budgets force cost reductions (Geary and Vitasek, 2008). Therefore, the military must not only be agile, flexible, robust and effective, but also lean and efficient (Claiborne, 2004; Breunig et al., 2006). Balancing military requirements (effectiveness) with economy necessities (efficiency) is one major aspect of optimising military logistics. This is similar to the discussion over Fisher’s (1997) often cited lean-agile model. In line with the findings of the interviews conducted, we used effectiveness (agility) to reflect military demand contingencies, and efficiency (lean) as the approach towards military supply contingencies.

The necessity of ensuring effectiveness is related to the research about customer-orientation and agility (Mason-Jones et al., 2000; Towill and Christopher, 2002; Fisher, 1997). Agility reflects the ability to ensure “demand satisfaction” in volatile situations such as those that are common for military logistics. This includes proactive measures to increase the robustness against intended or unintended risks and where resilience (the ability to react) allows for flexible reaction (Giunipero and Eltantawy, 2004). Several portfolio approaches use the axes “resilience” and “robustness” to analyse supply
chain effectiveness or to describe military or crisis organisations (Kaufmann and Germer, 2001; Kovács and Tatham, 2009). Accordingly the portfolio for the demand side evaluates military logistics with respect to these two factors.

As agility always means reacting to the emerging dynamics in terms of altered quantities or qualities, efficient (lean) military supply depends strongly on minimizing the forecast risks for a provider. The more accurately disruptions are anticipated and the lower the value of the demand object (weighting factor), the lower the forecast risk is and vice versa. Additionally, lean supply depends on the contractor itself and the inputs of upstream suppliers. Long life-cycles, concentrated market structures, and rapid technological progress may inherit risks, particularly obsolescence, for the availability of at least parts of the military demand. Therefore, the portfolio for the supply side uses the axes forecast and supply market risks.

The PBL portfolio

This section develops the PBL portfolio on the basis of four contingencies in order to extract recommendations relating to the usage of different PBL types. The starting point is a make-or-buy decision, where an outsourcing initiative can be distinguished based on size, scope and complexity. The implementation, as one perspective on PBL, may distinguish several steps (e.g. level 1 – spare parts supply; level 2 – subsystem technical support; level 3 – system technical support, and level 4 – system operation). For each level, there exists a range of organisational alternatives. As is also mentioned in the perspectives on PBL, various cooperation and pricing models are applicable between the extremes of total in-house military support (insourcing) on the one side, and total responsibility for the supplier (full outsourcing) on the other. PBL is one sourcing alternative.

The military requirements relating to the demand side are analysed using the axes resilience and robustness and split into four quadrants (areas I-IV), apart from the extreme requirements of war or combat situations, which are properly the fields of military activities. Possible factors to operationalise robustness are the capacity limit, the average capacity utilisation, storage (reserve) capacities, or redundancies. The demand requirement in respect of resilience depends on sort, size, speed of exogenous dynamics and the relational complexity in (worst-) case disruptions.

If only a low level of robustness and resilience (area I) is required, the logistics task is performed in a stable and secure environment, e.g. non-critical maintenance activities in domestic bases. Tasks that require a high level of robustness, but a low level of resilience (area II), are logistics services in stable but insecure environments such as the supply of long-term missions (e.g. the Balkan missions). Higher requirements for resilience (area III) mean that the provider must be able to rapidly establish a logistics system when required, e.g. transport to disaster areas. If the requirements for resilience and protection are both at a high level (area IV), the logistics system must be very reliable due to the direct impact on the success of the military mission; examples are the supply and support near a combat zone.

On the supply side, the service providers will not take on extremely high market risks, or they are not allowed or not willing to do so. For example, if private company employees (non-combatants) work in the mission theatre for soldiers (combatants), this might contravene international humanitarian law. Other concerns are about strikes or resignation of private employees in case of changed security conditions. Therefore, military in-house support handles the areas of very high risk levels internally. Supply
situations with lower risk levels are classified into four quadrants (areas 1-4). Factors that operationalise the forecast risk are the share of predictable to unscheduled tasks, product value, average storage time, and lot sizes. Factors for the supply market risks are the technological progress in the examined industry, market power (especially monopoly or oligopoly structures), obsolescence risks, the availability of substitutes, etc.

