IMPLICATIONS OF PERFORMANCE-BASED CONTRACTING ON LOGISTICS AND SUPPLY CHAIN MANAGEMENT: A MULTI-METHOD APPROACH

Hasan Celik

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APPROVED:

David Nowicki, Major Professor
Audhesh Paswan, Committee Member
Brian Sauser, Committee Member
Divesh Ojha, Committee Member
Jeffrey Ogden, Chair of the Department of Marketing, Logistics and Operations Management
Marilyn Wiley, Dean of the G. Brint Ryan College of Business
Victor R. Prybutok, Dean of the Toulouse Graduate School

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Performance-based contracting (PBC) redefines the relationships between suppliers and buyers and differs from traditional contracting approaches with its reward/payment scheme, emphasis on the performance outcomes, increased supplier autonomy, and transfer of risk and responsibilities to suppliers. Given the 70% of life cycle costs of products/systems reside in sustainment, PBC has led to substantial improvements in availability, maintainability, reliability, and thus total cost of ownership of systems/products. Though PBC has changed the way of doing business and its presence has increased across multiple industry, private and public sectors, for profit and not-for-profit, its implications on various aspects of logistics and supply chain management have been understudied. It is important to explore and establish evidence regarding these implications through academic rigor. Therefore, this three-essay dissertation aims to give some insight regarding structural and behavioral implications of PBC using a multi-method approach. Specifically, it (1) explores the relationship between PBC and supply chain resilience (SCRES), (2) examines the supplier goal commitment (i.e., motivation) in PBC, (3) proposes a mathematical model to find optimal contract length, periodic contract price and investment that concurrently maximizing supplier profit and satisfying buyer requirements. This dissertation offers theoretical and managerial contributions as well.

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INTRODUCTION

Today's business organizations' success is heavily dependent on the successful management of their supply chains. Moreover, as supply chains grow into more complex than ever, the center of gravity of competition has shifted towards supply chains from individual business organizations. Therefore, resilient and sustainable supply chains are of critical importance for every stakeholder in a supply chain. Governance of relationships among supply chain stakeholders plays a substantial role in the end purpose: competitive advantage. There are two main types of governance used in inter-organizational relations (IORs): contractual governance and relational governance. While these two approaches can be employed individually, they are mostly used complementarily. As a contractual governance approach, the popularity of performance-based contracting (PBC) has increased in multiple businesses and across public and private areas (Hypko et al., 2010). For example, DoD has been using PBC as the preferred sustainment strategy since 2001 (Guidebook, P.B.L., 2014). Briefly, PBC links a considerable amount of supplier payment to their performance outcomes (Selviaridis & Wynstra, 2015). The key idea underlying PBC is highlighted by a famous quote from Theodore Levitt (1972): "The customer does not want a drilling machine; he wants a hole-in-the-wall." PBC specifies and evaluates performance outcomes rather than deal with necessary activities, inputs, or processes (Martin, 2007). The central assumption of PBC is that the cost will go down as the supplier has autonomy and flexibility to design the product and production process to deliver a determined performance level (Nowicki et al., 2010), which may also stimulate innovation. As a governing approach of inter-organizational relations (IOR) and transactions, performance-based contracting (PBC) has altered the way of doing business, thereby producing many implications for diverse aspects of logistics and supply chain management. Under the supply chain relations theme, this research focuses explicitly on the PBC as a governing mechanism and its structural and behavioral implications.

The first essay explores the effects of PBC characteristics on supply chain resilience (SCRES), which is defined by Ponomorov & Holcomb (2009, pp.131) as "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function." SCRES is one of the top priorities of business organizations to maintain continuity of supply chains. Creating appropriate contractual agreements, which govern supply chain relations among supply chain stakeholders, is one of the proactive strategies to improve SCRES (Tang 2006a, 2006b; Urciuoli et al., 2014). On the other hand, Ali et al. (2017) put forth SCRES capabilities such as anticipate, adapt, respond, recover and learn, and reveal 27 elements regarding these capabilities including visibility, collaboration, coordination, risk/revenue sharing or risk control/transfer, trust, and increasing innovativeness. Even though creating appropriate contractual agreements is defined as one of the proactive strategies for improvement of SCRES by Tang (2006a, 2006b) and Urciuoli et al. (2014), there is no substantial research on this topic. Moreover, the above-mentioned inherent features of PBC might have an impact on the strategies/capabilities of SCRES. However, the literature in both areas is not addressing this gap. More specifically, this study develops a conceptual framework and systemigram linking fundamental tenets of PBC with SCRES capabilities through the lens of agency theory and reveals the mediators. It proposes that with its low term specificity, risk/responsibility transfer, and incentive schemes, PBC has positive effects on SCRES in terms of visibility, risk management, and innovation. It also points out the moderating role of risk propensity of the organizations, contract length, and payment/reward scheme. This study contributes to the literature by bridging the gap between PBC and SCRES literature. It also provides managerial implications for practitioners to some extent. Since choosing a contract type is of critical importance for companies/businesses, decision-makers would have a chance to incorporate the effects of PBC on SCRES in their decision-making

process, which would finally have an impact on their companies' SCRES. Moreover, managers may take advantage of the effect of PBCs on SCRES and optimize key elements (reward scheme, contract length, performance outcomes, and risk share) to improve their SCRES.

In PBC, suppliers bear nearly almost all of the responsibilities related to the contracted work and are supposed to provide performance outcomes specified by the buyers. Therefore, their performance plays a critical role in the success of the contracted work and whole buyer performance. Though the PBC research stream has been expanding, the behavioral implications of PBC on supply chain stakeholders are understudied. The second essay examines the behavioral implications of PBC and sheds light on the effects of PBC on the supplier goal commitment that is a primary prerequisite for supplier performance. Specifically, using the theoretical lenses of Agency Theory (AT), Goal Setting Theory (GST), and Job Characteristics Theory (JCT), it highlights the role of PBC characteristics such as payment/reward scheme, increased autonomy provided to the supplier, and transfer of responsibilities to the supplier on the supplier goal commitment. Furthermore, it examines the mediating role of goal alignment between supplier and buyer and felt accountability of supplier between PBC characteristics and supplier goal commitment. This empirical study, first, develops hypotheses and provides a conceptual model through the lenses of AT, GST, and JCT based on a thorough literature review. Later, it develops a survey instrument following a structured method consisting of a literature review, interviews, Q-sort, and a pilot study to collect data. And, lastly, based on CFA analysis, it establishes a measurement model and tests the hypotheses using SEM. The results reveal that with its incentive schemes, responsibility transfer to the supplier, and increased supplier autonomy, PBC has positive effects on the supplier goal commitment, which is crucial for supplier performance. This study also points out the mediating role of goal alignment and felt accountability/responsibility on the goal commitment of suppliers. This study, which is the first behavioral study in this line of research, provides both theoretical and

managerial implications. Theoretically, this study extends both the theories used and PBC research. It applies goal-setting theory in inter-organizational context and introduces goal alignment and felt accountability as new antecedents of goal commitment. Second, it introduces a new, validated construct (transfer of responsibilities), which might be used in future studies. Third, it highlights the importance of contracts, which governs the IOR and transactions formally, in organizational motivation and work performance. In terms of managerial implications, it presents a new validated insight for contract type selection. Managers/executives or decision-makers are encouraged to consider the effect of PBC on supplier goal commitment to enhance their knowledge when evaluating competing contract mechanisms. Moreover, being aware of the effect of PBC on supplier goal commitment, managers may pay more attention to the fundamental tenets of successful implementation of PBC to enhance supplier goal commitment.

The third essay develops a pricing model for optimum solutions in PBC based on subscription pricing model (Fruchter & Sigué, 2013). Reward/Payment scheme is one of the essential characteristics of PBC to incentivize suppliers to provide demanded performance outcomes by investing in activities that improve reliability, availability, and maintainability of contracted work. This study uses a mathematical modeling approach to develop a pricing model to optimize key performance outcomes/parameters, along with the total cost of ownership in PBC. Specifically, this study offers new decision insight regarding the optimal investment, optimal contract length, and optimal periodic contract price that concurrently maximize the profit to the supplier and satisfy the buyer's needs. This study also strives to address different contexts using two different distributions for buyers' reservation fees, which is critical for determining the contract price, and analyzing the effects of changes in parameters such as usage rate, market size, marginal investment parameter, initial system's reliability, repair cost per failure, discount rate expected by the buyers per period on the optimal investment, optimal

contract length, and optimal periodic contract price and reliability.

To summarize, these three essays take a multi-method approach to examine the implications of PBCs on logistics and supply chain management and provide theoretical and managerial contributions. First essay explores and reconciles two different concepts, PBC and SCRES, and offers propositions, conceptual framework and systemigram regarding the relationship between these two concepts through the lens of agency theory using a systems thinking approach based on an inclusive literature review. Second essay focuses on the behavioral implications. Specifically, it investigates the effects of key tenets of PBC on the supplier goal commitment using a quantitative approach. This study collects data using survey approach, tests the developed research model using SEM, and provides empirical findings along with theoretical and managerial contributions. Finally, third essay aims to develop an optimal PBC design using a mathematical modeling approach. It offers a decision-theoretic model for both buyers and suppliers for optimal solutions in PBC. This mathematical model maximizes the total profit to the supplier with optimal solutions for periodic contract price, reliability investment and contract length while analyzing the effects of two different distributions for buyers' reservation fees and changes in the parameters.

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ESSAY 1

THE EFFECTS OF PERFORMANCE-BASED CONTRACTS ON SUPPLY CHAIN RESILIENCE

Introduction

Inter-organizational relationships (IORs) are of critical importance to accomplish competitive advantage. There are two main types of governance used in IORs in the related literature as follows: contractual governance and relational governance. Performance-based contracting (PBC) has been used in an increasing fashion in multiple businesses and across public and private areas (Hypko et al., 2010). Briefly, as a contract type, PBC links a great amount of supplier payment to supplier performance outcomes (Selviaridis & Wynstra, 2015). The key idea underlying performance-based contracting is highlighted by a famous quote from Theodore Levitt (1972): "The customer doesn't want a drilling machine; he wants a hole-in-the-wall." PBC specifies and evaluates performance outcomes rather than deal with necessary activities, inputs, or processes (Martin, 2007). The central assumption of PBC is that the cost will go down as the manufacturer has the autonomy and flexibility to design the product and production process so as to deliver a determined performance level (Nowicki et al., 2010), which may also engender innovation.

PBC has some fundamental differences from other contract types as follows: Firstly, PBC emphasizes customer orientation with regard to provided value through specific performance outcomes (Datta & Roy, 2011), which leads to improvement in goal congruence and incentives throughout the whole supply chain (Randall et al., 2011). Secondly, PBC converts performance accomplishment/failures into rewards and/or punishments, which leads an increase in rewards and risks for the supplier (Simab et al., 2012; Carlson et al., 2010). Thirdly, PBC underlines the buyer-supplier collaboration for achievement of performance outcomes (Guo & Ng, 2011), which emphasizes the role buyers (Sampson & Spring, 2012).

Since there is a paradigm change in the way of doing business, this paper highlights the central characteristics of the PBC and examines their impacts on supply chain resilience

On the other hand, in recent years, many disruptions – unexpected and unplanned events that interrupt the normal supply chain flow (Kleindorfer & Saad, 2005) such as earthquakes, hurricanes, political chaos, economic crises, terrorism etc. – have occurred and had severe devastating impacts on the firm performance. Such events have led to an increase in search for remedies to improve supply chain resilience (SCRES) to diminish the potential devastating effects of disruptions. For example, the World Economic Forum (2013) put forward that at least 80% of firms are worried about their SCRES (Tukamuhabwa et al., 2015).

Even though firms can employ effective strategies for risk management so as to deal with disruptions and mitigate vulnerability (Manuj & Mentzer, 2008), a comprehensive approach is required for strategies that would both detect, identify, monitor, and diminish risks and disruptions; and moreover respond rapidly, efficiently, and effectively (Melnyk et al., 2010). Consequently, combination of these of strategies have led to emergence of SCRES concept (Ponomarov & Holcomb, 2009). SCRES would enable SC stakeholders to adapt to the changing business environment and keep their competitive advantage (Ponomarov & Holcomb, 2009). Tukamuhabwa et al. (2015) summarize 24 different proactive and reactive strategies for attaining SCRES in which creating appropriate contractual agreements is defined as one of the proactive strategies by Tang (2006a, 2006b) and Urciuoli et al. (2014). Ali et al. (2017) define the abilities of anticipation, adaptation, responding, recovery and learning as SCRES capabilities and find twenty-seven elements regarding these capabilities including visibility, collaboration, coordination, risk control/transfer, trust and increasing innovativeness in the literature.

Even though creating appropriate contractual agreements is defined as one of the proactive strategies for improvement of SCRES by Tang (2006a, 2006b) and Urciuoli et al.

(2014), for our knowledge, there has been no research investigating the effects of contract types specifically PBC on SCRES. We believe that PBC has changed the way of doing business and it has led to a paradigm change. It has important implications for SCRES as well as supply chain management. Both research streams of PBC and SCRES reveal that there might be relationship between the outcomes of PBC and antecedents/capabilities/strategies of SCRES. Therefore, we argue that with its inherent features and implications, it deserves to examine PBC's effects on the strategies/capabilities of SCRES. However, to our best knowledge, the literature in both areas has not addressed this gap. Thus, this research seeks to explore the relationship between PBC and SCRES and put forth impacts/implications of PBC on SCRES.

In this research, we use systemigrams to present the visual representation of the relationship between PBC and SCRES through innovation, risk management, and visibility. Systemigram, which was developed by Boardman & Sauser (2008), is a great tool to make people visualize what is presented in a written form with a systemic approach. We first present a systemigram for our mainstay and then use a systemigram scene for each proposition or a group of propositions to delineate how PBC yields to increased SCRES.

This study will provide valuable theoretical and managerial contributions. Since choosing a contract type is of critical importance for companies/business, decision makers would have a chance to incorporate the relationship between PBC and SCRES in their decision-making process, which would finally have an impact on their companies' SCRES.

Literature Review

Performance-Based Contract

Performance-based contracting (PBC), which is also mentioned in the literature as "Performance Contracting" (Hansen, 2006), "Availability Contracting", "Contract for Availability" (CfA) (Hockley et al. 2011), "Performance-Based Service Acquisition (PBSA)" (Gansler et al., 2011), "Performance-Based Logistics (PBL)" (Boyce & Banghart, 2012), and

"Outcome-Based Contracting (OBC)" (Sandborn et al., 2017), aims to make a contractor deliver performance outcomes (instead of goods and services/labor as in the conventional contracts) as specified by key performance indicators for the contracted work. For example, Rolls-Royce launched "power-by-hour" for the engines of its airplanes where it is responsible for the availability of the engines that requires maintenance, repair, and overhaul and it is paid per hour of flight (Sandborn et al., 2017). Theodore Levitt (1972) highlighted the fundamental idea behind performance-based contracting saying that: "The customer doesn't want a drilling machine; he wants a hole-in-the-wall."

