An Analysis of Incentive Strategies for Single-Source Suppliers to Drive Cost Reduction

by

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Bachelor of Science Electrical Engineering
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Submitted to the MIT Sloan School of Management and the Department of Electrical Engineering and Computer Science in Partial Fulfillment of the Requirements for the Degrees of

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Master of Science in Electrical Engineering and Computer Science

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Abstract

An organization's decision on which aspects of its operations to outsource represents a key, strategic issue that should be based on maximizing performance throughout the entire value chain. In certain instances strategic outsourcing decisions make it ideal for firms to source from one particular supplier. Single-source relationships, in particular, necessitate strategic contract development to ensure incentives are aligned throughout the value chain.

Much of the existing research in contract development focuses on mitigating fluctuations in demand. Forecasting demand is highly uncertain and can lead to inefficiencies throughout the value chain that contracts can alleviate. However, the defense industry typically has low uncertainty in demand, which offers a unique environment to study contract development. This thesis focuses on contract development with certain demand through case studies in the defense industry.

The essence of this thesis revolves around a strategic framework for developing contracts. This framework begins with a discussion of methods for performing a strategic analysis of suppliers. Next an overview of investigating supplier alternatives is provided. The framework then addresses the execution of a contract, which includes writing and negotiating the contract. Finally, contract maintenance is discussed, which includes contract validation as well as managing latent concerns.

After the framework is laid out, four different single-source supplier relationships are analyzed. Each of these supplier relationships is investigated to understand the motivation for initiating these particular relationships. The four supplier case studies revolve around the issues of supplier investment costs, internal competition, commodity negotiations, and supplier power. After each case study, the pertinent aspects of the contract development framework are applied to the specific supplier relationship and conclusions are drawn.

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1 Introduction & Background

1.1 Introduction

The focus of this thesis was developed during a six-month internship at Principal Defense Supply (PDS), a division within Armament Solutions (AS). Facing a tightening market scenario, where the customer is increasingly focused on cost reduction, PDS is turning to a product development model that depends on outsourcing as a key aspect of their product supply chain. Furthermore, due to the specialized nature of the defense business, the products these suppliers are producing frequently must be single-sourced. This situation has led to increased supplier power, which has impacted cost. The main goal during my internship was to analyze these supplier relationships and to determine how to make PDS more competitive in the defense market.

All company names and figures have been disguised in this thesis.

This thesis is divided into three sections. The first section provides an overview of the company and the methods through which the research was completed. The second section is dedicated to laying out a framework for aligning supplier incentives through contract development. Finally, four case studies based on PDS supplier relationships are analyzed using the supplier incentive framework. Throughout this thesis, it is critical to keep in mind the implications incentives create not only within first level suppliers but also across the entire value chain.

1.2 Why Outsource?

The degree of vertical integration is the primary strategic question for any supply chain organization. Outsourcing should be a holistic decision that takes into account all aspects of the value chain. In the field of supply chain management several theories have evolved regarding outsourcing. Espino-Rodrigez et al discuss the differences between the transaction cost economics (TCM) and the resource-based view (RBV) of a firm's decision to outsource. Coase first developed the TCM theory in 1937 and it exclusively

focuses on the economic decisions to outsource (Coase 1937). In contrast, the RBV theory provides a more strategic view of outsourcing and takes into account the imbalance of resources and capabilities between companies (Espino-Rodriguez and Padron-Robaina 2006).

According to the RBV theory, outsourcing can contribute to the competitive advantage of a company by ensuring the core-competencies of a firm are fully utilized. Much empirical evidence supporting TCM theory is available in the literature, however this takes a short-term view of the success of an organization. RBV focuses on long-term, strategic success based on the idiosyncrasies of a particular company (Espino-Rodriguez and Padron-Robaina 2006).

It is also important here to distinguish between the ideas of outsourcing and procurement. Gilley and Rasheed point out that:

> "*Defining outsourcing simply as procurement activities does not capture the true strategic nature of the issue. Outsourcing is not simply a purchase decision, because all firms purchase elements of their operations. Outsourcing may arise through the substitution of external purchases for internal activities. In this way, it can be viewed as a discontinuation of internal production or service and an initiation of procurement from outside suppliers.*" (Gilley and Rasheed 2000).

Therefore it is important to note that firms pursing a strategy of differentiation, rather than cost leadership, will benefit less from outsourcing. Consideration of which aspects of an operation to outsource is also extremely critical.

Once a decision to outsource has been made, the next major strategic decision is the nature of the supplier relationship. The criticality of the element being sourced plays a major role in determining the type of relationship. For instance, a commodity product in a very mature market will only require a loose relationship between supplier and buyer. However, a buyer should

maintain a close, strategic relationship with a supplier that has a newly developed technology critical to the success of a product.

Beckman and Rosenfield provide a spectrum of supplier relationships that helps visualize the available options:

Degree of Vertical Integration

Relationship Type	Interaction with Supplier	Pricing Leverage	Trust
Arm's length relationship	Compete commodity products with other suppliers	H	L
Modified vendor relationship	Share in-house mfg & technical expertise with supplier; reduce product technical specifications	M	H
Long-term contracts	Profit-sharing contracts with efficiency cost reduction clauses	M	M
Non-equity based collaboration	Teaming agreements with suppliers	L	H
Licensing arrangements	License technology to third parties for manufacturing	M	M
Investment integration	Parallel sales of other products; Increase market share for same product	M	H
Full ownership	Some components built in house but at high prices due to overhead allocation	L	L

Table 1 - Supplier vertical integration spectrum - Adapted from (Beckman and Rosenfield 2008)

In Table 1 above, the spectrum of vertical integration corresponds to specific relationships between PDS and different suppliers. For each level within the spectrum, a supplier strategy is discussed that corresponds to the relationship type. Furthermore, each relationship is ranked based on its ability to leverage price and also the level of trust building that occurs between the two parties. The spectrum of price and trust varies across the different interactions and will be addressed in the case study chapters of this thesis.

1.3 Single Source Suppliers

It is important to distinguish between single-source and sole-source suppliers. A sole-source supplier exists when there are no alternatives for a particular buyer. Whereas, a single-source supplier implies that

there are options for a buyer to source from other suppliers but the buyer makes a conscious decision to chose a single supplier. A buyer will decide to single-source for a variety of reasons. These reasons can include (Beckman and Rosenfield 2008):

- Uniqueness of a sourced item
- Significance of the total business to the supplier
- Competitiveness of the market
- Branding implications of the supplier
- Ease of coordination

This thesis focuses predominantly on single-source supplier situations. However, the principals discussed can just as easily be applied to sole-source situations.

2 Company Overview

Principal Defense Supply is a division within parent company Armament Solutions. AS is a multi-billion dollar conglomerate that operates primarily as a holding company for several defense-related divisions. AS has followed industry trends of consolidation over the last decade and acquired PDS over ten years ago. PDS has around 300 employees, many of whom have been with the company since before the acquisition by AS. Consequently, there are many "lifers" at PDS and complacency throughout the organization is rampant. Additionally, PDS is proud of its independent history and there is very little coordination with other divisions of the parent company.