If the supply market and the forecast risks are both at low levels, the situation for this demand object is stable and predictable (such as simple spare parts, food and uniforms), and many suppliers or substitutes exist (see area 1). The opposite is true in a situation with unstable forecasts and high market risks. Due to the high product specificity, few or no substitutes exist, and only few suppliers are available; an example is the supply of ammunition and the predictability of its "consumption" in the mission theatre (area 4). The other two areas lie between these extremes (areas 2 and 3). Scheduled repairs of a weapon system are an example of a logistics activity in which the demand is critical for the operability of the armed forces, and the task is of high complexity; however, this repair task is predictable (area 2). The unscheduled demand for simple products, e.g. spares for vehicles, is relatively uncritical (area 3). In the PBL portfolio (Figure 3), we combine the analysis of the demand and supply sides.

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Figure 3.
The PBL portfolio
and its dimensions
The areas of stable military contingencies (I/II) and reliable forecasts (1/2) are most likely to allow a cost control strategy using fixed-price contracts (PBL Type C or D). The opposite cases of unstable military contingencies (area III/IV) and significant forecast risks (area 3/4) necessitate a strategy to secure supply as the supplier will be reluctant or unable to cover these risks. Here, even cost-plus contracts may be appropriate because the supplier cannot price the risk and there is no incentive to cut corners at the expense of performance. At best, a contract with additional incentives can be negotiated (PBL Type B).

In the other two quadrants, there are situations most likely indicating a PBL Type A. However, the decisions in respect of the PBL type depend on the risk aversion of either the military or the supplier. Incentives can help to address specific risks, e.g. incentives for reducing delivery time (area I/II and 3/4). Additionally, private service providers may be willing to assume risks even in dangerous scenarios, e.g. in Afghanistan, by obtaining adequate incentives (area III/IV and 1/2).

However, military buyers are reluctant to outsource tasks near the front-line, at least in the context of nations in the case studies. Therefore, it depends on the risk aversion of the military buyer whether a PBL Type A is chosen or other contract types are awarded. This conclusion was supported by our qualitative interviews. One manager of a commercial organisation, who is responsible for the provision of a weapon system support service, stated that the service is executed as a domestic backup for one “risk averse”, “conservative” nation; whereas the same weapon system is supported with contractor personnel at bases near the front line for other nations. The same service demand had been assessed in two different ways, mainly due to the degree of risk aversion.

**Insights from the case examples**

In this section, the PBL portfolio is illustrated using three defence projects for Air Force product support in Austria, Switzerland, and Germany.

In the first example, a supplier is responsible for the supply, stock and obsolescence management of aircraft spares. The contract is limited to domestic supply, with clear interfaces to military in-house logistics (area I). Market conditions are only partially predictable due to the obsolescence of material and sole sources (area 4). Performance is measured with availability rates, but payments are linked to costs (cost-plus contract). Nevertheless, the outcome increased from approximately 80 to 95 percent availability even though incentives were not included. The analysis with the PBL portfolio recommends developing the contract from a cost-plus (non-PBL contract) to a pay-for-performance contract (PBL Type A) by identifying and diminishing market risks (life-cycle stocks for low-value spare parts, substitution of spare parts in danger of obsolescence). If performance stabilises at a desired level, then even a fixed-price is conceivable (PBL Type C or D).

The second example is a contract for the support of an aircraft sub-system (engine). The supplier is responsible for the domestic maintenance of this sub-system (area I) and guarantees the availability of spares and engines within a specific time frame (72 hours) on basis of a fixed performance contract. The risks in the supply market are very low due to the existence of reliable suppliers and forecasts (area 1). There are no incentives, but penalties for performance failure. Due to its stability and low risks,

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the PBL portfolio recommends a fixed-performance contract (PBL Type D), which is actually what has been implemented. The third example is, again, a supplier of an aircraft subsystem (radar). Maintenance costs are high due to dismounting and installation costs. Simultaneously, each dismount of the radar affects the military mission availability of the aircraft. For this reason, the military demand requirement is very high, including service support abroad (area III/IV). Due to low forecast risks stocks are not the problem, but rather the danger of obsolescence (area 3). The PBL portfolio suggests establishing an incentive contract (PBL Type A). However, the contracting agency did not want any incentive in the contract, whilst the supplier had a high risk affinity and agreed to a fixed-price contract with increasing performance indicators (PBL Type D). The performance is measured by the indicator “mean time between unscheduled repairs” (MTBUR). This indicator has been developed through an *ex ante* negotiated curve over the contract term. The supplier must meet the objectives to receive the fixed price. The incentive is, thus, for the supplier to invest in early contract periods and to amortise the investments over time. After the first three periods of the contract, the supplier has managed to increase the MTBUR by over 40 percent, which is above the original objective. Thus, this contract constitutes an effort to use pay-for-performance mechanisms without the use of incentives (Figure 4).