PBC approach unveils a paradigm change in business model by changing the way doing business. We thus argue that this paradigm change deserves an analysis of its implications on behavioral aspects of supply chain stakeholders. The buyer assigns the supplier to provide specified performance outcomes and ties the payment to the supplier's performance (Vitasek et al., 2007; Gansler & Lucyshyn, 2006). The supplier also assumes the most of responsibilities and related risks, which comes with an increased level of autonomy (Sols & Johannesen, 2013; Caldwell & Howard, 2014).

In PBC, buyer aims to use supplier's knowledge, experience, expertise, capacity, and capabilities so as to have the best commercial practices. In PBC, just desired outcomes are specified whereas traditional approach contains processes, specifications about what is supposed to be done, which in turn provides flexibility, autonomy and more room for creativity and innovation (Yukselen, 2012). As a result, suppliers have the required liberty and opportunity to use their domain knowledge and expertise to innovate and deliver the determined performance outcomes in the exchange of rewards and/or payments (Sols et al., 2007).

Vitasek et al. (2006) suggest that though suppliers assume additional risks, they are incentivized to invest in innovation that will enhance performance, lead to higher profits, and

diminish total cost of ownership through the careful alignment of performance objectives, accountability, and control. They assume PBC as an opportunity for the suppliers as they would have enjoy more autonomy in providing support, guarantee stable cash flow for a long term, and increase their revenue by rewards thanks to the investments in innovation that would improve related processes. On the other hand, it is an opportunity for the buyer to gain specified performance outcomes with a decrease in costs and logistics footprint (Vitasek et al., 2006). Table 1.1 shows the substantial improvement in the supply chain of the US Navy.

Table 1.1: Improvements in availability and response times of US Navy programs.

Program	Availability		Response Time	
	Pre PBL	Post PBL	Pre-PBL	Post PBL
F-14 Lantern	73%	90%	56.9 days	5 days
ARC-210			22.8 days	5 days
H-60 Avionics	71%	85%	52.7 days	8 days
F/A-18 SMS	65%	98%	42.6 days	2 days CONUS
F/A-18 SMS			42.6 days	7 days OCONUS
Tires	70%	85%	28.9 days	2 days CONUS
Tires			28.9 days	4 days OCONUS
APU	65%	90%	35 days	6.5 days

Note: Reprinted from Vitasek et al., 2006.

Randal et al. (2010) presents PBC a new approach of using service-dominant-logic (SDL) theory in a supply chain. Hou & Neely (2014) mention PBC approach as a journey (or “servitization") that is "the innovation of an organization's capabilities and processes to better create mutual value through a shift from selling a product to selling product-service-systems" (Neely, 2008). SDL perspective mainly highlights the significance of relational governance (i.e. collaboration, trust, commitment, information sharing etc.) to attain service outcomes through the co-production of the supply chain partners (Essig et al., 2016; Ng et al., 2009). Batista et al. (2017) highlight the evolution towards value co-creation and emphasize that this evolution encompasses development of co-capabilities of both supplier and buyer in that they both collaborate to generate the performance (Ng & Nudurupati, 2010).

Visnjic et al. (2017) emphasizes the major transition in the business model from

"product business model (PBM)" to "outcome business model (OBM)" or moving from a "basic service offering (e.g. maintenance services)" to "advanced services such as outcome-based contracts" (Amit & Zott, 2001; Zott et al., 2011; Ng et al., 2013). This change consequently leads to various implications in the value creation process (Normann & Ramirez, 1998; Maine et al., 2012), which also constitutes the foundational basis for our study.

Successful implementation of PBC would achieve the required performance outcomes at a lower cost, improve productivity, lead to innovation and best practices, reduce system risks, and enhance reliability in the "supplier-customer system" (Anatassacos, 2016). In PBC, aligned incentives between supplier and customer can considerably increase both effectiveness and efficiency whereas decrease moral hazard, ambiguity in businesses. and Being successful in PBC necessitates significant changes in "business model, strategy, organization, competencies, resource deployment and delivery system and, often, overhead level and balance sheet management" (Anatassacos, 2016). This change in the business model requires buyer and supplier to develop joint culture and performance language, which can be facilitated through creating tools for data collection, monitoring, tracking, and analysis of contract relevant data (Anatassacos, 2016). This research will put the aforementioned characteristics of PBC at the center and try to examine its implications on SCRES.

Supply Chain Resilience

The study of SCRES has been eliciting attention both in the academia, and in the field since the 2000 fuel protest that disrupted transportation in UK and especially after 9/11 events because of its possible influence on stability and competitiveness of businesses (Christopher & Peck, 2004). Supply chains increasingly have subjected to disruptions because of the natural and manmade disruptions, supply chain complexity, global competition, and the attempt of companies to improve their financial performance (Wagner & Neshat, 2010; Tang & Tomlin, 2008).

Even though there are many definitions in the literature, Ponomorov & Holcomb (2009) offer one of the broadest and coherent definitions of SCRES that underlines SCRES as an adaptive capability: They define it as follows: "The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function." Tukamuhabwa et al. (2015) present 24 different strategies for attaining SCRES. They reveal the most used SCRES strategies as follows: building redundancy, improving flexibility, establishing collaborative relationships, and developing agility. Designing proper contractual agreement is also defined as one of the proactive strategies by Tang (2006a, 2006b), and Urciuoli et al. (2014).

For the capabilities that are required to be resilient and cope with disruptions, Ali et al. (2017) define the abilities of anticipation, adaptation, responding, recovery and learning as SCRES capabilities and find twenty-seven elements regarding these capabilities including visibility, collaboration, coordination, risk control/transfer, trust and increasing innovativeness in the literature.

Theoretical Framework

Agency Theory

In terms of buyer–supplier relations, design, and management of PBC can be assumed as a matter of control and governance (Ring & van de Ven, 1992). Agency theory (AT) examines contracts as mechanisms to arrange benefits and risks (Mitnick, 1973). AT typically strives to establish the most effective contract according to the standpoint of principals where an uncertain environment and information asymmetry exist (Jensen & Meckling, 1976). AT tries to address two types of problems: First is the adverse selection due to the hidden information where the agent misrepresents itself to win a contract or get beneficial terms from the principal (Bergen et al., 1992). The second is the "hidden action" suggesting "moral hazard"

where the agent just follow its own goals (Ross, 1973). The principal (buyer) can cope with these challenges through selecting right agent (supplier), designing appropriate contract, and collecting information (Bergen et al., 1992).

With its structure and climate, PBC can handle the aforementioned problems (Gordon et al., 2018). It can facilitate addressing the adverse selection due to the misrepresentation of agents (Ross, 1973). In PBC, the agent (supplier) is not expected to misrepresent as the compensation is tied to achievement of performance outcomes. PBC also can tackle moral hazard problem where the agent (supplier) behaves opportunistically (Ross, 1973). Since the incentive/reward system is tied to achievement and/or improvement of performance outcomes, which is also principal's (buyer) objectives, it would align the goals of the stakeholders and make agent (supplier) dedicate its resources to these endeavors (Gordon et al., 2018). Consequently, AT can provide an appropriate framework to PBC research.

Resource Dependency Theory

Resource dependency theory (RDT) analyzes the governance of inter-organizational relations with an emphasis on dependence and competitive advantage through the share of complementary unique resources that might be inaccessible for one side of the stakeholders (Heide, 1994; Fynes et al., 2004). Therefore, it is an appropriate theoretical perspective to analyze buyer-supplier relationship in PBC. RDT suggests that organizations can bring together their complementary resources to attain competitive advantage while being resilient against environmental uncertainty (Salancik & Pfeffer, 2003). As mentioned in the previous sections, PBC yields to goal alignment between the buyer and the supplier through the share of resources and establishes a "win-win" atmosphere for both parties, which fits the RDT perspective. In PBC, while the buyer accesses to the supplier's knowledge, experience, expertise, capacity, and capabilities for its operations, the supplier receives rewards/payments based on the achievement of predetermined performance outcomes, has longer contracts,

increased level of autonomy, and opportunities to implement cost avoidance strategies to maximize its profit. Both sides are dependent to each other and have appropriate instruments and leverages to govern the relationship to achieve mutual benefits, which makes the RDT an appropriate lens to examine PBC.

Development of Propositions

We mainly argue that with its characteristics such as payment/reward scheme, low term specificity, transfer of most of the responsibilities to the supplier, and investment in information technologies, PBC have positive effects on visibility, risk management and innovation, thus yields to improved SCRES (Please see Figure 1.1).

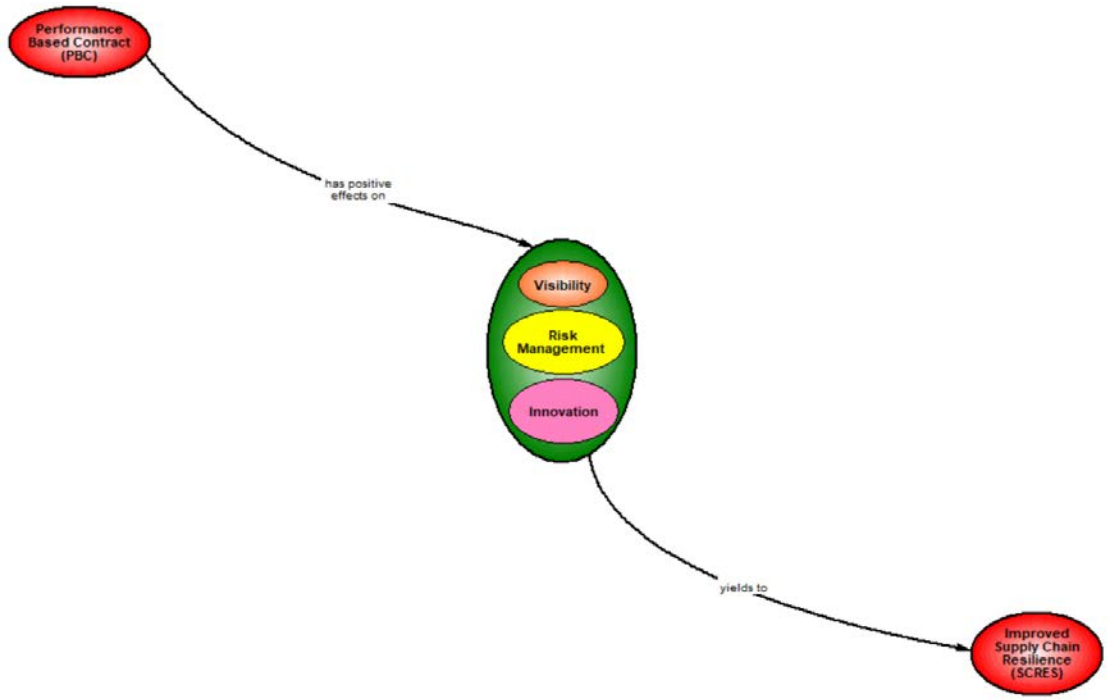

Figure 1.1: Mainstay of the systemigram for PBC and SCRES relationship.

Innovation

In this research, we adopt the definition of innovation from the Sumo et al. (2016). They state innovation as "partner-initiated, proactive undertakings that take place within the context of a specific IOR, either in collaboration with, but in any case for, a focal organization, that result in new or improved ways of delivering transactions", which incorporates both radical

innovation (e.g., novel service concepts) and incremental innovation (e.g., developments in process) On the other hand, innovativeness is the inspiration and competence to pursue and create novel business ideas such as novel products, processes, services, technologies, and methods that mitigate vulnerability (Golgeci & Ponomarov, 2013), which leads to agility (Christopher & Peck, 2004) , and anticipation capability (Ali et al., 2017)

In today's business environment, partners are one of the key sources of providing innovative contributions (Roy et al., 2004; Van Echtelt et al., 2008). In PBC, suppliers are incentivized to invest in innovative solutions to enhance system/product reliability and improve processes to accomplish performance outcomes, which increases mutual benefits (Randall et al., 2012, 2015). Sumo et al. (2016) suggest that in PBC, suppliers may innovate to improve their daily activities to provide performance outcomes to the buyer with more efficiently, which offers benefits for both parties.

Innovation is one of the key principles of PBC which leads to decrease in cost. Randall et al. (2010) reveal how PBC fosters innovation. While traditional contract types have an intrinsic incentive deficiency, where the suppliers profit from system failures (Randall et al., 2011), PBC removes this deficiency by "monetizing" suppliers' potential cost evasion employing a return-on-investment (ROI) governance system (Kratz & Diaz, 2012), where supplier get profit as the total cost of ownership decreases due to investment in innovations. Moreover, guaranteed funding provides the incentive that boosts investments, which in turn improve system reliability, decrease costs, and increase profitability (Randall et al., 2010).

Though Williamson (1985) suggests that contracts should be as complete as possible to decrease risks, and increase transaction gains, contracts are unavoidably incomplete. Sumo et al. (2016) revisit the reasons why contracts are unavoidably incomplete. First, all the terms and clauses cannot be specified due to bounded rationality of stakeholders (Aghion & Holden, 2011; Tirole, 1999). Second, organizations seek to reduce the before and after costs with

regards to costs of designing complete/incomplete contracts (Crocker & Masten, 1991). Third, contracts may be designed purposefully incomplete for the sake of freedom and flexibility (Bernheim & Whinston, 1998).

Even though incomplete contracts cannot adequately reflect the transaction features, which might lead to opportunistic actions (Williamson, 1985; Goldberg, 1976, 1985), they, being less prescribing, offer two significant benefits compared to detailed contracts. First, they allow flexibility for contingency adaptability by which to address unexpected situations (Bernheim & Whinston, 1998; Luo, 2002). Second, they offer increased level of autonomy for the supplier to determine how to provide the performance outcomes (Bernheim & Whinston, 1998; Luo, 2002), which is believed to foster innovation (Sumo et al. 2016).

Term specificity is "the extent to which processes and behaviors are specified in the contract, which relates to the degree of freedom that the supplier has in designing, managing, and executing the outsourced service processes" (Sumo et al., 2016); which implies that a high term specificity refers to low level of liberty, whereas a low level refers high level liberty. PBCs have relatively low term specificity with a specification of performance outcomes instead of the required inputs and processes to attain performance outcomes (Sumo et al., 2016).

The PBC is an intentionally left incomplete agreement. Having specified the performance outcomes rather than supplier's implementation, PBCs have low level of term specificity, and incentives are tied to achievement of performance outcomes by the supplier. (Sumo et al., 2016; Kim et al., 2007). Having a low level of term specificity, PBC provides freedom facilitating suppliers to use their expertise and creative thinking to address problems and approach to performance metrics (Woodman et al., 1993) and offers them the autonomy to invest in innovative activities for their operations (Abbey & Dickson, 1983).

Tying rewards to accomplishment of performance outcomes comprise the second feature of PBC (Martin, 2002), which incentivize and stimulate supplier innovation as any

increase in net profits due to the innovations will largely return to the supplier (Sumo et al., 2016). Sumo et al. (2016) examine how PBC with low term specificity affects innovation in IORs. In PBC context, the suppliers have the autonomy/freedom to provide performance outcomes in a fashion they believe best (Sumo et al., 2016; Wang et al., 2011; Johnson & Medcof, 2007).