The marketplace has changed drastically over the last few years as the major customer of PDS, The US Government, has cut defense budget spending. This has led to aggressive price cuts by one of PDS's main competitors. PDS has maintained a competitive edge in technical development, however they have struggled with costs. A strengths, weakness, opportunities, and threats (SWOT) analysis shows where PDS lies within the competitive landscape:

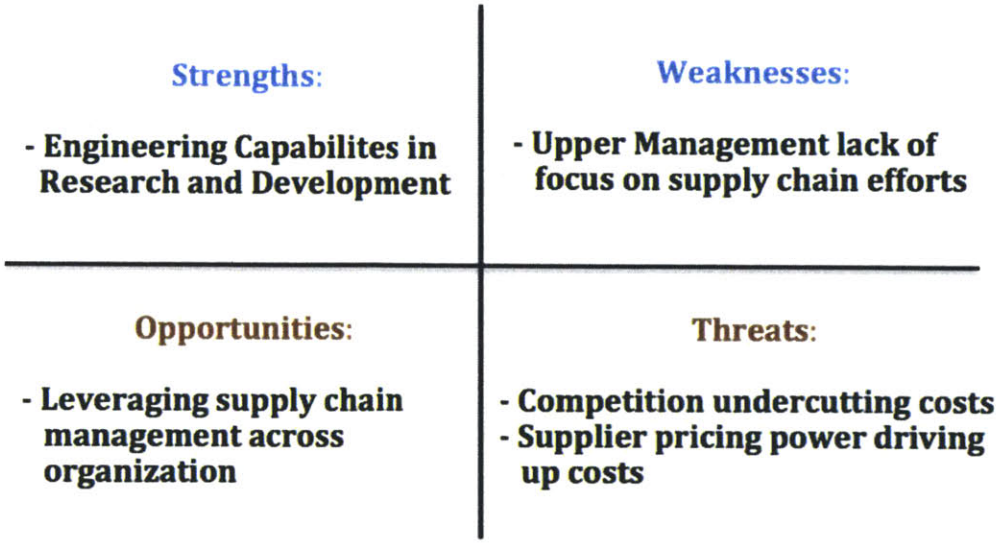

Figure 1 - A SWOT analysis of the organization

The SWOT analysis in Figure 1 investigates the company from both an internal and external pressure perspective. The astute engineering staff that PDS maintains ensures that they are an industry leader in research and development. However, upper management at PDS does not fully appreciate the supply chain management capabilities necessary to succeed in a highly outsourced environment. Their decisions to outsource tend to be based on availability of resources rather than the financial or strategic impact of the aspect of the product in question.

Additionally, the main competitor of PDS has been able to drive prices down and win business in the past. PDS certainly has a technological edge in the industry, but this comes at a cost. A program director at PDS is quoted as saying: "PDS offers the Cadillac version to the customer while [the competition] offers the Yugo." Competing on price is never a good idea in any industry and will simply drive out margins. Overall, PDS' focus needs to shift to the customer and how much they are willing to pay for the "Cadillac" premium.

2.1 Organizational Overview

PDS is managed through a matrix organization similar to that depicted in Figure 2 on the next page. The program director role focuses on product groups within each of the divisions. Similarly, the functional roles of engineering, supply chain, R&D, finance, etc. span across each of the different divisions. There is a Vice President of each division to whom both the program directors and senior directors report to.

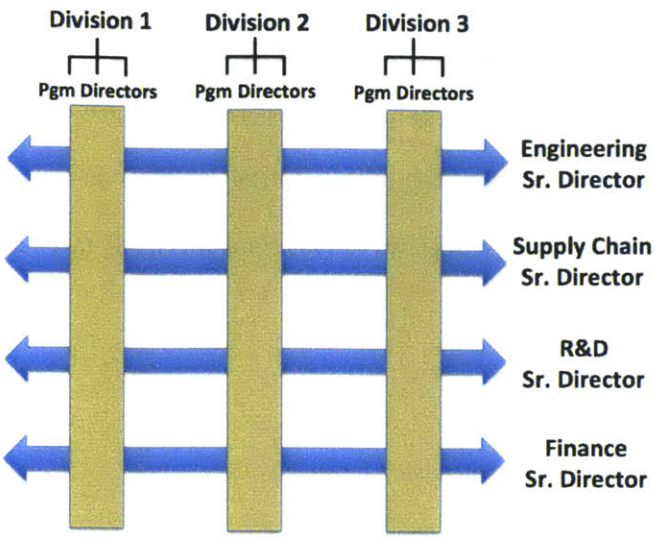

Figure 2 – Structure of the matrix organization

PDS's engineers have developed a market leadership for the company in the technical arena and therefore have strong decision-making power within the company. The result of which is a culture of engineers with high influence throughout the organization. Engineers are deeply involved at the product level and certainly have the know-how to make the right technical decisions. However, there are few checks and balances to their decisions in terms of cost and performance. In certain instances, engineers are choosing designs and suppliers that exceed the customers' perceived value in the end product.

A more influential supply chain organization could provide the necessary oversight to balance the engineers' decisions in terms of cost and performance. However, this would require an investment in human capital for the supply chain organization and strategic guidance of the team. Management needs to acknowledge the importance of the supply chain group outside of being a simple source of procurement. Developing a global supply chain group that has the influence to manage projects across the company is key to the competitive success of PDS.

2.2 Industry Idiosyncrasies

From an academic standpoint, the defense industry has certain elements that make it ideal for analyzing supply chain issues. In examining several projects at PDS, it is clear that the customer mitigates much of the risk for the contracts it provides. Specific variables are effectively taken out of the equation for PDS's business including:

- Negligible inventory costs
- Scheduled demand that is forecasted far in advance
- Reimbursements for high inflationary items
- Upfront recouping of technology and manufacturing capability investments

It is interesting to note that some of these practices, especially the inventory payment policies, incentivize companies away from a lean manufacturing system. For example, PDS is paid upfront for inventory and receives positive cash flow for items as soon as they are procured from suppliers. Additionally, demand for products is communicated years in advance and rarely changes for large contracts. Furthermore, the US Government provides economic price adjustments for specific items a contractor justifies as highly inflationary. Finally, the customer provides cost-plus contracts to cover design and manufacturing qualification costs for any potential contractor that wins the final bidding process.

3 Research Methodology

The research conducted for this thesis at PDS was initiated with the broad goal of making the company more competitive in the marketplace. The initial investigation focused on an analysis of costs for a specific product. This cost analysis led to understanding the competition and developing a model to estimate their capabilities. Further information was gathered through interviews and working directly with employees at all levels of the organization.

3.1 Competitive Analysis

The competitive analysis research began with the idea of modeling the capabilities of the customer. The model is based on historical cost information found in a publicly available website. Previous generations of the product were manufactured by the competition and there is detailed public information available regarding costs and quantities.

The competitive model is based on three key aspects:

1. Normalization
2. Elasticity calculations
3. Extrapolation

Normalization of the historical data is based on producer price indices (PPI) and a manufacturing learning curve. The historical PPI information is available from the US Bureau of Labor Statistics website. This provides a baseline for offsetting historical data for inflation in the specific industry in which PDS operates. The Producer Price Index is calculated based on the "average change in prices received by domestic producers of commodities in all stages of processing" (Bureau of Labor Statistics). This is effectively a measure of the price changes that manufacturers experience in their selling prices based on 100,000 monthly quotations directly gathered from producers across the US.

The manufacturing-learning curve is calculated based on PDS' previous manufacturing experience on older generations of the product. This learning curve is the accumulated experience in a manufacturing environment that reflects the ability to perform and repeat the same task more efficiently. The learning curve is calculated from the power law function defined in Equation 1 as follows:

$$Equation1: C_n = C_1 * n^{-a}$$

Where:
C_n = Cost of the nth unit of production
C_1 = Cost of the first unit of production
a = Elasticity of cost with regard to output

Figure 3 below depicts the learning curve calculated from historical manufacturing data at PDS. A power function regression line was fit to the manufacturing data with an R squared value of 0.85 signifying a sufficient fit to the data. The cost of the first unit is around 52 with an elasticity of -0.401.