**Discussion**

In our analysis one fact became obvious: there is no “single” PBL approach for military logistics; rather, several types of PBL must be distinguished. The PBL portfolio provides a first instrument that integrates strategic military outsourcing decisions with private supply market risks. The recommendations of the PBL portfolio are consistent with the findings of our case examples and can be summarised as follows:

- PBL Type A is recommended for situations where significant risks exist, but fixed-price or cost-plus options are unacceptable for one contracting party or are not sufficient to share the risks (“risk – gain and pain – share”).
PBL Type B is suggested when both demand and supply contingencies are significant and unstable ("security of supply").

(PBL Types C/D are recommended when contingency factors are stable and predictable ("cost and performance control").

For practitioners, the proposed instrument can serve as a guide for PBL and may help in the evaluation of military logistics projects. The PBL portfolio is a tool that allows military decision makers to review their assessment of military and supply risks.

Of course, military logistics situations differ from the private sector. Whereas in one situation, the military wants to have full in-house control even for back-up services, in another case, outsourcing is conceivable even near the front line. Our work with practitioners has revealed the value of the PBL portfolio which lies in drawing attention to the consideration of alternative (future) service structures, and with the possibility of transforming existing contractual structures. The sensitivity analysis underlines this effect. If one contingency factor is changed, e.g. the assessed requirement for protection according to a new coupling point or the assessed supply risk due to the reduction of obsolescence risks, then a new contracting type is conceivable.

As an example, the transformation of a status quo situation is presented in Table II: the first scenario expands the supplier's responsibilities with new coupling points and reduced military in-house capabilities, while the second scenario shows a possible situation of the system at the end of the life-cycle. Both scenarios demand for a new risk assessment with another PBL Type (Table II).

Conclusions
There is a long tradition of contingency based supply chain research (Fisher, 1997). The main criticism of this kind of research is its oversimplification (Mason-Jones et al., 2000; Towill and Christopher, 2002). Also, the PBL portfolio is only a first approach to consideration of military logistics from distinct procurement and contractual perspectives. Nevertheless, it does provide a support tool for practitioners. The PBL portfolio is one of very few instruments that explicitly consider both the military

<table>
<thead>
<tr>
<th>Situation</th>
<th>Characteristics</th>
<th>PBL portfolio dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status quo (initial situation)</td>
<td>Coupling point: domestic base Military capabilities: available Service character: back-up Contract type: PBL Type D</td>
<td>Demand side: III Supply side: II</td>
</tr>
<tr>
<td>Scenario 1 (outsourcing)</td>
<td>Coupling point: service support in bases of the mission theatre Military capabilities: emergency Service character: full-service Contract type: PBL Type A</td>
<td>Demand side: II Supply side: II</td>
</tr>
<tr>
<td>Scenario 2 (end of life-cycle)</td>
<td>Coupling point: domestic base Military capabilities: available Service character: back-up Contract type: PBL Type C (incentives for cost reductions)</td>
<td>Demand side: II Supply side: II</td>
</tr>
</tbody>
</table>

Table II. Scenarios and the PBL portfolio
and the (private) industry side. The instrument opens the discussion to alternatives, considering not only “single” but several PBL approaches.

Although interesting for the military practice, our findings are limited due to the high level of abstraction, the mainly deductive methodology and the limited case examples originating only from one geographic region. However, the PBL portfolio may be useful for future research in the field of military logistics, guiding it into different directions, e.g. focusing on cost and performance control, focusing on supply security or focusing on risk-sharing approaches.

Of course, further development is required, e.g. empirical testing whether the chosen contingency factors really are key factors, or whether others should be included in an expanded model. Generally there is a lack of empirical data about PBL. Therefore, we recommend the development of a PBL management concept that explicit considers defence peculiarities. Whereas our instrument focuses on analysis, other instruments may help to implement, control and change PBL. One possible avenue is to enhance the understanding by confronting the concept more intensely with scientific theories such as transaction-cost, principal-agent or organisational theories.

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**Further reading**


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