Sumo et al. (2016) argue that low level of term specificity fosters innovation, however, it might also yield to supplier opportunism when it is very low (Shimizu, 2012; Eisenhardt, 1989; Guth & MacMillan, 1986). Therefore, simultaneous mechanisms such as financial compensation are required to overwhelm opportunistic behavior and increase innovative actions as suggested by AT (Eisenhardt, 1989; Sumo et al., 2016). Such schemes offer incentives to embrace dynamic behavior, promote efficient adaptation, and encourage agents (suppliers) to follow and meet principals' objectives and expectations (Eisenhardt, 1989; Furlotti, 2007; Sumo et al., 2016). By linking rewards to performance outcomes, PBC aligns the interests/goals of the two stakeholders and diminish the opportunism stemming from contracts with low level of term specificity (Kim et al., 2007; Eisenhardt, 1989; Sumo et al., 2016).

In a study, Glas & Kleemann (2017) find that PBC provides considerable opportunities such as less cost, higher quality, and improved competitive advantage. But more importantly, PBC offers the differentiation opportunity by facilitating innovation, and improving the buyer satisfaction (Glas & Kleemann, 2017). Moreover, Randall et al. (2015) find that PBC aligns the goals of the buyer and the supplier, which leads to innovative investments.

Visnjic et al. (2017) argue that PBC offers a constant co-creation of value among supply chain partners (Lusch & Vargo, 2014) and suggests that there are three types of innovation occur in PBC as follows: "customer-driven innovations, data-driven innovations, and emergent innovations." They argue that PBC allows suppliers to extract customer preferences or generate

knowledge about them and transform them into specific outputs. Moreover, supply chain data analysis offers new opportunities to optimize the system by innovations. Lastly, emergent innovations refer to unexpected innovations that might happen as PBC act as a catalyst and provide an efficient environment such as enabling room for trial and error (Visnjic et al. 2017).

To summarize; PBC has two main features that pave the way for innovation. First, having specified the performance outcomes rather than supplier's implementation, PBCs have a low level of term specificity, which provides autonomy/freedom and flexibility that allows suppliers to use their expertise and creative thinking to achieve performance outcomes. Second, payment/incentive schemes are tied to the accomplishment of performance outcomes, which align the goals of both parties and foster innovation. Based on the arguments, we contend that with its structural elements (i.e., low term specificity and incentive/payment scheme), successful implementation of PBC would engender innovation, which thus have a positive effect on agility and anticipation capabilities thereby increasing SCRES (Please see Figure 1.2).

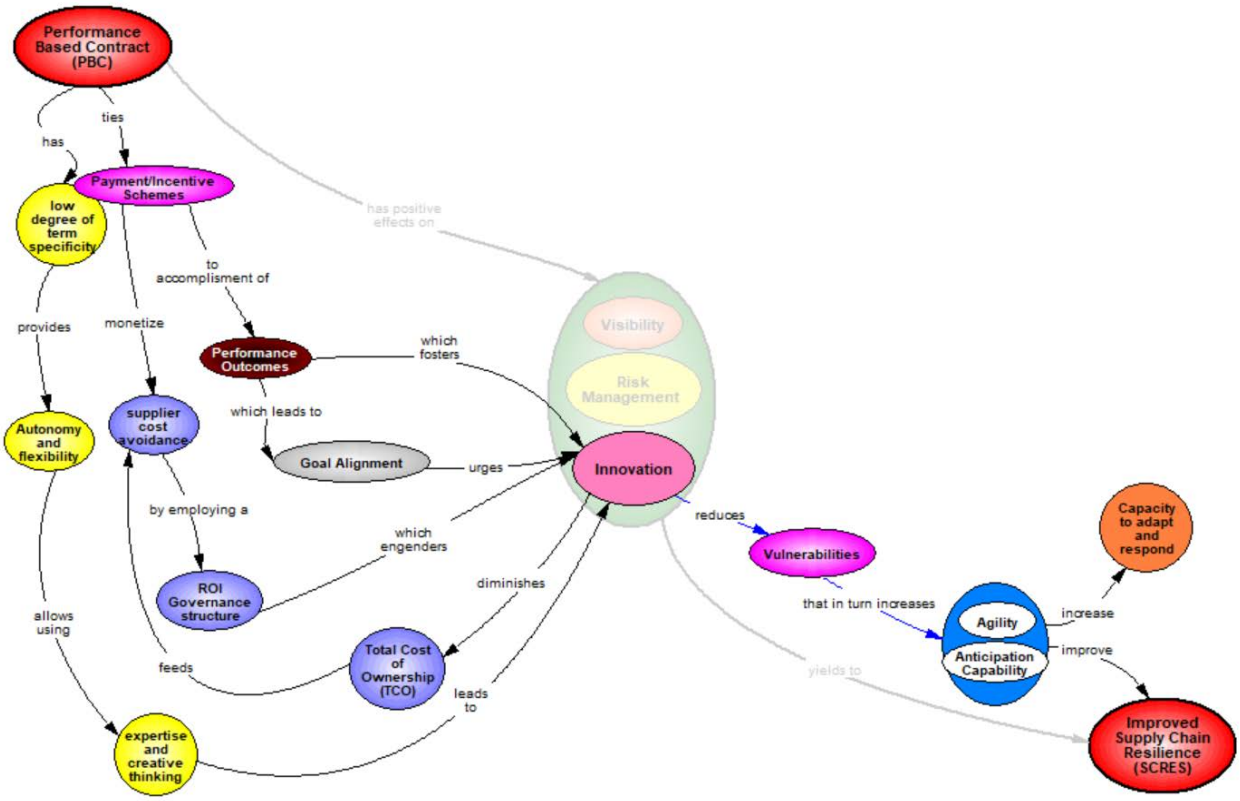

Figure 1.2: Systemigram scene for PBC effect on innovation, and thus on SCRES.

Therefore, the first proposition will be as follows:

P1a: Successful implementation of PBC facilitates innovation,

P1b: Innovation leads to an improved SCRES.

On the other hand, AT proposes that the optimal reward/incentive structure is contingent on the supplier's risk propensity (Eisenhardt, 1989). When the payment is tied to performance outcomes, risk averse suppliers might be more cautious and more cost sensitive which in turn make them choose conservative activities instead of creative ones (Sumo et al. 2016). Consequently, since innovative activities have integral risks, this might lead the risk averse suppliers to decrease their innovative activities (Sumo et al., 2016; Makri et al., 2006; Bloom & Milkovich, 1998).

The AT posits that risk propensity of the supplier has impact on optimal reward scheme (Levinthal, 1988; Eisenhardt, 1989). Tying payment to achievement of performance outcomes, instead of processes or activities, increases liabilities of suppliers (Gates et al., 2004), which also make supplier assume more responsibility and risk due to uncertainty of income stream (Ng & Nudurupati, 2010; Kim et al., 2010; Gruneberg et al., 2007; Guajardo et al., 2012).

Consequently, we argue that the level of risk-averseness of organizations would have negative effect on the innovativeness of the supplier (Please see Figure 1.3). To that end, the second propositions will be as follows:

P1c: The risk propensity of a supplier moderates the relationship between PBC and the innovation.

Gardner (2008) underlines the importance of contract length as one of the key incentives for encouraging investment in PBC. Kim et al. (2007) argue that suppliers would be interested in investments in reliability improvements in the long run.

Longer contracts enable suppliers to balance investment risk, provide cash-flow continuity and offer the required “payback period” to get return on investment (ROI), thereby urging them for product and process improvements (Sols et al., 2007; Vitasek et al., 2007;

Dibenedetto, 2007; Kobren, 2009).

Sols et al. (2007) highlight the remaining life of systems and advise performance-based approach for the systems where there is enough service life left for the systems to operate. Moreover, they consider long-term contracts as necessary for the supplier to spread the costs of upfront investments such as reliability enhancement and to have ROI (Straub 2009, Randall et al., 2012).

Randall et al. (2012) expound the supplier motivation for investments in long-run and short-run contracts. Their findings exhibit in the long run, suppliers become motivated for more quality investment solutions and innovative processes, whereas, in the short term, they mostly strive to improve existing processes, such as inventory management, transportation, and repair services. Straub (2009) underlines the necessity of long-term contracts to reward suppliers or facilitate return on investment for their innovative investments in product quality and repair processes in PBC.

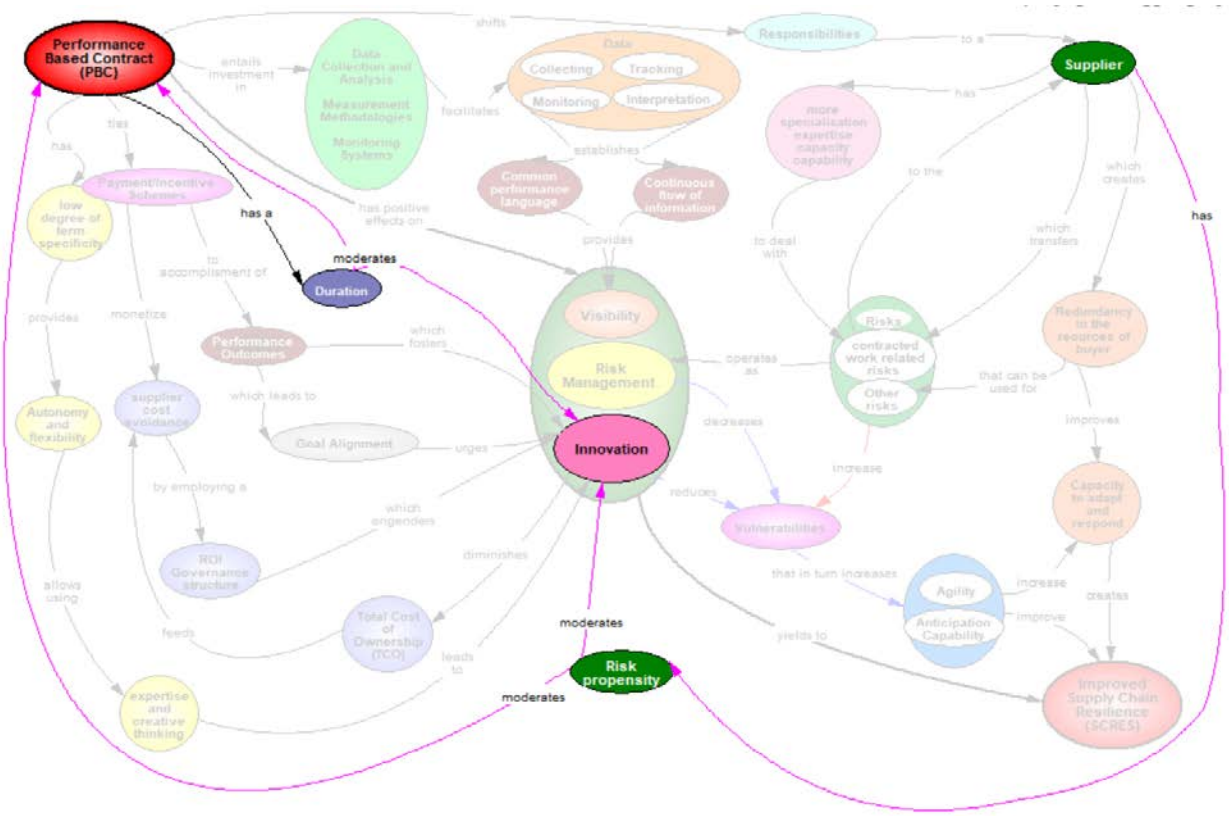

Figure 1.3: Systemigram scene for moderation effects of both supplier risk propensity and contract length on the relationship between PBC and innovation.

As a structural element of the contract, contract length is emphasized by many scholars such as Vitasek et al. (2006) as one of the key tenets of PBC and underlined the importance of long term commitment, which also crucial for developing long term relationships (Yukselen, 2012).

Literature reveals the importance of contract length in the PBC context, as longer contracts motivate suppliers to invest in innovative solutions and enable them to balance risk against their investments, provide cash-flow continuity and offer the required "payback period" to get ROI. Therefore, we posit that contract length would moderate the relationship between PBC and innovation. Longer contracts will foster innovation in a PBC (Please see Figure 1.3). Our third proposition is as follows:

P1d: The contract length moderates the relationship between PBC and the innovation.

Transfer of Responsibilities and Risks, and Risk Management

Supply chain risk has a close relationship with the supply chain vulnerability (Colicchia & Strozzi, 2012), which is described by Svensson (2000) as follows: "the existence of random disturbances that lead to deviations in the supply chain from normal, expected or planned activities, all of which cause negative effects or consequences." Companies happen to be more vulnerable to unanticipated disruptions as risks in the supply chain rise.

It has been accepted that risk management is one of the key capabilities that improves SCRES (Colicchia & Strozzi, 2012). Risk management of supply chains is defined by Jüttner et al. (2003) as follows: "The identification and management of risks for the supply chain, through a coordinated approach among supply chain members, to reduce supply chain vulnerability as a whole." Risk management decreases vulnerabilities of supply chains as it reduces the disruption probability when employed effectively and efficiently, thereby leading improved SCRES (Bogataj & Bogataj, 2007; Sheffi & Rice, 2005).

On the other hand, establishing redundancy – extra capacity or resources – would enable

adapting and responding to the disruptions (Ali et al., 2017). Redundancy can be used to address disruptions during a crisis (Christopher & Peck, 2004).

Since supplier is assigned to provide performance outcomes, PBC transfers most of the responsibilities related to achievement of the specified performance outcomes from the buyer to the supplier. PBC involves wide-ranging supplier responsibilities to provide specified performance outcomes (Abdi, 2014). Ng. et al. (2010) mentions the differences between supplier and customer regarding risks and responsibilities. Suppliers generally have full responsibilities for performance and risks for activities such as utilized capability, maintenance, ownership, investments, recycling etc. (Glas & Essig, 2008).

In their study, Salim & Watson, (2017) find that since the hospitals employ PBC and purchase the performance, they do not own the capital goods anymore, thereby "freeing financial capital." They also provide evidence that PBC enables improvement in the effectiveness and efficiency of both the supplier and the buyer. Kim et al. (2007) contend that PBC provide higher alignment of risks and incentives between the supplier and the buyer than the traditional contract.

Vitasek & Geary (2007) argue that a PBC contract will actually reduce the risks borne by stakeholders once it is properly designed. Sols et al. (2007) posit that risks will be tackled through the contractual framework. Partnership, sharing risk and exercised flexibility are other factors that help to reduce the risks borne in PBC (Vitasek & Geary, 2007; Vitasek et al. 2007).

The literature review from both SCRES and PBC provides valuable insights regarding risk transfer to the supplier as risk management strategy, transferrin responsibilities thereby creating redundancy in resources, the impact of contract length, and effect of risk propensity of in transferal of risk. We contend that when PBC transfers risk to suppliers due to shift of most of the responsibilities and tying payments/incentives to achievement of performance outcomes, it results in two consequences. First, since suppliers have more expertise and

resources in terms of contracted work, they may handle risks regarding those activities more efficiently and effectively. Second, since buyers transfer responsibilities and risks, they will have more resources (building redundancy) at hand to use while addressing risks regarding their own activities. Namely, engaging a partner to their supply chain with a nearly whole responsibility by assignment of accomplishment of performance outcomes, buyers are actually introducing a new risk management strategy with the successful implementation of PBC by gaining two strategic advantages: assignment of work to a partner (supplier) that is capable and expert in doing the given work and handling the related risks, and having more resources to use for their own core competencies (building redundancy) and addressing related risks.