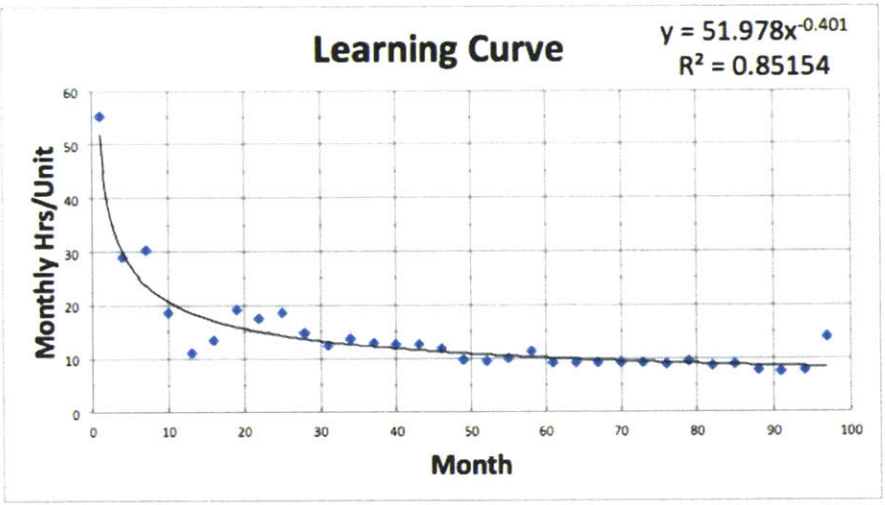

Figure 3 - PDS Manufacturing Learning Curve (actual figures masked)

Next, the elasticity calculations attempt to estimate the cost structure of the competition. The amount of fixed versus variable costs is determined by investigating historical data as seen in Figure 4 below.

Figure 4 - Elasticity calculations for the competition

It is important to note that the elasticity of the entire equation is unevenly weighted on the data point at quantity 800. If the analysis were to be based on a number less than 800 then it would be prudent to review the importance and accuracy of that one critical data point as it weighs heavily on the overall slope of the regression line.

Finally, the normalized and elasticized data is extrapolated out to the actual production years. The extrapolation was determined using an estimated projection of US Bureau of Labor Statistics future inflationary values. It is important to note that as we project out further in time the uncertainty of the inflationary estimates compound year over year. A single year of inflationary data can be estimated by a log-normal distribution. This leads to significantly higher uncertainty as we go out in time and should be considered during the analysis.

The full analysis, presented in Figure 5 below, was shared with management at PDS. These finalized results, along with estimates for current internal costs, provided insight into where PDS stood with the competition. It was an eye-opening moment for management and resulted in a list of actions focused on driving down costs across their wide base of suppliers.

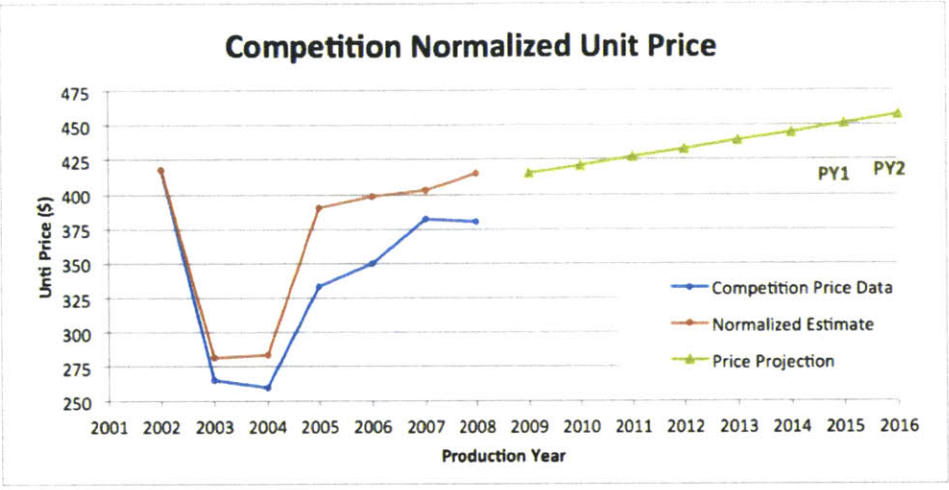

Figure 5 - Complete competitive analysis model

3.2 Understanding the Industry

Much of the information regarding the market and general industry trends was collected from a series of interviews with individuals at all levels of the organization. These discussions provided anecdotal evidence that gave a qualitative feel for how the competition, customer, and suppliers interacted. Additionally, the supplier relationships were examined through site visits and regular conference calls to a subset of key suppliers. This direct supplier interaction also provided a qualitative feel for the trust and general nature of the relationships between suppliers and PDS.

4 Incentive Alignment Framework

4.1 Basis for Framework

For the purposes of this thesis, we will assume suppliers and buyers are completely rational and that their decisions are solely based on maximizing their own profits. Within a supply chain this mentality can lead to inefficiencies whereby individual firms operate based on local optimization. This idea is defined in economic terms as double marginalization. Furthermore, as intermediate suppliers are added to the supply chain, efficiency losses are magnified. In certain situations, double marginalization can lead to losses in efficiency of up to 40% (Perakis and Roels 2007). Thus, strategic efforts must be made within a supply chain to align incentives across players to eliminate this inefficiency.

An analysis of buyer-supplier relationships between organizations is key to developing a strategy for mitigating efficiency losses. M. Bensaou's operations research divides the closeness of the buyer-supplier relationships into the following categories (Bensaou 1999):

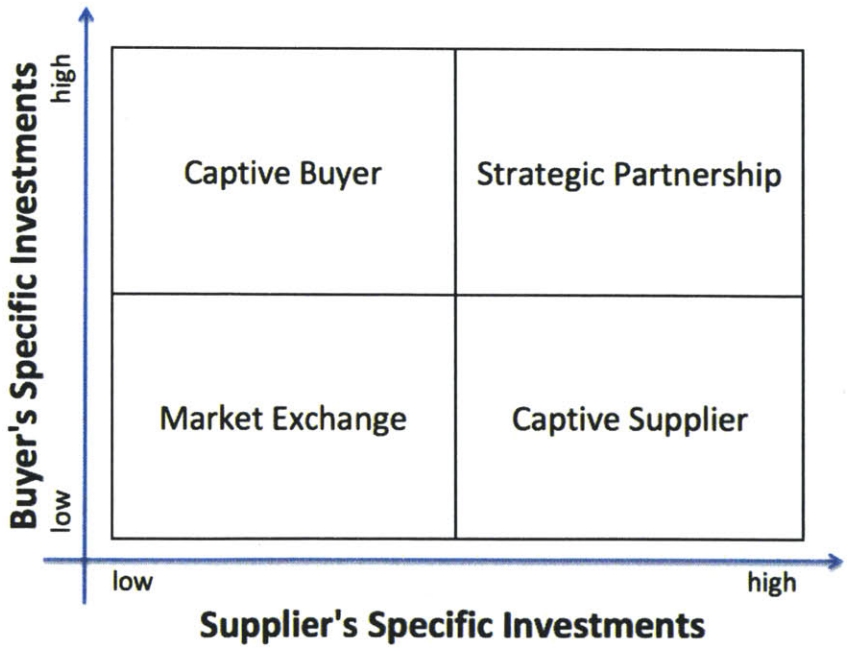

Figure 6 - Buyer/Supplier relationship spectrum - Adapted from (Bensaou 1999)

Bensaou concludes that organizations must match their levels of coordination, information, and knowledge exchange capabilities with the needs of the relationship. He argues that over-designing a market exchange relationship unnecessarily incurs costs to the supply chain. Conversely, under-designing a strategic partnership could lead to a lack of trust and/or coordination that could lead to ineffective results (Bensaou 1999).