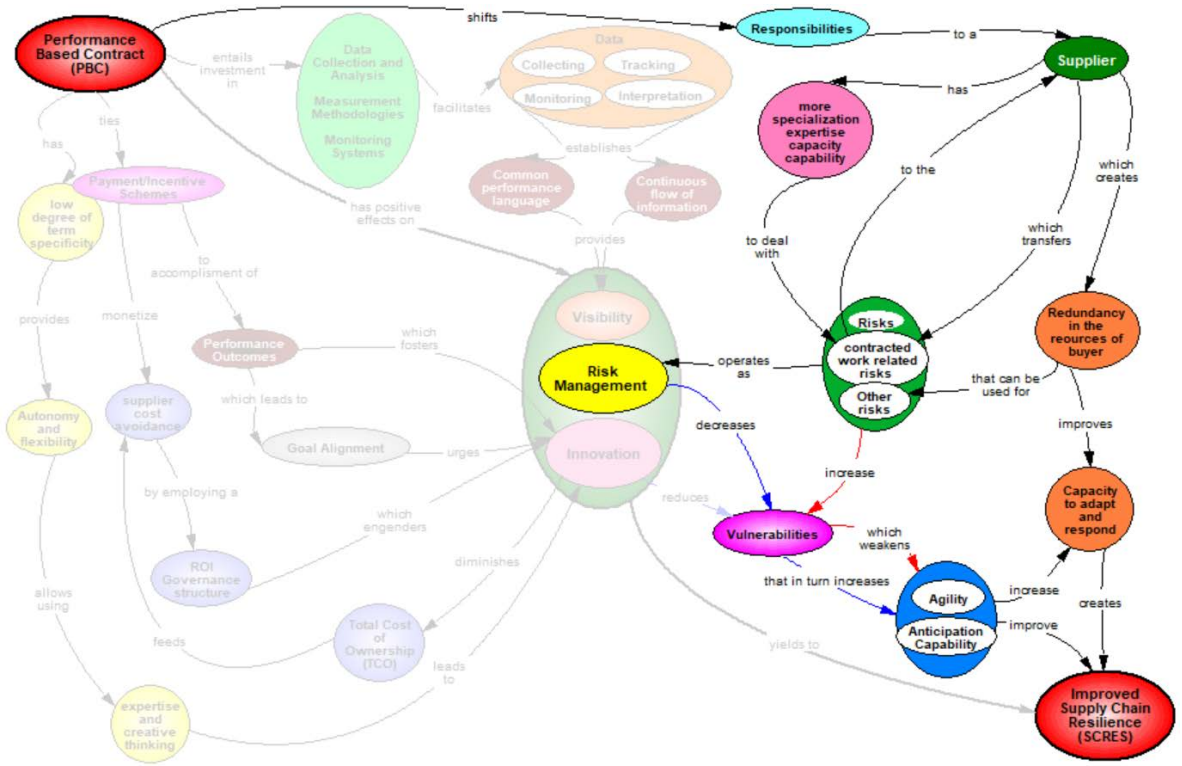

Figure 1.4: Systemigram scene for how PBC has positive effects on risk management, and thus SCRES.

Consequently, successful implementation of PBC leads to redundancy in the resources of buyer that can be allocated to core competency related risks thereby increasing SCRES. Moreover, successful implementation of PBC enables the buyer to cope with the risks thanks to supplier thereby increasing SCRES. Namely, risk/responsibility transfer will serve as a risk

management strategy thereby enhancing SCRES. Our propositions are as follows (Please see Figure 1.4):

P2a: PBC has positive effects on buyer's risk management capabilities.

P2b: Risk management capabilities lead to an improved SCRES.

On the other hand, buyer-supplier risk propensity is of critical importance when designing PBC. I would be less expensive to transfer risks to the less risk averse supplier in PBC. (Selviaridis & Norrman, 2014). Supplier risk averseness can be tackled through rewards schemes (McInerney, 2010). Consequently, we argue that the risk propensity of both buyer and supplier would be influential in risk transfer, and, in turn risk management of buyer (Please see Figure 1.5). The proposed argument will be as follows.

P2c: Risk propensity of the supplier moderates the relationship between PBC and the risk management of the buyer.

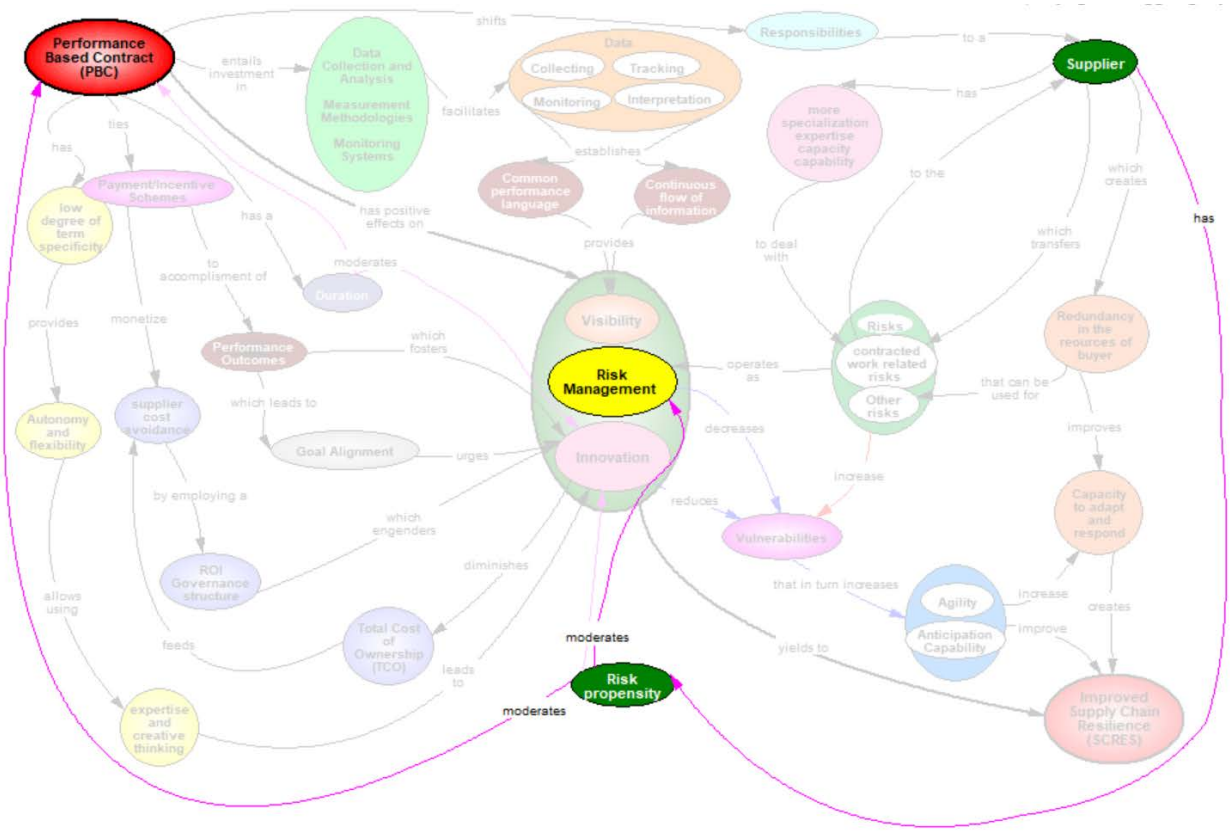

Figure 1.5: Systemigram scene for moderation effects of both supplier risk propensity on the relationship between PBC and risk management.

Visibility

Visibility – the capability to understand and follow all the links and nodes of a supply chain, which supports identifying possible risks (Glickman & White, 2006) – functions as a warning strategy by which firms can gain valuable time to modify/develop their competences to reduce disrupting consequences (Stecke & Kumar, 2009). Visibility helps to spot signals of imminent disruptions. It also engenders situational awareness regarding the supply chain and its environment (Fiksel et al., 2015) via monitoring performance by specified metrics (Ambulkar et al., 2015; Melnyk et al., 2014).

Visibility can be increased by improving competence in information technologies (IT) (Jüttner & Maklan, 2011; Melnyk et al., 2010). PBC involves significant investments in collecting and analyzing data (Glaser & Tolman, 2008; Anastasopoulos et al., 2009; Fallah-Fini et al., 2012), monitoring systems (Schulz et al., 2010; Panet & Trebilcock, 1998), and measurement methodologies (Meterko et al. 2006; Byrnes et al., 1997).

In PBC, information sharing is key to accomplishing performance outcomes in PBC (Ng et al., 2013; Ng & Nudurupati, 2010). It is crucial for both enhancing responsiveness, by sharing data such as inventory level, and achieving cost avoidance investments (Kleemann & Essig, 2013).

For the purpose of situational awareness, both buyer and supplier should develop proper systems for performance management in PBC (Gruneberg et al., 2007). Moreover, successful implementation of PBC necessitates comprehensive awareness with detailed information regarding the supply chain (Randall et al., 2012).

A successful PBC generally demands “continuous flow of high-quality information about the status and history of every element of the supply chain and about the parts, systems, or even platforms subject to the contract” (Gansler et al., 2011). Visnjic et al. (2017) suggest that data analytics can enhance visibility thereby allowing partners to lessen conflict.

Anatassacos (2016) underlines the change in the business model and argues that PBC requires the development of a "common performance language and culture" among partners. And, he emphasizes the importance of monitoring, and tracking, collecting and analysis of data (Anatassacos, 2016).

Consequently, PBC inherently induces both buyers and suppliers to invest in IT for collection and analysis of data, monitoring, methodologies of measurement, and information sharing (Please see Figure 1.6). Therefore, we argue that:

P3a: Successful implementation of PBC leads to an improvement in visibility of that supply chain for buyer

P3b: SC visibility yields to an improved SCRES.

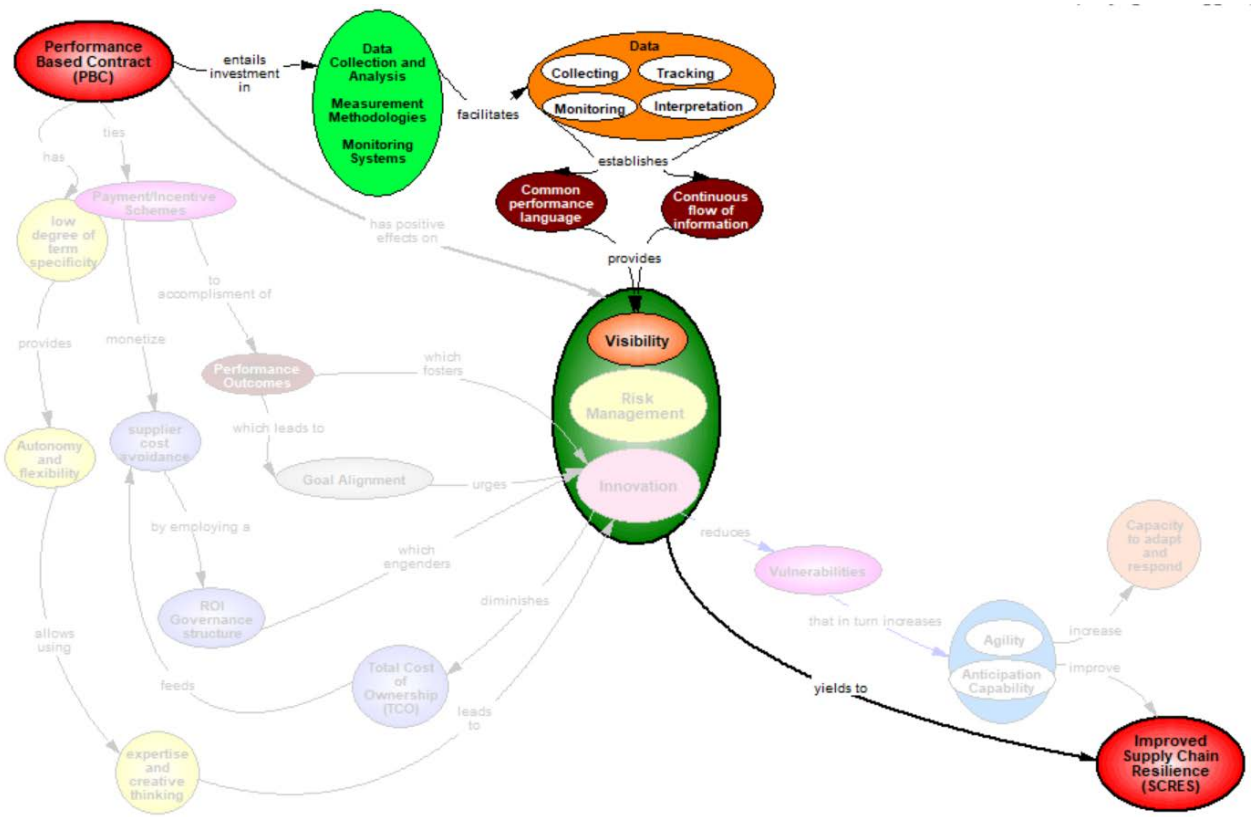

Figure 1.6: Systemigram scene explaining how PBC has positive effects on visibility and, thus SCRES.

These proposed relationships, which are displayed in a complete systemigram in Figure 1.7, elucidate the effects of PBC on SCRES. In a nutshell; we argue that with their fundamental structural elements such as low term specificity, linking payments/rewards to the achievement

of performance outcomes and transfer of risks/responsibilities to suppliers, PBCs have positive effects on SCRES by improving innovation, risk management and visibility (See Figure 1.8 for the conceptual framework). We propose these positive effects with the assumption of successful implementation of PBC, whose key tenets are discussed before, because these effects may not exist if the key mechanisms/tenets are not exercised thoroughly.