Independent of the level of interaction between buyers and suppliers, business relationships are based on some combination of trust, information, and contracts. This thesis will primarily focus on developing a framework for creating contracts to align incentives between suppliers and buyers. In complex organizations, contracts provide a clear definition of each party's obligations. In contrast to trust-based relationships, contracts are designed to survive personnel changes in an organization. Furthermore, contracts provide a legally binding aspect that forces each party to weigh the legal costs of their actions. Additionally, the perspective of contract development will be from the buyer's side, dealing exclusively with single-source suppliers. Specific attention will be paid to the ex post incentives that contracts create for each party.

4.2 Novel Approach

Most academic literature on contract development focuses on the ability of a firm to mitigate double marginalization created by uncertainty in customer demand. Because demand is difficult to forecast in many markets, it is important that contracts address this issue so optimization can occur at a global level. However, the defense industry provides an environment with highly certain demand that the customer communicates many years in advance. This eliminates much of the uncertainty in demand and creates a unique environment with controlled variables to study different aspects of contract development. A framework for developing incentives through contracts is developed in the next section that will then be used to analyze four supplier relationships at PDS.

4.3 Framework Definition

The decision to partner with one single supplier can greatly limit a buyers' power during negotiations. Therefore, much analysis and forethought must be put into contract development before any formal, single-source relationships are established. The following contract development framework is designed to preform an upfront analysis and maximize flexibility for the buyer:

Step 1 - Strategic Analysis:
- Understand supplier motivations
- Weigh risk vs. cost

Step 2 - Option Investigation:
- Determine alternatives to supplier
- Chose incentive structure

Step 3 - Execution:
- Write Contract
- Negotiate

Step 4 - Contract Maintenance:
- Validation of metrics
- Adoption of latent concerns

4.3.1 Step 1 - Strategic Analysis

4.3.1.1 Supplier Motivations:

Before a company is to be considered as a supplier, their motivations for being in business should be investigated. This information can be gathered from many sources including company websites, public financial documents, internal anecdotal evidence, or even the suppliers' competition. The motive for this analysis is to ensure the contract incentives that the buyer creates are aligned with the supplier's interests. For example, if a supplier has invested heavily in a new technology, their goal is to seek a return for their investment in this technology. An expected rate of return on this investment can be estimated based on gathered information and then product pricing can be calculated.

Additionally, buyers should ensure that the incentives of the key stakeholders within the organization are aligned with that of the company. While working with a program manager of one of PDS' suppliers, there

was clear misalignment of incentives between the organization and the individual. Internal politics of this particular supplier encouraged the manager to delay certain deliverables because his internal performance was gauged solely on keeping with the original pre-defined schedule. Any updates to the original task-list were not completed in time to make an impact on the project.

4.3.1.2 Supplier Risk Vs. Cost:

The risk of choosing one particular supplier can be weighed against the potential cost savings for the entire value chain. To quantify this decision, Lockamy & McCormack have developed a method of breaking supplier risks into estimated likelihoods and outcomes of different events. They divide risk into three categories:

- **Operational Risk** – quality, delivery, and service issues
- **Network Risk** – ownership structure, supplier strategies, and supplier's supply agreements
- **External Risk** – weather, earthquakes, political disruption, and market forces

The authors then proceed to define a set of Bayesian networks based on these risks that quantify a specific revenue impact for each supplier. A group of potential suppliers can then be compared against each other to determine which supplier will maximize revenue for the buyer (Lockamy and McCormack 2010).

It is important to note that a Bayesian network method of analyzing supplier risk is sophisticated and costly. Therefore it would be prudent for any organization to perform a cost-benefit analysis before they gather the expertise and conduct such an analysis. The strategic importance of each supplier should be taken into consideration and weighed against the cost of performing the analysis. If this analysis is deemed prohibitively expensive, then a simple, qualitative analysis of the perception of risk in these areas can also be beneficial.

4.3.2 Step 2 - Option Investigation

4.3.2.1 Supplier Alternatives:

Once an appropriate analysis of potential suppliers is complete, it is then necessary to weigh all possible alternatives to a potential supplier. These alternatives can include different suppliers, internal manufacturing, or even a substitute product. The previously discussed risk analysis is critical when considering alternative suppliers. This risk analysis will provide a holistic view of which supplier will be of the highest strategic importance to the buyer and customer. Additionally, importance of each of these risk categories can be weighted based on customer concerns.

The financial impact of internal manufacturing has most likely already been accounted for if a decision to outsource has been made. However, a feasibility analysis of internal manufacturing versus other supplier alternatives will be beneficial during contract negotiations. The option to supply internally can be used as a baseline target or even a potential threat during supplier pricing negotiations.

Furthermore, buyers should consider whether or not a particular supplier is adding sufficient value to the customer to justify the price impact. For example, if the end customer does not value a feature enough to justify the price increase then dropping that particular feature should be taken into consideration. This valuation of the supplier can also come into play during final pricing decisions for the customer.

4.3.2.2 Incentive Structure:

The legally binding nature of contracts makes them a critical aspect of every business relationship. From a game theory perspective, a physical contract eliminates moral hazard issues that can arise from simple verbal or trust-based agreements. Moral hazard occurs in supply chain management when a supplier that is insulated from risk behaves differently than if it were fully exposed to this risk. Contracts ensure that if a supplier does not perform they are obligated to share the risk with the buyer.

While sharing risk with suppliers eliminates moral hazard issues, sharing gains compensates suppliers for the added risk they are taking. In regards to how to implement this risk-reward sharing, Roels et al.

identifies three distinct contract incentive structures. The first structure is fixed price, which determines, up-front how much the project will cost contingent upon either effort or output. The second is a time and expense method, which is based on the costs of the actual labor and materials that go into producing the product. Finally, there are performance-based contracts which reward a supplier based upon a measurable output. The authors next delve into each of these structures highlighting the benefits and challenges (Roels, Karmarkar, and Carr 2010):

Contract	Benefits	Challenges
Fixed Price	Predefined outcome Accurate budget	Lack of price validation Inability to change scope
Time and Expense	Transparency into supplier efforts Knowledge of labor requirments	Focus on effort not outcome No incentive for efficiency
Performance Based	Greater supplier responsiveness Ability to clearly align goals	Longer negotiations Supplier contol of project

Table 2 - Contract incentive structures - Adapted from (Roels, Karmarkar, and Carr 2010)

Yao et al. also examine situations in which each of these incentive structures is most applicable. The authors claim that fixed price contracts should be used when the profit margin is unclear and changes in future costs are highly uncertain. Time and expense contracts should also be used when profit margins are unclear and when capital cost is high. Performance based contracts should be used when the supplier's operating cost is expected to increase and when competition is weak among suppliers. (Yao et al. 2010)

Furthermore, it is important to note the implications a strong buyer can have on a supplier's ability to operate efficiently. Abuse of buyer power could potentially lead to supplier failure. This reduction in the size of the supply chain could translate into an increase of costs and risks throughout the value chain.

4.3.3 Step 3 - Execution

4.3.3.1 Writing the Contract:

Once an exhaustive supplier analysis is complete and the appropriate incentive mechanism is chosen, the next step is to write the contract. The key decision at this juncture is to determine how much effort should be expended in actually writing the contract. Jean Tirole breaks the completeness of a contract down into three areas. The first is unforeseen contingencies, which are defined as the inability to define ex ante the actions that may be feasible in the future. Another area is the cost of writing the contract that includes itemizing all known contingencies within the contract. The last area is the cost of enforcing the contract, which covers identifying the terms of the contract so the contingencies can be verified and enforced (Tirole 1999).