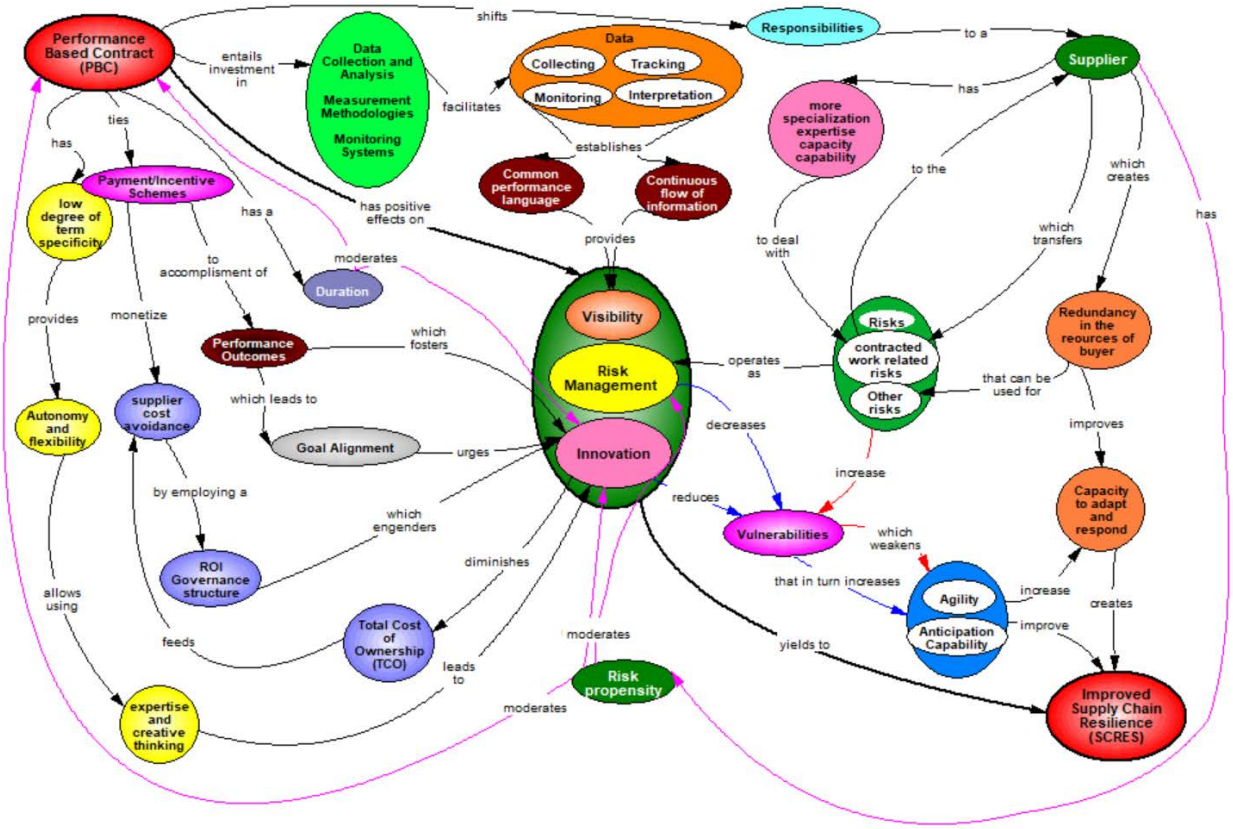

Figure 1.7: Overall systemigram depicting the relationship between PBC and SCRES.

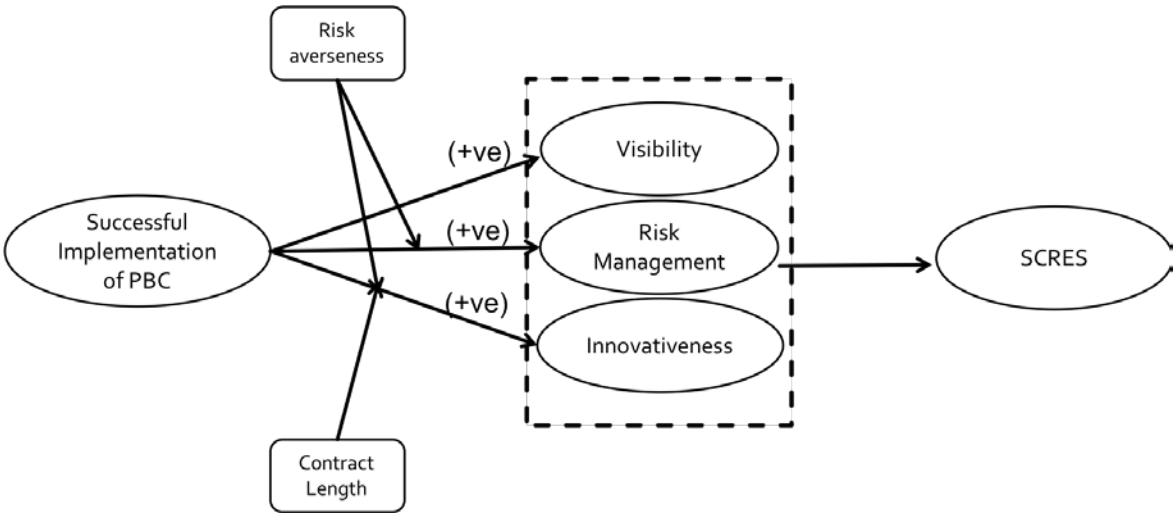

Figure 1.8: Conceptual framework of the relationship between PBC and SCRES.

PBCs have a low level of term specificity, which provides autonomy/freedom and flexibility that allows suppliers to use their expertise and creative thinking to achieve performance outcomes. Second, payment/incentive schemes are tied to the accomplishment of performance outcomes, which align the goals of both parties and foster innovation. Based on the arguments, we contend that with its structural elements (i.e., low term specificity and incentive/payment scheme), successful implementation of PBC would engender innovation, which thus have a positive effect on agility and anticipation capabilities thereby increasing SCRES. However, risk-averse suppliers might be more cautious and more cost sensitive which in turn make them choose conservative activities rather than creative ones thereby leading to a decrease in innovation. Moreover, contract length will have moderation effect on the relationship between PBC and innovation as contracts will as longer contracts motivate suppliers to invest in innovative solutions and enable them to balance risk against their investments, provide cash-flow continuity and offer the required "payback period" to get ROI.

In terms of risk management aspect, with the successful implementation of PBC buyers gain two strategic advantages: assignment of work to a partner (supplier) that is capable and expert in doing the given work and handling the related risks, and having more resources to use for their own core competencies (building redundancy) and addressing related risks. Consequently, risk/responsibility transfer will serve as a risk management strategy thereby enhancing SCRES. However, this transfer will be contingent on the risk propensity of both buyer and supplier. While risk-averse suppliers will not be eager to assume risks, risk-averse buyers will be inclined to transfer it. Lastly, PBC inherently induces both buyers and suppliers to invest in IT for collection and analysis of data, monitoring, methodologies of measurement, and information sharing, which in turn improve visibility and thereby enhancing SCRES.

Conclusion and Discussion

Both as an emerging research streams, SCRES and PBC are promising. For all we

know, this research is the first one that puts forth a conceptual framework with multiple propositions revealing the relationship between SCRES and PBC by bridging the concepts and constructs present in them. We examined the relationship between these two construct through the lenses of AT and exhibited that successful implementation of PBC will have a positive effects on visibility, risk management and innovativeness of the buyer through either initiated by it or the buyer, which will, in turn improve SCRES. Being the first study in this research, it provides both theoretical and managerial implications. Theoretically, it provides two contributions. First, it extends both SCRES and PBC research and reconciles them; second, it highlights the importance of contracts, which governs the IOR and transactions formally, in establishment or improvement of SCRES. In terms of managerial implications, it presents a new input for the decision making the process of contract type. Managers/executives or decision makers may take into account the effect of PBC on SCRES while they are choosing contract type or designing it. If they already employ PBC, being aware of the impacts of successful PBC on SCRES, they may strive to pay attention to the key tenets of successful implementation of PBC to improve their SCRES.

The limitations of the study are as follows. First, it investigates the relationship from the buyer standpoint. Future studies may also include supplier viewpoint or dyadic look into the model and extend it. Second, this study only focuses on the inherent structural aspects of PBC and its effects on SCRES; therefore, future studies should focus on relational aspects such as trust, collaboration, goal pursuit etc. and its influences on SCRES. Lastly, this study can be improved by the inclusion of insights from the field as well.

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ESSAY 2

SUPPLIER GOAL COMMITMENT IN PERFORMANCE-BASED CONTRACTS: A MANAGERIAL PERSPECTIVE

Introduction

Inter-organizational relationships (IORs) are critical for competitive advantage. In the extant IOR literature, there are two main types of governance present: contractual governance and relational governance (Lee & Cavusgil, 2006; Mahapatra, Narasimhan & Barbierie, 2010; Cao & Lumineau, 2015). Contractual governance is central to the success of a performance-based contracting (PBC) as it focuses on IORs between trading partners, a buyer and a supplier. As firm's focus on the necessary contractual governance of a PBC, its presence is increasing across multiple industry sectors, private and public, for profit and not-for-profit. (Hypko, Tilebein, & Gleich, 2010; Selviaridis & Wynstra, 2015). For example, PBC is used in the procurement and maintenance of highway and railway infrastructure (de la Garza & Arcella. 2013; Radović, Mirković, Šešlija, & Peško, 2014; Gajurel, 2014; Famurewa, Juntti, & Kumar, 2011), health and social care (Zeng, Cros, Wright, & Shepard, 2012), energy (Papalexopoulos & Andrianesis, 2012; Wang, Zhao, & Guo, 2019), manufacturing (Hypko et al., 2010), defense (Kratz & Diaz, 2012), and aerospace (Kim, Cohen, Netessine & Veeraraghavan, 2010). The U.S. Department of Defense (DoD) uses PBC as its preferred sustainment strategy since 2001 (Guidebook, P.B.L., 2014). The current PBC practices in different industry sectors have resulted in a 25–40% increase in product reliability and a 10-20% reduction in the cost per unit of performance along with an improvement of availability (Guajardo, Cohen, Kim & Netessine, 2012; Boyce & Banghart, 2012).

The central assumption of PBC is that a product or service's life-cycle cost will go down and innovation will increase with greater supplier autonomy and flexibility to design, produce, and support a product or service to deliver determined performance outcomes

(Nowicki, Randall, & Gorod, 2010). In order to realize this assumption, PBC has some fundamental differences from other supplier-buyer contract types. First, PBC emphasizes performance outcomes (Datta & Roy, 2011). A PBC's emphasis on outcomes is captured by Theodore Levitt (1972), as he states that the key idea underlying PBC is: *"The customer doesn't want a drilling machine; he wants a hole-in-the-wall."* PBC focuses on outcomes, not necessarily on how you arrive at those outcomes. More specifically, PBC defines and evaluates performance outcomes rather than focusing on the necessary activities, inputs, or processes to achieve these outcomes (Martin, 2007). By concentrating on outcomes there is an improvement in goal congruence largely due to the incentives provided to supply chains trading partners (Randall, Nowicki, & Hawkins, 2011). Second, PBC links supplier payment to supplier performance outcomes (Selviaridis & Wynstra, 2015). Namely, PBC converts performance outcomes into rewards and/or punishments, which leads to an increase in rewards and risks for the supplier (Simab, Alvehag, Soder, & Haghifam, 2012; Carlson, Sullivan, Garrison, Neumann, & Veenstra, 2010). Third, PBC underlines the importance of buyer-supplier collaboration for the achievement of performance outcomes (Guo & Ng, 2011).

The buyer-supplier behavior contributes to a successful collaboration that will achieve performance outcomes. Even though the behavioral aspects of PBC greatly influences supplier performance, it is an underrepresented area of research in the PBC literature. More specifically, the extant literature identifies PBC as a business paradigm shift (Vitasek, Geary, & Quick, 2006; Amit & Zott, 2001; Zott, Amit, & Massa, 2011; Ng, Ding, & Yip, 2013), however, further study on the change in behavior of buyer-supplier is needed. To address this gap in the literature, this paper identifies the central characteristics of PBC (i.e., (reward/payment scheme, increased supplier autonomy, and transfer of responsibilities) and examines how PBCs change the business environment that effects behavioral change in suppliers' business practices, specifically on their goal commitment.

Motivation is a key topic in organizational behavior that includes supply chain trading partners; however, it is largely understudied at the inter-organizational level, central to supply chains. Goals (outcomes) and goal commitment are part of this overarching research area of motivation. A goal, defined as the purpose of action (Latham & Locke, 1991), is a fundamental and ubiquitous construct (Austin & Vancouver, 1996) that affects self-regulation (Klein, Wesson, Hollenbeck, & Alge, 1999). The goal is an outcome and based on that outcome it affects a firm's motivation through its self-regulating behavior. Goal commitment represents a firm's motivation to achieve an objective and the perseverance to maintain that objective over time (Locke, Shaw, Saari, & Latham, 1981).

Goal Commitment is a key construct in Goal-Setting Theory (GST) (Klein & Wright, 1994). It involves both the effort needed to obtain a goal but also the reluctance to abandon that goal (Campion & Lord, 1982; Hollenbeck & Klein, 1987). If there is no goal commitment there is no motivation to affect behavior to achieve goals (Locke et al., 1981; Locke, Latham, & Erez, 1988; Locke &Latham, 1990). Goal setting, which is the process to establish the goals and the measurement of these goals, will not regulate behavior in the absence of goal commitment (Locke et al., 1988). Though goal commitment is commonly studied in individual motivation contexts, we believe there is a discernable lack of research in the context of supplier-buyer relationships.

Baum, Locke, & Smith (2001) develop a multi-dimensional model of venture performance that applied GST, an individual-level motivation theory, at the inter-organizational level. They use individual-level attributes such as motivation and confidence as determinants of venture growth and contend that organizations having decision-makers with high motivation may begin to reflect their characters, which in turn may improve performance (Hambrick & Mason, 1984; Baum et al., 2001). Similarly, this study applies GST, at the buyer-supplier context (i.e., inter-organizational) as individuals represent organizations, and their

motivation may have effects on organizational performance. Namely, this study argues that the goal commitment of decision-makers in supplier firms plays a vital role in supplier performance; thus, supplier goal commitment in a PBC context deserves an in-depth exploration.

It has been widely accepted that PBC has changed the way of doing business and it has led to a paradigm change (Vitasek et al., 2006; Amit & Zott, 2001; Zott et al., 2011; Ng et al., 2013) with implications for supply chain stakeholders. The buyer enters a contractual relationship with a supplier or collection of suppliers, to attain desired outcomes and ties the suppliers' payment to their performance. Consequently, the supplier assumes risks and accountability to provide specified performance outcomes (Vitasek, Cothran, & Rutner, 2007; Gansler & Lucyshyn, 2006). With the increased adoption of risk and accountability, the supplier now has more autonomy to act towards achieving performance outcomes (Sols & Johannesen, 2013; Caldwell & Howard, 2014). Ultimately, we posit that PBC influences the suppliers' behavior and motivation. However, for all we know, there has been no study investigating the behavioral effects of PBC on supplier motivation.

We thus argue that this paradigm change deserves an analysis of its implications on the behaviors of supply chain stakeholders. Namely, we contend that with its inherent features and implications, an examination of PBC's effects on supplier goal commitment is justified and well-deserved. Thus, this research aims to investigate the behavioral implications of PBC and put forth the effects of PBC on supplier goal commitment based on the following research questions: a) Is there a relationship between PBC characteristics and supplier goal commitment? b) If yes, how and why?

This study provides valuable theoretical and managerial contributions. First, it addresses the behavioral research gap in the extant PBC literature, discussing its timeliness and relevance. Second, this study introduces goal alignment and felt accountability as new

antecedents of goal commitment. Third, it improves the validity, generalizability, and utility of the relevant theories, applies them in a new context (i.e., buyer-supplier or inter-organizational context) and extends the extant literature of PBC through the lens of organizational behavior. Fourth, this research studies the behavioral effects of PBC on supplier performance and discusses our key findings on how these behavioral effects might affect a firm's contract selection decision-making process. Lastly, this study shows which mechanisms the behavioral effects of PBC on supplier performance is manifested and their potential boundaries, this research might help managers as an addition to their PBC 'best-practice' list.

The rest of the study continues as follows. We first present the literature review and theoretical framework, research hypotheses, and conceptual model. Then, we discuss the research method with detailed information regarding the followed process and the results. Lastly, we discuss the results, and provide contributions to academia and practice with limitations, and future research recommendations.