Focusing on the cost of writing contracts, Battigalli and Maggi examine the amount of detail necessary for a contract to be effective. They investigate the costs associated with determining the relevant contingencies, thinking of how to describe them, time needed to write the contract, and the lawyers. They also describe contract incompleteness in terms of discretion and rigidity:

> *"...discretion meaning that the contract does not specify the parties' behavior with sufficient precision; and rigidity, meaning that the parties' obligations are not sufficiently contingent on the external state. For example, a construction contract is characterized by discretion if it does not specify the materials with sufficient precision (and this results in the contractor choosing low-quality materials); and is characterized by rigidity if the completion time for the project is fixed, when it would be more efficient to make it contingent on certain exogenous events."* (Battigalli and Maggi 2002).

They further argue that contracts represent a balance of rigid clauses, contingent clauses, and the degree of discretion given to the agent. In general, the authors define an optimal contract as one that regulates tasks of high importance through contingent clauses, tasks of intermediate importance through rigid

clauses, and tasks of low importance are left to the agent's discretion. Furthermore, in examining uncertain environments they found that optimal contracts should contain more contingent clauses, fewer rigid clauses, and give more discretion to the agent (Battigalli and Maggi 2002).

4.3.3.2 Negotiations:

Final contract negotiations play a critical role with respect to supplier pricing. In a recent Harvard Law Program on Negotiation interview, two experts in the field of negotiation identify three major areas of negotiation power:

> *"**1. A strong BATNA.** Your best alternative to a negotiated agreement, or BATNA, is often your best source of bargaining power. By cultivating a strong outside alternative, you gain the power you need to walk away from an unappealing deal. For example, a home buyer could improve her power in a negotiation with a seller by finding another house she likes just as much.*
>
> ***2. Role power.** Power can come from a strong role, title, or position, such as a high rank in an organization. When negotiating with your boss, for instance, you sometimes may need to cede to his preferences because of his high status.*
>
> ***3. Psychological power.** Negotiators can bring a sense of psychological power to the table—the feeling that they're powerful, whether or not that's objectively the case. Simply thinking about a time in your life when you had power can bolster your confidence and improve your outcomes."* (Galinsky and Magee).

For buyers to utilize this power during negotiations it is critical they first understand their BATNA before entering into a negotiation. This BATNA can come from the analysis of supplier alternatives performed in the previous step of the framework. Furthermore, utilizing an individual of high rank within the buyer organization enables additional power during the negotiation.

4.3.4 Step 4 - Contract Maintenance

4.3.4.1 Contract Validation:

A well-defined contract is one that specifies a clear recourse of action when a specific clause of the contract is not met. Certain clauses that contain verifiable information must be monitored throughout the length of the contracted relationship between supplier and buyer. When designing incentive contracts, one consideration should be reducing the likelihood of disputes. Ideally a contract should be defined with symmetric information so dispute resolution is quick and inexpensive. Asymmetric information typically leads to costly disputes due to the inability of one party to verify the information. Additionally, contracts should categorize performance in simple terms to ensure lower enforcement costs (Doornik 2010).

However, in certain instances, there exists what Doornik defines as "prohibitively costly enforcement." This type of enforcement corresponds to situations in which the principal's judgment of performance is purely subjective or a third party cannot objectively measure the agent's performance (Doornik 2010). In such situations it is not advisable to settle in court due to the lack of information availability.

When a specific clause has been violated, then the offending party must be informed and action must be taken. Enforcement of contracts through the legal system is expensive and parties typically negotiate out of court to avoid these costs. Historically, 90% of disputes are resolved without trial in the form of private arbitration or informal dispute resolution (Galanter 1983). In addition to legal costs associated with upholding a contractual obligation, the implications in regards to the business relationship should also be weighed.

4.3.4.2 Latent Concerns:

Latent concerns are contingencies that were unforeseen during the time of contract development. In many instances it is prohibitively costly to spell out all possible contingencies that could occur throughout one particular business relationship. Battigalli and Maggi reference an example of latent concerns in the US natural gas industry from 1946 to 1985. During 1975 most of these contracts were amended to include a

new clause for renegotiating prices if there is deregulation in the industry (Battigalli and Maggi 2002). This clause was not initially included in the contracts because the probability of deregulation in the industry was very small.

As seen in the example with the US natural gas contracts, latent concerns can be dealt with ex post contract development. However, instead of spelling out each specific contingency within the contract, general terms for how new circumstances will be handled can be useful (Wheeler 2007). This can foster a mutual re-negotiation of the contract and avoid costly legal battles.

4.4 Additional Considerations

The strategic importance of each supplier relationship should be the main focus when determining the level of resources to allocate in a particular analysis. For instance, when dealing with a supplier for a short-term, commodity product, it is not necessary to complete a detailed and costly analysis. Conversely, before entering a long-term, strategic partnership with a company, a firm should exhaust all possible resources before entering into an agreement. Furthermore, the organizational structure of how supply chain resources are allocated should be done at a high level. This will ensure that projects will be examined across the company for strategic importance and resources will be utilized in the most efficient manner possible.

The remainder of this thesis is dedicated to a discussion of four supplier relationships that PDS fostered during a specific project. These case studies focus on four unique conflicts of interest that can arise throughout the supplier-buyer life cycle. The aforementioned framework is used to analyze each situation in retrospect and recommend the best course of action.

5 Case Study I: Supplier Investment Costs

5.1 Supplier Background

Defense Systems International (DSI) is a large, Fortune 500 company specializing in defense related work. DSI has been a partner with PDS for many years and people within both organizations have good working relationships. PDS has designed-in a specific piece of technology from DSI for their upcoming product. This technology is critical to reaching the technical goals the customer has set.

The team at DSI that PDS mainly interacts with consists of a program manager and a team of technical engineers. Much of the discussions on the project have been regarding technical difficulties and these discussions have been between the engineering teams from the two companies. The engineers also have a good working relationship, however concerns over manufacturability and cost have recently surfaced.

5.2 Strategic Analysis of the Relationship

DSI has invested millions of dollars in research and development for this technology and has had no return as of yet. Their only customer for this technology is PDS, with limited options for additional customers. This project is slated to be of relatively low volume and not constitute a large percentage of revenue for DSI. However, for PDS, this element represents a significant portion of the cost of their product. Pricing is a very sensitive issue for the end-customer and high costs could put the entire project in jeopardy.

The original contract between these companies was created in the early stages of a six-year product development cycle. A high initial price target was quoted by DSI with little justification. Further into the project, upon visiting the factory, there was a clear indication that their process for mass-producing this item was nonexistent. This concern was flagged to PDS management and they requested a full feasibility analysis for full-scale production. However, DSI was slow to respond. All PDS customer validation

exercises have been successfully complete based on this technology. Therefore, it is too late in project development to change suppliers.

5.3 Response by Internal Management

With the entire project at risk due to one supplier, the supply chain team developed several strategies to mitigate the situation. PDS re-opened negotiations with DSI to reduce the price. These negotiations were unsuccessful. Additionally, they developed the novel idea of paying a royalty to DSI for their technology and having a third party complete the manufacturing. Again slow to respond, DSI eventually returned with a royalty fee that, when averaged out over the number of parts, was actually higher than the original price. Management of DSI was clearly taking a hard stance in response to pricing and had refused to budge.

5.4 Critical Framework Analysis

The Incentive Alignment Framework developed in the previous chapter is now used to examine this particular supplier situation. All steps are not analyzed, however, special attention is paid to the critical steps in this relationship. It is important to keep in mind that the below analysis is done in hindsight with all information available.

5.4.1 Step 2 - Option Investigation

In terms of alternatives for this project it was clear that DSI's technology was necessary to meet the customer's technical goals. Therefore, PDS's decision to outsource in this instance was prudent. Internally manufacturing this product would have violated the patents on this particular design with DSI. Alternatives to this technical solution could have been investigated by PDS. However, DSI had invested years of research and development on this project and the resources necessary and timeline for the product would not have allowed this alternative.

Furthermore, the incentive structure that PDS initially had in place was a simple time and expense solution. This did not incentivize DSI for any enhancements in manufacturing productivity and also did

not give the buyer insight into the costs structure of the program. Internal management's reasoning for going with this incentive structure was that the project was a winner-take-all contract. Therefore the belief is that DSI will have the incentive to drive down costs to win the contract; otherwise they will get no revenue.

When considering a game theory analysis of this scenario we begin by looking at the payouts for each firm. PDS has a payout that is orders of magnitude larger than DSI. Additionally, if DSI takes a hard stance on pricing then that may force PDS to simply push other supplier's costs down. This will ensure the contract is won and DSI also maximizes their individual payouts.

The Biform game theory model describes exactly this situation. The Biform model consists of two separate stages played independently from each other by the buyer and supplier. The first stage is a non-cooperative game played only by the supplier where a decision to invest in technology is made independent of the other party. The next stage is a cooperative stage whereby the buyer and supplier form a coalition and must reach a decision jointly. It is important to note that in the cooperative stage, side-payments can be used to transfer utility between the two parties (Cachon and Netessine 2003).

Below, Figure 7 shows the non-cooperative decision of DSI to invest in the technology in the first stage. This investment by DSI affects the decision of PDS to form a coalition based on the change in probability of winning the contract and the added value of the payout in stage two. From the theoretical payouts shown, it is clear that the player with the most power will be able to take claim to a higher percentage of the incremental profits. By making the investment in technology, DSI has increased the overall utility from 110 to 130 and consequently increased its power, evident from the increase in payout from 9% to 15% of the total utility.

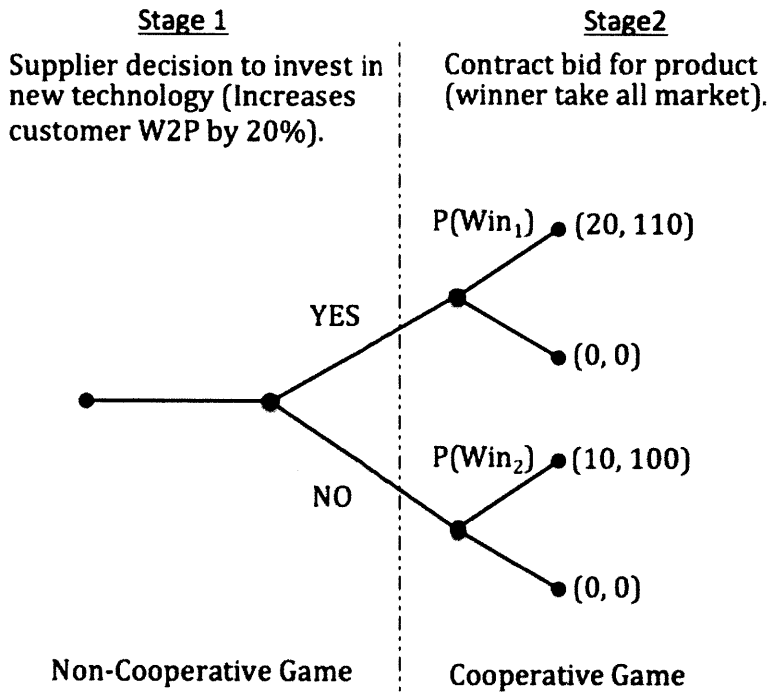

Figure 7 - Biform game theory model

The ideal incentive solution in this case is a performance-based contract. Supplier competition is certainly weak in this case and the supplier power must be mitigated. Therefore, a performance-based incentive structure provides a motivation for DSI to reduce costs over the life of the project.

5.4.2 Step 3 - Execution

Execution was clearly premature in this case. There was limited analysis to understand the cost structure of the overall company and little thought put into how pricing with this supplier fit into the strategic pricing of the entire project. This is due, in part, to the reliance on engineering for most of the communication. The early focus was built on achieving the technical goals of the project and not cost. Organizational design is somewhat to blame with respect to the engineering focus. Historically, PDS is an technical company that emphasizes its engineering strength. This leads to a strong voice within the engineering community and a greater focus on technical ability rather than cost. To remedy this, the organization should be structured such that the supply chain organization makes the final say in supplier selection after receiving input from all stakeholders.

Furthermore, management should have negotiated pricing before this supplier was designed into the project. Once the supplier is an integral part of the project they have few incentives to re-negotiate on price. Timing is critical here. During the first set of negotiations, DSI was anchored on the initial price and the expected ROI. Any negotiations ex post initial contract would be a hard sell.

6 Case Study II: Internal Competition

6.1 Supplier Background

The Metal Works Operations Group is a division within PDS that has historically handled all of the heavy industrial manufacturing for the company. Metal Works' operations are extremely capital intensive and much of their assets have been fully depreciated. As such, there are extremely high overheads across the factory and very little in tax incentives. These overheads were previously offset by external manufacturing for a commercial industry. However, the cyclical nature of this industry has limited much of this business. Therefore, PDS is left to allocate these overheads across their existing product line.

Present internal manufacturing capacity has been sufficient to cover overheads to a reasonable degree. However, there is much uncertainty regarding future factory capacity and exactly how overhead allocation will be divided between product groups. The projected overhead in the upcoming years is currently jeopardizing PDS's ability to provide a competitive bid on their upcoming product. This is due mostly to the downward spiral effect in regards to overheads. High overheads are pushing future product releases within PDS to outsource, which are further driving up overheads.

6.2 Strategic Analysis of the Relationship

Metal Works operates in an organizational silo with a separate management and engineering group from PDS headquarters. This poses many problems during internal discussions. Metal Works' response to conversations on cost reduction is defensive in nature as they are concerned about losing their jobs. Even though Metal Works is physically under the same company, they are siloed to the degree that they are almost treated as an independent supplier.

Additionally, a few individuals in senior management at PDS headquarters have close ties to Metal Works' operations. Some have even worked at the factory in previous roles. Internal discussions around outsourcing this particular aspect of the company are highly emotional and are generally avoided. Despite

this contentious relationship and high cost, PDS has turned to Metal Works for manufacturing this product because previous generations have been manufactured there, providing a learning curve advantage.

6.3 Response by Internal Management

One potential solution to the downward spiral effect is to mandate that specific products manufacture in Metal Works itself. This would increase capacity over time and allow for allocation of overheads across multiple projects. However, the PDS finance director stated that this operation simply did not represent enough of the company's revenue to justify forcing projects to manufacture at Metal Works. Additionally, the project in discussion was slated to be in Metal Works five years out in time while the overhead estimates were only calculated for the next three years. Furthermore, the forecasts regarding which products would be in manufacturing out in time are highly uncertain.

The supply chain team's response to these high overheads was to make a site visit to Metal Works to understand the situation. The purpose of this trip was to discuss methods for driving down factory overhead costs and understand the feasibility of outsourcing. Although the supply chain team's intentions were to benefit the company, they were not well received by Metal Works. After returning from the trip, the supply chain team was encouraged to avoid conflict at the facility.

6.4 Critical Framework Analysis

Again, this supplier situation will be examined based on the Incentive Alignment Framework developed previously in this thesis. The question of whether or not PDS should outsource the capabilities of Metal Works is addressed. Additionally, the Strategic Analysis and the Option Investigation are analyzed for the relationship between Metal Works and PDS.