Literature Review

We will first discuss PBC as it relates to this research with a focus on the transfer of responsibility from a buyer to a supplier and on how this transfer of responsibility leads to greater supplier autonomy. After the PBC literature is presented, we then discuss the extant literature relevant to goal commitment and its interrelationships with PBC

Performance-based Contract

PBC, also known as "Performance Contracting" (Hansen, 2006), "Availability Contracting" (McEwan & Butterfield, 2011), "Contract for Availability" (Hockley, Smith, & Lacey, 2011), "Performance-based Service Acquisition" (Gansler, Lucyshyn, & Vorhis, 2011), "Performance-based Logistics (PBL)" (Boyce & Banghart, 2012), and "Outcome-based Contracting (OBC)" (Sandborn, Kashani-Pour, Goudarzi, & Lei, 2017), aims to hold a supplier

accountable for its performance by defining mutually agreeable, quantifiable outcomes (i.e., key performance indicators) between the supplier and the buyer. For example, Rolls-Royce launched its "power-by-the-hour" program where they are paid based on the hours of operation a customer uses their engines. The customer holds Rolls-Royce accountable for the performance (e.g., operational availability) of their engines. Rolls-Royce is responsible for the necessary maintenance, repair, and overhaul to ensure the engine's contractually agree upon performance and is paid per hour of flight (Sandborn et al., 2017).

In PBC, the buyer aims to use the supplier's knowledge, experience, expertise, capacity, and capabilities for its operations (Randall, Brady, & Nowicki, 2012; Randall, Hawkins, Haynie, Nowicki, Armenakis, & Geary, 2015). Visnjic, Jovanovic, Neely, & Engwall (2017) emphasize the major transition in the business model from "product business model (PBM)" to "outcome business model (OBM)" or moving from a "basic service offering (e.g., maintenance services)" to "advanced services such as outcome-based contracts" (Amit & Zott, 2001; Zott et al., 2011; Ng et al., 2013). This change consequently leads to various implications in the value creation process (Normann & Ramirez, 1998; Maine, Lubik, & Garnsey, 2012), which also constitutes the foundational basis for our study.

With the transfer of responsibility from the buyer to the supplier comes an increase in supplier autonomy. Unlike the traditional approach for contracting after-market support in which processes and specifications are identified, PBC specifies desired outcomes, thus providing to the supplier increased flexibility and autonomy that lends itself to creativity and innovation (Yukselen, 2012; Glas & Kleemann, 2017). As a result, suppliers have the required autonomy and opportunity to use their domain knowledge and expertise to innovate and deliver performance outcomes in exchange for rewards and/or payments (Sols, Nowicki, & Verma, 2007). Vitasek et al. (2006) suggest that though suppliers assume additional risks, they are incentivized to invest in innovation that will enhance performance, lead to higher profits, and

diminish the total cost of ownership through the careful alignment of performance objectives, accountability, and control. Vitasek et al. (2006) position PBC as an opportunity for the suppliers as the suppliers would experience more autonomy in providing support. This autonomy will lead to a guaranteed stable, long-term cash flow, and increased revenue as a result of achieving performance outcomes. To achieve these outcomes and the financial rewards tied to these outcomes, supplier will invest in innovation (technology, process, people, policy, infrastructure, and more). On the other hand, the buyer also benefits. The buyer gains specified performance outcomes with a decrease in costs and logistics footprint (Vitasek et al., 2006).

Table 2.1: Examples of PBC benefits

Program	Availability Benefits	Cycle Time Benefits	Cost Benefits
Navy Tires	+ 17%	- 92% LRT; - 100% B/O's	$46M (15%)
F/A-18 FIRST		- 74% LRT; - J533% RTAT	$688M
LANTRIN	+ 17%	- 90% LRT	$9.6M (14.6%)
Navy Cockpit	+ 57%	- 100% B/O's	$71M (16.5%)
F-404 Engine	+ 46%	- 25% RTAT; - 90% B/O's	$79M (13.4%)
Patriot		- 100% B/O's	$1M (13.1%)

Note: Data compiled from Office of the Deputy Assistant Secretary of Defense (Materiel Readiness), (2011).
LRT: Logistics Response Time, RTAT: Repair Turn Around Time, B/O: Backorder

The transfer of responsibility from a buyer to a supplier and the increased supplier autonomy are necessary to successfully execute a PBC (Sols & Johannesen, 2013). A representative list of successful PBCs are discussed in a study by the Office of the Deputy Assistant Secretary of Defense (Boyce & Banghart, 2012). After analyzing the effectiveness of twenty-one PBC programs, the study concludes that PBC reduces the cost per unit of performance (10%-20%), while simultaneously improving availability of system when adhered to key tenets of PBC programs (See Table 2.1). In addition, in their comparative study, Guajardo et al. (2012) revealed that Rolls-Royce's "power-by- the-hour" approach has led to a

25–40% increase in product reliability compared to conventional contract approaches such as time and material-based contracts.

A successful implementation of PBC achieves the required performance outcomes at a lower cost, an improved productivity, and leads to innovation and best practices while reducing system risks and enhancing reliability in the buyer-supplier system (Anastassacos, 2016). And, fundamental characteristics of PBC (i.e., reward/payment scheme, increased supplier autonomy, and transfer of responsibilities) and their implications play a central role in the achievement of these benefits. Therefore, this research focuses on the fundamental characteristics of PBC and specifically examines their implications on supplier goal commitment.

Goal Commitment

Supplier performance is central to a successful PBC. Goals and commitment to goals are critical for achieving performance. Goal Setting Theory (GST) examines goals as predictors of performance and argues that specific and challenging goals foster higher performance compared to ambiguous or easy goals under certain conditions (Locke & Latham, 1990; Klein et al., 1999). Locke & Latham (1990) state that "it is virtually axiomatic that a goal that a person is not *really* trying for is not really a goal and therefore cannot have much effect on subsequent action." Goal commitment is one of the most used conditions for this argument of goal–performance relationship to hold (Klein et al., 1999). Goal commitment, the extent to which a goal is accompanied by a determination and motivation to put the effort in reaching it (Brunstein, 1993; Hollenbeck & Klein, 1987, Locke & Latham, 1990), is a key concept in GST. The GST will not be valid in the absence of goal commitment (Locke et al., 1988). Goal Commitment moderates the relationship of goal with the performance (Locke & Latham, 1990; Klein et al., 1999). When only challenging/difficult goals are present (i.e., goal difficulty is held constant), goal commitment will have a direct effect on performance (Latham & Locke,

1991; Johnson & Perlow, 1992; Harrison & Liska, 1994; Klein & Kim, 1998; Klein et al., 1999). Goal commitment has positive consequences such as dimensions of the psychological well-being (e.g., positive emotions) along with the persistence and increased performance in pursuit of the goal (Hollenbeck & Klein, 1987; Locke et al. 1988; Brunstein & Gollwitzer, 1996; Pomerantz, Saxon, & Oishi, 2000, Boudrenghien, Frenay, Bourgeois, Karabenick, & Eccles, 2014).

The GST literature has highlighted the factors affecting goal commitment. Taking an expectancy theory (Vroom, 1964) approach, Hollenbeck & Klein (1987) put forth a model with two categories of proximal antecedents, attractiveness and the expectancy of goal attainment, which directly affect goal commitment. They also present two categories of distal antecedents, which have indirect effects on goal commitment through proximal antecedents (Boudrenghien et al., 2014). These distal antecedents include: (a) situational factors (For attractiveness: publicity, competition, explicitness, reward structures, volition; for expectancy: performance constraints, social influence, supervisor supportiveness, task complexity), (b) personal factors (For attractiveness: Type A personality, endurance, need for achievement, job involvement, organizational commitment; for expectancy: locus of control past success, ability, and self-esteem). Locke & Latham (2002) similarly underline that the two key categories of factors enabling goal commitment are the attractiveness of goal achievement and (b) self-efficacy. Considering these factors affecting goal commitment, in this study, we investigate the effects of PBC characteristics on goal commitment. Specifically, we argue that the goals (necessary and critical for successful achievement of performance outcomes) of PBC would be very attractive for the suppliers as their reward/payments are substantially tied to the achievement of performance outcomes. Moreover, since PBC transfers almost all of the responsibilities to the suppliers, their job involvement and volition would be more than the suppliers in traditional contracts.

Theoretical Framework

As a consequence of our exploratory research, we identified a behavioral research gap in the extant PBC literature. We will now discuss existing theories relevant to inter-organizational (buyer-supplier) behavior and extend the existing literature of PBC through the lens of organizational behavior. Specifically, we draw from Goal Setting Theory (GST), Job Characteristics Theory (JCT), and Agency Theory (AT) to examine the implications of PBC on supplier goal commitment. In this study, we prefer GST over other motivational theories as it has emerged as one of the principal motivation theories (Fried & Slowik, 2004) and it highlights the key role of goal commitment (Latham & Locke, 1991). JCT examines the job design effect on felt responsibility (Hackman & Oldham, 1976), which is a critical mediator in this study. AT focuses on devices such as contracts to align incentives and share risks between buyers and suppliers (Mitnick, 1973; Jensen & Meckling, 1976) and provides the theoretical context to examine relationships in PBC (Howard, Wu, Caldwell, Jia, & König, 2016).

Goal-Setting Theory

GST focuses on purposefully directed action and examines why some people outperform others with equal ability and knowledge on work related tasks. GST attributes this difference to motivational factors and puts forth that having different performance goals as the central explanation (Latham & Locke, 1991). It originated from Ryan's (1970) proposition that conscious goals influence/direct action, and has been developed inductively and mostly based on empirical research for nearly five decades (Latham & Locke, 2002).

GST defines goal as "the object or aim of an action. In a work setting, it might be a level of performance to be attained", which has two key attributes: content and intensity (Latham & Locke, 1991). In terms of content, goal specificity (goal content extends from vague to specific) and difficulty have been studied so far (Latham & Locke, 1991). Prior research in this area has shown that specific, and challenging/difficult goals result in better performance

than ambiguous and easy ones when there is sufficient ability, and goal commitment, (Locke & Latham, 1990; Latham & Locke, 1991; Latham & Locke, 2002). With regard to intensity, it is a general term indicating mental effort, clarity, and scope, etc., faced in a mental process (Latham & Locke, 1991).

According to the GST, goals have effects on performance through four mechanisms (Latham & Locke, 1991; Locke & Latham, 2002). First, goals direct attention and effort toward activities related to a goal. Second, goals control the extent of effort put in according to the goal's difficulty. Third, goals influence persistence. Fourth, goals also have indirect effects on action through task-related activities (Wood & Locke, 1990). Locke & Latham (2002) state that "the effects are applicable not only to the individual but to groups (O'Leary-Kelly, Martocchio, & Frink, 1994), organizational units (Rodgers & Hunter, 1991), and entire organizations (Baum et al., 2001)". GST is one of the most common and valid motivation theories in organizational psychology, and it can be applied to different contexts (Miner, 1984; Lee & Earley, 1992; Locke &Latham, 2002; Pinder, 2014). It also emphasizes the importance of goal commitment, specifically when challenging/difficult goals are present and examines the antecedents of it. Therefore, we analyze the effects of PBC characteristics on supplier goal commitment through the lens of GST.

Job Characteristics Theory

JCT examines the effects of job characteristics on individuals' work outcomes (Hackman & Oldham, 1976). Hackman & Oldham (1976) posit that five key job characteristics, which are "skill variety, task identity, task significance, autonomy, and feedback" (Hackman & Oldham, 1976, pp.257-258), have impacts on various favorable personal and work outcomes through three psychological conditions. Moreover, individual growth and need strength moderate both the relationship between the job features and the psychological conditions and between the psychological conditions and the outcomes. While

three job characteristics, which are skill variety, task significance, and task identity, are positively associated with experienced meaningfulness of work, job autonomy engenders experienced responsibility, and feedback enhances knowledge of results (Hackman & Oldham, 1976). Finally, all these three psychological states, which are "experienced responsibility for the work outcomes, experienced meaningfulness of the work, and knowledge of the results of the work activities" (Hackman & Oldham, 1976, pp.255), improve personal and work outcomes such as "high internal work motivation, high-quality work performance, high satisfaction with the work, and low absenteeism and turnover" (Hackman & Oldham, 1976, pp.256). Since JCT examines the job characteristics and its effects on individuals' psychological states and their work outcomes, we contend that it can be employed to analyze the effects of PBC structures, which governs the relationships/transactions between the supplier and the buyer, on the suppliers' psychological states and their performance outcomes.

Agency Theory

Buyer-supplier relation in the configuration and management of PBC is a matter of control and governance (Ring & Van de Ven, 1992). To control and govern the buyer-supplier relationship, AT examines contracts as mechanisms to arrange benefits and risks (Mitnick, 1973). AT strives to establish the most effective contract through the standpoint of principals (buyers) where an uncertain environment and information asymmetry exist (Jensen & Meckling, 1976). AT tries to address two types of problems. First, is the adverse selection due to the hidden information where the agent (supplier) misrepresents itself to win a contract or get beneficial terms from the principal (Bergen, Dutta, & Walker, 1992). The second is the "hidden action" suggesting "moral hazard" where the agent just follows its own goals (Ross, 1973). The buyer (principal) can cope with these problems by selecting the right supplier (agent), designing an appropriate contract, and collecting information (Bergen et al., 1992).

Inherently, PBC is well positioned to handle these potential problems (Mouzas, 2016;

Gordon, Morris, & Steinfeld, 2018; Patra, Kumar, Nowicki, & Randall, 2019). PBC addresses the adverse selection problem due to the misrepresentation of agents (Ross, 1973). In PBC, the agent (supplier) is not expected to misrepresent as the compensation is tied to the achievement of performance outcomes. PBC also can mitigate the moral hazard problem where the agent (supplier) behaves opportunistically (Ross, 1973). Since the incentive/reward system is tied to achievement and/or improvement of performance outcomes, which is also the principal's (buyer) objectives, it would align the goals of the stakeholders and provide incentive to the agent (supplier) so the agent will use its resources to achieve mutually beneficial goals (Gordon et al., 2018; Patra et al., 2019). Consequently, AT provides a theoretical framework to understand the effects of PBC characteristics on goal commitment.

Conceptual Framework and Development of Hypotheses

We develop a conceptual framework and testable hypotheses (see Figure 2.1) that define the relationship between PBC and supplier goal commitment through the lens of AT, GST, and JCT. This conceptual framework introduces goal alignment and felt accountability as new antecedents of goal commitment and includes the effects of key PBC characteristics (i.e., reward/payment scheme, increased supplier autonomy, and transfer of responsibilities) on these new antecedents and goal commitment.