6.4.1 Step 1 - Strategic Analysis

The first question that PDS should ask itself is: Why are we not outsourcing? This type of manufacturing certainly does not represent a core competency or a competitive advantage for PDS. Furthermore, there

are large risks of owning a capital-intensive factory due to volatile internal demand over the long run. Additionally, liquidating Metal Works' high value assets could add cash to the balance sheet at PDS. Finally, the capabilities that Metal Works provides are extremely commoditized and could be competed for in the open market at a greatly reduced cost.

In addition to the strategic reasons for not owning this factory, the business relationship between the sites needs to be addressed. There are personnel disputes and misaligned incentives between headquarters and Metal Works. Internal politics could be mitigated and better supplier relationship could be formed if this operation is divested. However, the existing politics and short time frame make it difficult to outsource at this juncture.

6.4.2 Step 2 - Option Investigation

The supply chain team's response to this supplier was ideal considering the constraints of the situation. They began looking for ways to reduce overheads internally and, in parallel, investigated alternatives outside of the company. Since Metal Works was under the same parent company they were not technically a supplier. This internal relationship lends itself to certain difficulties in negotiations, specifically the politically motivated incentives discussed. Additionally, no physical contract existed between these two organizations so any negotiations were simply word of mouth. Also, it is important to point out the main control of cost was through managerial accounting methods used by the finance team to allocate overheads.

One option PDS can use to reduce cost is to strategically allocate overheads across the company. Projects that are more competitive and need lower cost structures could have lower overhead allocation rates and visa versa. However, implementing this would require an organizational change. Manufacturing capacity would need to be aggregated across the company and controlled centrally by the supply chain group.

7 Case Study III: Commodity Negotiations

7.1 Supplier Background

Machined parts manufacturing is a skill that has been commoditized by thousands of small suppliers across the US. The industry is extremely fragmented in terms of revenue and there are no dominant players in the market. However, high quality machining certainly demands a price premium over the average supplier. PDS has one specific machine shop it works with that has a proven track record in quality. SMP Manufacturing charges a large price premium over the competition and consequently has never been responsible for any major quality issues. It is also important to point out that the success of SMP is due mainly to the direct management of the owner who is aging and reportedly declining in health. With the new product release under pressures to reduce costs and risks, alternatives to SMP Manufacturing are being investigated.

7.2 Strategic Analysis of the Relationship

PDS is an engineering-dominated company and the engineers certainly have their say in which suppliers they prefer. The current engineering team at PDS has a long history with SMP Manufacturing, trusts their capabilities, and has high confidence in their quality review metrics. When posed with the question of changing suppliers on this project, the engineers declared that no one could come close to the quality of SMP Manufacturing. They refused to even consider alternatives despite the potential cost savings that could arise. From the engineer's perspective, augmenting uncertainty on an already complex project would be adding risk unnecessarily. However, management certainly had opposing views with regards to cost.

7.3 Response by Internal Management

Management tasked the supply chain group with reaching the overall cost goals for the project. After investigating the market for machined parts manufacturing, the supply chain team put together a list of potential suppliers. They then approached the engineering team to discuss their concerns regarding

quality. After several contentious discussions, the engineering team developed a methodology for grading manufacturing quality across competing suppliers. The supply chain team, in coordination with engineering, was then able to identify additional suppliers that could be procured at greatly reduced costs without a significant loss of quality.

7.4 Critical Framework Analysis

7.4.1 Step 2 - Option Investigation

When working with commodity suppliers it is helpful to have enough volume to leverage those suppliers, however, too much business with one supplier carries inherent risks. A centralized supply chain organization has the capability of aggregating demand across multiple projects. This centralized organization allows low volume projects to maintain this leverage and mitigates the risk of supplier default. Additionally, a centralized supply chain team can align incentives within the organization. As an example, a single manager at PDS running a large volume product was able to negotiate low prices with one particular supplier. The supply chain team approached this manager regarding aggregating his demand with a few smaller projects. This would result in higher prices for this manager's project but an overall cost savings for the company. This manager pushed back on this proposition because it would increase his costs. However, the centralized supply chain team was able to escalate this request and achieve a net savings for the company by globally optimizing.

According to the engineering team, SMP's success was attributed mainly to the owner's close involvement in the business. However, there were many rumors that the owner was in declining health and the viability of his business was at risk. Diversification of suppliers was necessary in this case and PDS's supply chain team identified this risk and responded. The overall outcome of the internal and external negotiations of the supply chain team resulted in a significant cost savings for the project and a lower risk profile.

7.4.2 Step 4 - Contract Maintenance

The necessity of gauging quality among suppliers is critical to the success of a project. This is especially true with commodity suppliers where there is a looser relationship between the two organizations. When considering suppliers, the ease and amount of information communicated between organizations is another important factor. The overall costs of monitoring quality in a supplier should also be a factor. Therefore, the buyer must ensure that investments necessary to ensure that contractual quality obligations are being fulfilled are not excessively high.

8 Case Study IV: Supplier Power

8.1 Supplier Background

International Guard (IG) is a large, foreign defense firm with billions in annual revenue. Similar to DSI, they have an innovative piece of technology that PDS must source from them. This technology provides a significant performance increase to the product that the end customer has expressed a high interest in. Consequently, there is a large market for this technology both in PDS and among the competition.

PDS is unable to manufacture this product internally due to license agreements and technical feasibility. However, they have entered into an exclusive agreement with IG that allows them to keep this supplier out of reach from the competition. Similarly, the agreement stipulates that PDS cannot turn to any other supplier for a similar solution to this problem. The main issue for PDS again is cost. IG knows they are under exclusive contract and is refusing to reduce their price.

8.2 Strategic Analysis of the Relationship

PDS's upper management has a good working relationship with IG and a history of successful projects over the years. Consequently, they have recently entered into several long-term, contractual teaming agreements with IG. Teaming agreements are defined by the Federal Acquisition Regulation (FAR) as when a "potential prime contractor agrees with one or more other companies to have them act as its subcontractors under a specified Government contract" (Department of Defense 2005).

The Department of Defense (DOD) does not define the exact nature of the relationship. However, PDS has leaned heavily towards longer-term, exclusive relationships. For several technologies, PDS has 10-year exclusive contracts with IG with little verbiage regarding pricing. In one instance, the supplier must simply be within 30% of the next highest bid. This is not sufficient for PDS to be competitive in the marketplace.

8.3 Response by Internal Management

The vice president of PDS has been the main supporter of these teaming agreements. When questioned regarding the need for these requirements he stressed the strategic nature of the supplier relationships. Brining these suppliers on as allies rather than competitors was critical to the overall competitive strategy. There were certainly dissenting arguments within the company regarding these relationships. However, these dissenters were not very vocal due, in part, to the tight knit and highly political organizational structure.

8.4 Critical Framework Analysis

8.4.1 Step 1 - Strategic Analysis

The technology in question is arguably the best in the industry. Therefore locking this supplier away from the competition through a teaming agreement was seen as critical by management. However, if the value-add to the customer could have been quantified, PDS could have used this as a basis for pricing constraints within the agreement.

Furthermore, this exclusivity contract is long-term, so the response by the competition is another key issue to consider. This supplier relationship has been in place for a few years and the competition has since responded. PDS's competitors now possess the internal capabilities necessary to manufacture this technology. It is rumored that they can now manufacture this aspect of the product much cheaper than IG. While the overall performance has not been gauged to be as superior, it is questionable how the customer will value each product.

Another consideration is additional breakthroughs in technology in this field. Given the contract's length, limited access to competing suppliers may be an issue for PDS for the life of the agreement. Therefore, there is inherent risk associated with this long-term teaming relationship both in price and limiting alternatives. Again, the value the customer sees in this technology is key to mitigating this risk.

8.4.2 Step 3 - Execution

Negotiations on pricing during ex-post contractual agreements have shown no results. Anecdotal evidence shows that IG is extremely stubborn during pricing negotiations. Logically so, IG knows PDS has no substitutes and even if substitutes exist they would violate their contractual agreement. Additionally, since the contract is long-term and exclusive, IG's strategy can be to use its strong supplier power against its buyers. If the relationship between the buyer and supplier is damaged after the end of the contract then IG can simply switch to teaming with the competition. That is assuming they still have an edge in the technology.

Timing the pricing negotiations is again critical in this relationship. Pricing should have been negotiated during adoption of the exclusivity contract itself and certainly before the customer knew of the value of this product. Furthermore, since pricing was critical in this highly competitive market it should have been a contingent clause within the contract. Additionally, quantifying the value the customer placed on this aspect of the project could have served as a BATNA during negotiations.

9 Conclusion

9.1 Framework Recap

A framework for aligning incentives during contract negotiations was developed based on an analysis of the strategic nature of supplier relationships. This framework first investigates suppliers through an analysis of the motivations for why each particular supplier is in business. Understanding this motivation, along with ensuring suppliers are aligned with all stakeholders is critical. Additionally, a risk analysis of all potential suppliers should be completed with emphasis on the crucial elements of the project. If not cost prohibitive, this risk analysis can take the form of a Bayesian network to quantify the operational, network, and external risks.

The next element of the incentive alignment framework is to complete a full investigation of all available options. This first involves delving into the available supplier alternatives. These alternatives range from different suppliers to internal manufacturing to substitute products. Furthermore, a method for understanding the exact structure of the contract is also discussed. This structure varies depending upon the specific relationship necessary for each supplier. A fixed fee contract is used when changes in future costs are uncertain but limits the ability to change the scope of a project. In contrast, a time and expense contract is useful when capital costs are high but does not focus on driving down efficiency. Finally, a performance-based contract is reserved for strategic supplier relationships where competition is weak but gives the supplier greater control of the direction of the project.

The third element of the framework is execution. Execution first involves understanding the detailed structure that goes into writing the contract. A contract consists of a balance of rigid clauses, contingent clauses, and the degree of discretion left to the supplier. An optimal contract regulates tasks of high importance through contingent clauses, tasks of intermediate importance through rigid clauses, and tasks of low importance are left to the agent's discretion. Additionally, in more uncertain environments, optimal contracts should contain more contingent clauses, fewer rigid clauses, and give more discretion to

the agent. After the physical contract is developed, buyers then turn to supplier negotiations. Negotiations revolve around having a viable BATNA. Additionally, involving people in the organization that have a perceived external power by the supplier organization is critical during any negotiation.

The final element of the framework is contract maintenance. This first includes a methodology to verify the rigid and contingent clauses within the contract itself. The buyer must monitor the supplier for the clauses in question and it is important to understand how the cost of monitoring these clauses affects the overall profitability of the project. Finally, it is important to specifically address latent concerns in the contract itself. Details on the exact procedure to follow if an unexpected conflict arises are beneficial to both the relationship of the parties involved and the legal costs of the contract.

9.2 Supplier Case Review

After the incentive alignment framework was fully defined, four supplier relationships at PDS were examined to understand how this framework would impact the organization. The first supplier relationship involves supplier investment costs. DSI has high investment costs in a particular technology and is expected to make a return on their investment in research and development. PDS designed their technology into their product and negotiated with the supplier prematurely. This led to greater supplier power, which DSI used during a second round of negotiations to maintain their profits. The key lesson in this relationship is to rapidly understand the cost structure of a project and ensure that your supplier's incentives are aligned with the rest of the value chain.

The second case study dealt with a supplier that was actually an internal division of PDS. Due to the politics of the different divisions of the company, Metal Works Operations is acting in a manner consistent with an external supplier. Due to internal political complications, organizational structure, and external market influences, Metal Works is experiencing high overhead rates that are being allocated to the few product groups still manufacturing in their operations. The solution to these high overhead rates is

to either liquidate this operation or dictate that specific groups within PDS use this operation to eliminate the downward spiral effect of overhead rates.

The next supplier case study investigates supplier relationships in a commodity environment. The key issues here are driving cost reduction and eliminating risk of supplier default. Analyzing PDS's supply chain structure in this case highlights the need for globally aggregated demand for a particular supplier base across the company. This enables the supply chain management team to effectively leverage suppliers and optimize pricing for many projects at PDS. Additionally, it is important to understand the overall costs of verifying the contractual obligations of the supplier. This includes working closely with the supplier to understand their capabilities for tracking and communicating quality metrics to the buyer.

The final case discussion revolves around the idea of supplier power. PDS has developed a strategic alliance with IG to maintain a competitive advantage in the marketplace. However, this strategic alliance comes at a high cost since the agreement has loose verbiage around pricing. PDS is not able to renegotiate pricing post ex contract and they are now tied into a high cost supplier. An analysis of this situation shows that estimating the customer's valuation of this technology should have been completed before entering into the supplier agreement. This valuation could serve as a baseline for pricing in the initial contract negotiations for the strategic alliance.

Contracts are survivable over long periods of time and provide a legally binding method for organizing parties across a supply chain. However, contracts cannot replace the need for personal interaction in a supplier relationship. Regardless of how much thought and analysis is put into a contract, it is useless if organizations cannot effectively work together. When aligning incentives across organizations, it is critical to ensure there is a mutual respect among parties. Without this mutual respect, individuals tend to make irrational decisions that cannot be mitigated in any contractual setting.

Additionally, it is important to keep in mind the implications of driving down costs within the value chain. For certain situations, cost is critical. However, when buyers have strong power in a supply chain

they have the potential to drive away profits from suppliers. In the extreme case this can lead to supplier failure which may increase long-term costs in the supply chain and disrupt the end customer. An analysis and understanding of the supply base is critical to estimating the profitability of the supplier and knowing what an acceptable margin is.

Finally, every decision throughout the supply chain should revolve around how the end customer will be impacted. In general, aligning incentives throughout the supply chain leads to increased value for the customer. This value can either come in the form of a lower cost, higher quality, or a better service level. Maintaining a holistic view of the entire value chain will ensure that the end customer is supported in the best possible way.

9.3 Future Investigation

Certain aspects of the defense industry provide a unique approach to the analysis of supply chain issues. Constant variables, such as demand variation, limited inventory costs, and inflationary hedging ensures greater focus on the actual incentive relationship between the buyer and supplier. In the case of PDS, the customer mitigates most of these issues. However, in other industries it is critical to note that all three of these issues must be addressed. There would be much value in a research project that examined other industries in a similar manner as this thesis. The impact of demand variation is a widely discussed topic and research on contract negotiations in this area would be especially beneficial.

Some additional research in the area of supplier incentives could also include an empirical investigation into how different contract types have performed historically in different industries. A wide reaching study could be completed to understand the impact that fixed price, time and effort, and performance based contracts across many different types of suppliers. A quantified view of the historical performance of these contracts for similar suppliers could be correlated to specific contract types. This would enable a metric to gauge the actual performance of these contract types and validate some of the conclusions reached in this thesis.

Finally, another interesting, complementary line of research could include an in-depth study further down into the supply base. The impact of an incentive contract between supplier and buyer is directly observable. However, in certain markets the supply chain is fairly deep and runs many layers. Understanding the implications of incentive structures in tier two and tier three suppliers would be beneficial.

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