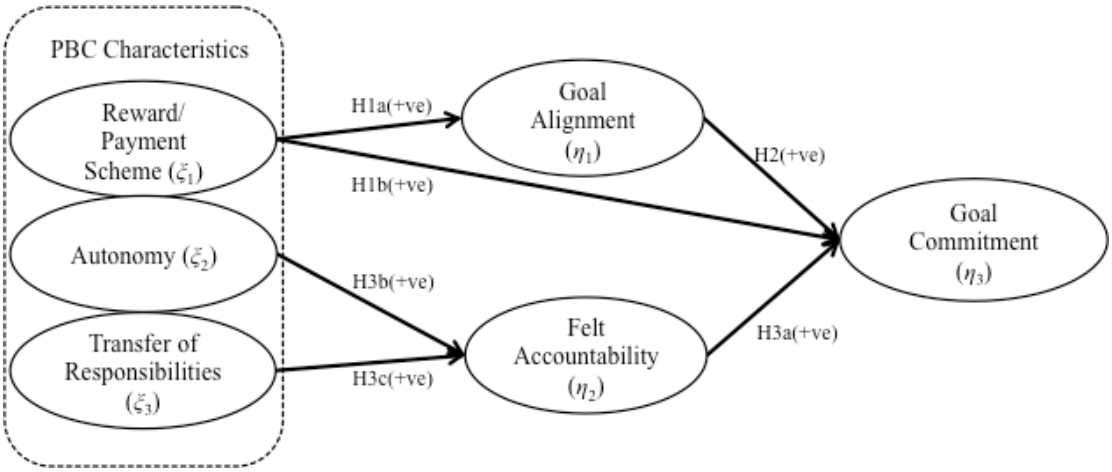


Figure 2.1: Conceptual framework of the relationship between PBC and supplier goal commitment.

Goal commitment is defined as “the degree to which the individual is attached to the goal, considers it significant or important, is determined to reach it, and keeps it in the face of setbacks and obstacles” (Latham & Locke, 1991). These attributes of goal commitment are the main aspects of goal intensity examined in the GST literature. Past research has shown that goal commitment can have moderating effect or causal effect on performance, and main effect occurs when the goal difficulty is kept at the same level (Latham & Locke, 1991).

Antecedents of goal commitment in the extant literature include two main categories. These are expectancy of attainment (i.e., goal achievement is possible), which is also termed as “self-efficacy” by Bandura (1982, 1986), and attractiveness of attainment (i.e., goal achievement is important or appropriate) (Hollenbeck & Klein, 1987; Latham & Locke, 1991). Since goal commitment has important performance consequences, further research is crucial to identify factors that affect goal commitment (Klein et al., 1999). Therefore, we adopt the same framework and examine the factors/antecedents that increase the attractiveness and expectancy of goal achievement in a PBC context.

Reward/Payment Scheme

Reward/payment scheme refers to “all the monetary, non-monetary and psychological payments that an organization provides for its employees in exchange for the work they perform” (Bratton & Gold, 2007, pp.358). Traditional support contracts are transactional and have an intrinsic incentive deficiency, where the suppliers profit from each maintenance transaction, that is, each system failure (Randall et al., 2011), PBC removes this deficiency by “monetizing” suppliers’ potential cost evasion by employing a return-on-investment (ROI) governance system (Kratz & Diaz, 2012), where the supplier receives greater profit as the total cost of ownership decreases due to investment in innovations.

By linking rewards to performance outcomes, PBC aligns the interests/goals of the two stakeholders (buyer-supplier) and diminishes the opportunism stemming from incomplete

contracts (Eisenhardt, 1989; Kim, Cohen & Netessine, 2007; Sumo, van der Valk, Duysters, & van Weele, 2016a; Sumo, van der Valk, van Weele, & Duysters, 2016b). Kim et al. (2007) contend that PBC provides higher alignment of risks and incentives between the supplier and the buyer than traditional support contract.

The reward/payment scheme of PBC leads to an alignment of the goals of the buyer and the supplier. In PBC, the buyer assigns performance outcomes (goals) to be accomplished by a supplier and ties payment/reward to the achievement of those outcomes (Glas, Henne, & Essig, 2018). Namely, achievement of performance outcomes increases the benefits to both the buyer and supplier, which in turn aligns both parties' goals (i.e., win-win situation). To that end, we argue that;

> *H1a: Reward/payment scheme is positively associated with supplier and buyer goal alignment.*

Thanks to the incentive structure of PBC, a supplier strives to meet its performance targets as defined in the PBC between the buyer and supplier. Rewarding performance, a contextual factor in GST, aligns well with a supplier's goal attainment (Hollenbeck & Klein, 1987). Locke et al. (1988) state "Expectancy, operant, and social learning theorists would all agree, at least by implication, that commitment to actions is affected by incentives and rewards". The value of the perceived outcomes (attractiveness of attainment) and the anticipated probability that effort and performance would lead to such outcomes (expectancy of attainment) would influence commitment and, in turn, performance (Locke et al., 1988). There are various reward structures/schemes across the organizations varying in the extent to which rewards/incentives are tied to performance (Wright, 1989). Rewards/incentives structures/schemes dependent on goal attainment would enhance the attractiveness of goal attainment, thereby increasing goal commitment (Wright, 1992; Klein & Wright, 1994). Yukl & Latham (1978) contend that the perceived instrumentality of goal attainment is significantly associated with the goal commitment. In the PBC context, the buyer is supposed to achieve the

performance goals to get paid and/or rewarded, which increases the instrumentality of goal attainment. While Locke (1968) posits that goal commitment mediates the impacts of incentives on performance, Locke & Shaw (1984) reveal a positive association between the overall value of accomplishing goals (winning) and commitment to getting a monetary prize, which denotes that monetary rewards may enhance the level of goal commitment (Locke & Latham, 1990). To conclude;

H1b. Reward/payment scheme is positively associated with supplier goal commitment.

Goal Alignment

Goal alignment between the buyer and the supplier is the extent to which both the buyer and the supplier achieves their objectives through attaining mutual goals (Cao & Zhang, 2011). Goal alignment between the buyer and the supplier is one of the key PBC characteristic (Vitasek & Geary, 2007; Vitasek et al., 2006). Goal alignment generates shared benefits throughout organizations and thus engenders integrated action (March & Simon, 1958). While goal conflict weakens performance as it leads to conflicting action propensities (Locke, Smith, Erez, Chah, & Schaffer, 1994), the group's performance is improved when there is congruence for specific, difficult goals of a person and a group (Seijts & Latham, 2000; Locke & Latham, 2002). With congruent goals, both parties are encouraged to demonstrate cooperative behaviors such as reciprocal support and adaptation, productive communication, and high commitment (Jap & Anderson, 2003; Yan & Dooley, 2013). Hollenbeck & Klein (1987) argue that higher organizational commitment requires an individual's commitment to the goals assigned by the organization, as they would have a strong identification with organizational goals. Consequently, we argue that goal alignment would motivate the supplier to adopt the goals assigned by the buyer and pursue those goals as if they are their own goals, which in turn enhances supplier goal commitment. Moreover, the supplier will attribute more importance to

the goals assigned by the buyer since the goals of both participants are aligned through reward/payment scheme. As such,

> *H2: Supplier goal alignment with the buyer is positively associated with supplier goal commitment.*

Felt Accountability

Felt accountability is defined as the "perceived expectation that one's decisions or actions will be evaluated by a salient audience and that rewards or sanctions are believed to be contingent on this expected evaluation" (Hall &Ferris, 2011). Responsibility (which contains values and beliefs), on the other hand, is usually accepted as a subcomponent of accountability in the extant literature (Schlenker, Weigold, & Doherty, 1991). Though some researchers use responsibility and accountability interchangeably (Frink, Hall, Perryman, Ranft, Hochwarter, Ferris, & Royle, 2008), accountability, unlike responsibility, requires an external audience (Cummings & Anton, 1990; Schlenker, Britt, Pennington, Murphy, & Doherty, 1994; Frink & Klimoski, 2004; Hall, Frink, & Buckley, 2017).

According to extant literature, accountability generally leads to emotional states, cognitions, behaviors, and decisions, where emotional states involve constructs including commitment, satisfaction, stress, and experienced tension (Hall et al., 2017). Lanivich, Brees, Hochwarter, & Ferris (2010) posit that interaction of person-environment fit with accountability has a positive relationship with greater job satisfaction, organizational commitment, and work commitment (Hall et al., 2017). Accountability affects cognitive processing (Frink et al., 2008). Individuals develop coping methods to meet accountability demands, which impacts their social behaviors (Tetlock, 1985, 1992; Hall et al., 2017).

Features of an accountability environment (i.e., accountability focus, accountability source, accountability intensity, and accountability salience) have direct impacts on felt accountability (Hall, Ferris, Bowen, & Fitzgibbons, 2007; Frink et al., 2008). Accountability

focus is “the extent to which an individual is responsible for processes (how things get done) versus outcomes (results/outputs)” (Hall et al., 2017). While Davis, Mero, & Goodman (2007) find a positive association between outcome accountability and performance, Langhe, van Osselaer, & Wierenga, (2011) reveal that outcome accountability yields to more informed, better decisions, especially as complexity increases. Accountability salience, which means “the extent to which individuals are held accountable for important outcomes” (Hall et al., 2007), makes individuals exert more cognitive effort and pay more attention (Hall et al., 2017).

Similar to process theories of motivation such as GST and expectancy, accountability conceptualizations focus on the cognitions people use to make decisions about direction, level of effort and determination (Tetlock, 1985; Hall et al., 2017). Therefore, we argue that the GST might benefit from the integration of felt accountability to understand goal commitment and performance, as suggested by Hall et al. (2017). On the other hand, JCT proposes that individuals would have more work motivation, more job satisfaction, and more interest in their work quality if they feel more responsibility for performance outcomes (Hackman &Oldham, 1976). Moreover, individuals feel more accountability for present and future actions when they intentionally take responsibility, which makes them not only focus on the work at hand but also think about the future achievement (Seiling, 2001; Fuller, Marler, & Hester, 2006). Based on these arguments and given that felt responsibility is a subcomponent of felt accountability, we contend that:

> *H3a: Felt accountability of a supplier is positively associated with the supplier’s goal commitment.*

Autonomy

Though Williamson (1985) suggests that contracts should be as complete as possible to decrease risks and increase transactional gains, contracts are unavoidably incomplete. Sumo et al. (2016a, 2016b) posits the reasons why contracts are unavoidably incomplete. First, all the

terms and clauses of a contract cannot be specified due to the bounded rationality of stakeholders (Tirole, 1999; Aghion & Holden, 2011). Second, organizations seek to reduce the ex-ante and ex-post costs related to the costs of designing complete/incomplete contracts (Crocker & Masten, 1991). Third, contracts may be left purposefully incomplete for the sake of freedom and flexibility (Bernheim & Whinston, 1998).

Even though incomplete contracts do not adequately reflect the transactional features that may lead to opportunistic behavior (Goldberg, 1976, 1985; Williamson, 1985), they, being less prescribing, offer two significant benefits compared to more detailed contracts. First, incomplete contracts allow flexibility for contingency adaptability to address unexpected situations (Bernheim & Whinston, 1998; Luo, 2002). Second, they offer increased level of autonomy for the supplier to determine how they will achieve the performance outcomes (Bernheim & Whinston, 1998; Luo, 2002), which is believed to foster innovation (Sumo et al. 2016a, 2016b).

Term specificity is directly related to contract completeness and is "the extent to which processes and behaviors are specified in the contract, which relates to the degree of freedom that the supplier has in designing, managing, and executing the outsourced service processes" (Sumo et al., 2016a. p.13). This implies that a high-term specificity refers to a low-level of liberty, whereas a low-level refers to a high-level of liberty. PBCs have relatively low-term specificity with a specification of performance outcomes instead of the required inputs and processes to attain performance outcomes (Sumo et al., 2016a).

We proffer that a PBC is an intentionally incomplete agreement. Having specified the performance outcomes rather than supplier's tasks for implementation, PBCs have low level of term specificity, and incentives are tied to the supplier's achievement of performance outcomes. (Kim et al., 2007; Sumo et al., 2016a). Having a low level of term specificity, PBC provides freedom facilitating suppliers to use their expertise and creative thinking to address

problems and approach to performance metrics (Woodman, Sawyer, & Griffin, 1993) and offers them the autonomy to invest in innovative activities for their operations (Abbey & Dickson, 1983). In the PBC context, the suppliers have the autonomy/freedom to provide performance outcomes and are not constrained on how they will achieve these outcomes (Johnson & Medcof, 2007; Wang et al., 2011; Sumo et al., 2016a).

Job characteristics theory (JCT) addresses autonomy (Hackman & Oldham, 1976) and it is the most common framework examining felt responsibility (Pearce & Gregersen, 1991). JCT argues that job characteristics foster employee performance as it provides motivation to exert more effort (Parker & Turner, 2002). JCT posits that autonomy is the central job characteristic that enhances felt responsibility (Hackman & Oldham, 1976). When job autonomy escalates, individuals increasingly consider their work outcome as a product of their own decisions and effort, which in turn makes them feel more responsible for this outcome (Hackman & Oldham, 1976). That is, job autonomy promotes the felt responsibility for one's own work outcome.

To summarize, having specified the performance outcomes rather than the details on how a supplier will achieve these outcomes, PBCs have a low level of term specificity, which feeds autonomy/freedom and flexibility that allows suppliers to use their expertise and creative thinking to achieve performance outcomes. JCT accepts that autonomy is the central job characteristic that enhances felt responsibility. Based on these arguments and given that felt responsibility is a subcomponent of felt accountability, we posit that with its structural elements (i.e., low-term specificity), PBC would provide autonomy to the supplier, thus engender supplier felt accountability. As a consequence,

> *H3b. The autonomy provided by PBC is positively associated with the felt accountability of a supplier*.

Transfer of Responsibilities

Since the supplier is assigned to provide performance outcomes, PBC transfers most of the risks and responsibilities of achievement of desired performance outcomes from the buyer to the supplier (Böhm, Backhaus, Eggert, & Cummins, 2016). PBC includes a wide-range of supplier responsibilities to provide specified performance outcomes (Glas & Essig, 2008; Randall et al., 2010; Sols & Johannesen, 2013). Ng & Nudurupati (2010) enumerate the differences between the supplier and the buyer regarding risks and responsibilities. With PBCs, suppliers generally assume the vast majority of responsibilities for performance and risks for activities such as maintenance, capability utilization, investments, ownership, recycling, etc. (Glas & Essig, 2008).

In their study, Fuller et al. (2006) includes both job autonomy and hierarchical position in the organization (i.e., job level) as structural antecedents of felt responsibility. They argue that as individuals advance to higher positions in the organization, they increasingly feel more responsibility as they also enable the work of their subordinates (Kiggundu, 1981). Consequently, overall felt responsibility for work outcome consists of a melding of both job autonomy (i.e., responsibility for one's own work) and job level (i.e., responsibility for others' work) (Kiggundu, 1981; Fuller et al., 2006).

Fuller et al. (2006) posit that when individuals are promoted to a higher level in an organization, they probably would experience an increase of felt responsibility because of role acceptance (Cummings & Anton, 1990). Cummings & Anton (1990) argue that assuming a specific role refers to the acceptance of its related responsibilities and expectations. Similarly, Hamilton (1978) suggests that as individuals take on more responsibility to perform in the direction of organizational goals they move to higher positions in the organization. On the other hand, Erez, Early, & Hulin (1985) argue that goal commitment is low as subordinates perceive their contributions to be low; likewise, it is greater as perceived contributions are higher.

Similarly, since PBC requires suppliers to provide performance outcomes, agreeing to those performance outcomes means the supplier accepts the associated workload and expectations, which in turn makes the supplier feel more responsible. Also, in PBC, since the supplier's contribution to the overall job relative to the buyer (i.e., work ownership) increases, this would consequently increase the value of the work outcome, and in turn foster supplier felt responsibility. We contend that as PBC transfers responsibilities and the related risks from the buyer to the supplier, this will increase the felt responsibility of the supplier:

> *H3c: Transfer of responsibilities and related risks from the buyer to the supplier is positively associated with the felt accountability of the supplier.*

Figure 2.1 exhibits the developed relationships in a conceptual model revealing the underlying mechanisms for the relationship between PBC characteristics and supplier goal commitment. We contend that with their fundamental structural elements such as low level of term specificity (i.e., autonomy), linking payments/rewards to the achievement of performance outcomes and transfer of most of the responsibilities to the suppliers, PBCs have positive effects on supplier goal commitment through goal alignment between a buyer and a supplier, and supplier felt accountability.

By linking rewards/payment to performance outcomes, PBC aligns the interests/goals of the both participants (buyer and supplier) and diminishes opportunism. That is, with its payment/reward scheme, PBC is positively associated with goal alignment between the buyer and supplier. Similarly, rewards/payment schemes contingent on goal attainment would enhance the attractiveness of goal attainment and, thus, goal commitment. We argue that goal alignment would motivate the suppliers to adopt the goals assigned by the buyers and pursue those goals as if they are their own goals, which in turn enhances supplier goal commitment.

Based on the suggestion of Hall et al. (2017), we include felt accountability to better explain the influences on goal commitment. We argue that suppliers would be more goal

committed as they feel more responsibility for performance outcomes. Namely, felt accountability of the supplier is positively associated with the supplier goal commitment.

PBCs have a low level of term specificity, which offers autonomy/freedom and flexibility for suppliers to use their expertise and creative thinking to achieve performance outcomes. JCT accepts that autonomy is the central job characteristic that enhances felt responsibility. Given that felt responsibility is a subcomponent of felt accountability, we posit that with its structural elements (i.e., low term specificity), PBC would provide autonomy to the supplier; thus, foster supplier felt accountability.

Since PBC requires suppliers to provide performance outcomes, agreement with those performance outcomes means acceptance of associated workload and expectations by the supplier, which in turn makes the supplier feel more responsible. Second, in PBC, since the supplier's contribution to the overall job relative to the buyer (i.e., work ownership) increases, this would consequently increase the value of the work outcome, and in turn, foster supplier felt responsibility. That is, as the vast majority of risk and responsibilities transfer from the buyer to the supplier, PBC is positively associated with the felt accountability of the supplier.

Research Method

Instrument Development

Scale items for measuring the constructs were adapted and developed based on the existing literature. For the construct of “Reward/Payment Scheme” in PBC, four of the scale items were adapted from the previous studies (Oliveira & Roth, 2012; Schulz, Wu, & Chow, 2010) while four of them were developed by the authors based on the extant PBC literature (Jacopino, 2018). As for the “Autonomy”, all of the scale items were adapted from the literature (Spreitzer, 1995; Beehr, 1976; Idaszak, & Drasgow, 1987). All of the items of the construct of “Transfer of Responsibilities” were developed by the authors based on the PBC literature (Glas & Essig, 2008; Randall et al., 2010; Ng & Nudurupati, 2010; Sols & Johannesen, 2013; Böhm

et al., 2016). The constructs of “Goal Alignment”, “Felt Accountability”, and “Goal Commitment” are also adapted from the related literature [(Jap, 1999; Stephen & Coote, 2007); (Hochwarter, Kacmar, & Ferris, 2003; Morrison & Phelps, 1999); and (Klein et al., 2001) respectively]. In order to adapt and generate new measurement items for the constructs, we followed a structured method consisting of a literature review, interviews, Q-sort, and a pilot study. First, a comprehensive literature review was carried out to find appropriate scale items used in previous studies, which resulted in a initial list of scale items. Second, an expert panel with eleven academics provided valuable input in terms of face and content validity of the scale items by examining the construct descriptions and the item wordings. Moreover, the measurement instrument was emailed to some of the academics, and they also contributed to its development. Third, doctoral students classified the scale items for corresponding constructs. Based on the results, required changes were done through removal or adjustment of unnecessary or uncertain scale items. Lastly, in order to check the scale items before the final study, a pilot study was carried out using Amazon Mechanical Turk (MTurk) with a sample size of 96. Based on the exploratory factor analysis (EFA) results, two items with high cross-loadings and low factor loadings were removed, and two items’ wordings were modified from 46 scale items. Finally, 44 scale items presented in Appendix A are utilized to gather data in the survey. A Likert scale (five-point) was presented to the participants for scale items (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree).

Data Collection

This study uses a survey instrument to collect data from a sample of respondents whose jobs are in logistics, operations and supply chain management in USA. Moreover, their positions in the organization played a significant role in selecting the sample frame (i.e., manager and the upper-level decision-makers are included in the sample frame). The MTurk was utilized as the medium to extract a appropriate sample frame and conduct the survey. Use

of MTurk as a medium to hire respondents was validated and discovered, leading to similar findings with traditional surveys (Buhrmester, Kwang, & Gosling, 2011). In their study, Goodman & Paolacci (2017) revealed that MTurk workers have demonstrated similar reliability with student and public samples, and they emphasize that efficiency gains of crowdsourcing do not come at the expense of data quality. Moreover, MTurk is accepted as a suitable medium to recruit respondents having expertise and experience in logistics, operations and supply chain management (Knemeyer & Naylor, 2011). MTurk's sample provides greater generalizability through its workers with diverse backgrounds and locations (Buhrmester et al., 2011). We adhered to the best practices and techniques documented in the literature to collect data and avoid the limitations of MTurk (Schoenherr, Ellram, & Tate, 2015; Stritch, Pedersen, & Taggart, 2017; Matherly, 2019).

Using Qualtrics, an online survey was developed and published on MTurk for hiring respondents. In order to restrict the participation to those having expertise and experience in logistics, operations and supply chain management at manager and higher level decision-making positions such as member of an executive board, supervisor, senior director or senior manager, two screening process was applied with two questions at the outset of the questionnaire. The questionnaire was immediately concluded when respondents could not pass the screening questions. Along with the screening process, an attention check process was carried out with two attention check questions embedded to the questionnaire to scrutinize whether participants were going through the questions carefully. The questionnaire was immediately concluded as in the screening process when participants could not pass the attention check questions. Moreover, only one participation from the same IP address was allowed, and a monetary compensation was offered to the participants who completed the survey.

A total of 1,241 respondents participated in the study. However, 231 of them were

eliminated due to the screening questions, and 501 of them were eliminated due to the attention check questions. Finally, 509 participants could finish the questionnaire. However, 13 of the participants were eliminated as their completion times were far less than the average time, and 29 of the participants were eliminated based on the outlier analysis. Having cleaned the data, the data of 467 participants were used in this study. Table 2.2. presents the demographic data of the participants.

Table 2.2: Sample demographics (N=467)

		n	%
Primary Job Function	Supply chain management	131	28
	Logistics management	112	24
	Operations management	224	48
Job Title	Member of management/executive board	53	11
	Senior director/director	18	4
	Senior manager	92	20
	Supervisor	146	31
	Manager	158	34
Firm Size	Greater than 1001 employees	90	19
	Between 751 and 1000 employees	50	11
	Between 501 and 750 employees	72	15
	Between 251 and 500 employees	94	20
	Less than 250 employees	161	35
Experience in Logistics/SCM/Ops. Mgmt.	1-5	268	58
	6-10	118	25
	11-15	42	9
	16+	36	8
	Age		
	1-30	163	35
	31-40	192	41
	41-50	66	14
	51-60	42	9
	61+	4	1
Gender	Male	248	53
	Female	219	47

		n	%
Education	Doctorate degree	8	1.8
	Master's degree	94	20
	Bachelor's degree	252	54
	Some college credit, no degree	80	17
	High school graduate	32	7
	Some high school, no diploma	1	0.2

Data Analysis and Results

A stepwise approach was used to analyze the data. First, an exploratory factor analysis (EFA) was carried out to reveal the underlying factor structure. Based on the EFA, 16 items with high cross-loadings and low factor loadings (below .6) were removed. Second, a confirmatory factor analysis (CFA) was carried out, and a measurement model was developed to ensure construct reliability and validity (i.e., convergent validity and discriminant validity). Third, in order to test the hypotheses, a structural equation model (SEM) was developed using AMOS 26. Moreover, in order to check the common method variance, which is defined by Bagozzi & Yi (1991, p. 426) as the "variance that is attributable to the measurement method rather than to the construct of interest", Harman's single factor (or one-factor) (Podsakoff & Organ, 1986) and common latent factor methods were used (Eichhorn, 2014).

Measurement Model

A confirmatory factor analysis (CFA) was performed to check construct reliability and construct validity (i.e., convergent validity and discriminant validity). During the CFA, several modifications, which include first removing scale items that have loadings lower than 0.6 (theoretical importance was also taken into account), second freeing covariances between error terms that have large covariances within the same factor, and lastly removing scale items that have standardized residual covariance value larger than 4, were implemented and the final measurement model was attained. As a result, 24 scale items are kept for testing the hypotheses

in the structural equation model. The factor loadings for the final model are exhibited in Table 2.3.

Table 2.3: CFA–measurement model: structural equation model estimates

Parameters		Path	Standardized Estimate	t-value
Reward/Payment Scheme (ξ_1)	RPS6	λ_2	0.65	λ set to 1
	RPS4	λ_3	0.76	11.679
	RPS3	λ_4	0.73	11.571
Autonomy (ξ_2)	Auto6	λ_5	0.68	λ set to 1
	Auto4	λ_7	0.70	13.536
	Auto3	λ_8	0.79	14.607
	Auto2	λ_9	0.73	14.064
	Auto7	λ_{10}	0.78	14.353
	Auto8	λ_{11}	0.69	13.312
Transfer of Responsibilities (ξ_3)	ToR5	λ_{13}	0.71	λ set to 1
	ToR4	λ_{14}	0.70	13.656
	ToR3	λ_{15}	0.71	13.199
	ToR2	λ_{16}	0.73	13.464
Goal Commitment (η_3)	GC1	λ_{19}	0.74	λ set to 1
	GC3	λ_{17}	0.79	16.106
	GC2	λ_{18}	0.73	15.068
Goal Alignment (η_1)	GA6	λ_{20}	0.67	λ set to 1
	GA5	λ_{21}	0.69	12.612
	GA4	λ_{22}	0.71	12.966
	GA3	λ_{23}	0.71	12.909
Felt Accountability (η_2)	FA8	λ_{30}	0.69	λ set to 1
	FA5	λ_{25}	0.67	12.879
	FA4	λ_{26}	0.67	12.896
	FA3	λ_{27}	0.70	13.397

The overall model fit was analyzed in terms of absolute model fit, incremental fit, and parsimonious fit. The indices used to evaluate the model fit were as follows: Comparative fit index (CFI), goodness-of-fit index (GFI), adjusted goodness-of-fit Index (AGFI), root mean square error of approximation (RMSEA), normed fit index (NFI), and normed chi-square

(CMIN/DF) (Bentler & Bonnet, 1980; Byrne, 2012; Bentler, 1990; Jöreskog & Sörbom, 1993; Chau, 1997; Hooper, Coughlan, & Mullen, 2008; Hair, Black, Babin, & Anderson, 2010). While an adequate fit is represented by values between 0.80 and 0.89 (Segars & Grover, 1998), a good fit in terms of CFI and NFI is displayed by values equivalent to or greater than 0.90 (Jöreskog & Sörbom, 1986). An acceptable fit in terms of GFI and AGFI is represented by values equal to or larger than 0.90 (Jöreskog & Sörbom, 1986). A good fit for RMSEA is shown by values less than 0.08 (Hair et al., 2010). Lastly, a good fit for CMIN/DF is represented by values smaller than 2.0, while a reasonable fit is proven by values less than 3.0 (Hair et al., 2010).

The measurement model was proven as satisfactory by the fit indices (Anderson & Gerbing, 1988; Bagozzi & Yi, 1988; Paswan, Gai, & Jeon, 2015). For the absolute model fit, the final model $\chi 2$ is 368.370, df = 235, (p = 0.000), indicating significant misfit between the model implied and sample covariance matrices even when the misfit per degree of freedom is quite low (CMIN/DF = 1.568). This is expected as the large sample size makes the total misfit value significant. However, RMSEA (0.035), and GFI (0.94) suggest an excellent model fit. In terms of incremental fit, CFI (0.97) also suggests an excellent model fit. And lastly, as for the parsimonious fit, both CMIN/DF (1.568) and AGFI (0.92) indicate an excellent model fit as well.

In order to check the construct reliability, convergent validity and discriminant validity, AVE and CR were calculated using the CFA results (Fornell & Larcker, 1981; Anderson & Gerbing, 1988; Bagozzi & Yi, 1988; Hair, Black, Babin, Anderson, & Tatham, 2006; Paswan et al., 2015; Henseler, Ringle, & Sarstedt, 2015). All the standardized λs were above 0.6 and significant (See Table 2.3), all of the CRs were above 0.6, and all of the AVEs were above 0.47. Most of the inter construct correlations (ϕ) were less than the square roots of AVEs for the corresponding constructs. The ϕ estimates, AVE, CR, and Alpha scores for each construct

along with values of overall model fit indices are demonstrated in Table 2.4. Cumulatively, these values indicate a good model fit and satisfactory levels of reliability and construct validity (Hair et al., 2006; Paswan et al., 2015).

Table 2.4: Evidence of reliability and construct validity.

Factors	GC	RPS	Auto	ToR	GA	FA	AVE	CR	Alpha
GC	**0.75**						0.57	0.80	0.80
RPS	0.46	**0.71**					0.51	0.76	0.76
Auto	0.43	0.23	**0.73**				0.53	0.87	0.87
ToR	0.73	0.49	0.43	**0.71**			0.51	0.81	0.79
GA	0.82	0.46	0.50	0.67	**0.70**		0.48	0.79	0.79
FA	0.90	0.49	0.49	0.80	0.79	**0.68**	0.47	0.78	0.78
Factor Mean	4.23	3.89	3.80	3.90	4.03	4.04			
Factor SD	0.68	0.81	0.75	0.70	0.66	0.67			

CFA global fit indices: Chi-square = 368.370; df:235; p-value:0.000; CMIN/DF = 1.568; NFI = 0.93; CFI = 0.97; GFI = 0.94; AGFI = 0.92; RMSEA = 0.035. The diagonal elements are $\sqrt{AVE}$ and the off-diagonal elements are ϕ estimates.

Moreover, the Heterotrait-Monotrait (HTMT) Ratio, which is a new benchmark for assessing discriminant validity developed by Henseler et al. (2015), is provided in Table 2.5. In the HTMT approach, two common thresholds (i.e., 0.90 and 0.85) are used to evaluate discriminant validity. If the values are less than one of these thresholds, then it means there exists discriminant validity. As seen in Table 2.5, all the values except between FA and GC are below even the more conservative threshold (i.e., 0.85), which reveals that all of the constructs have discriminant validity.

Table 2.5: Heterotrait-Monotrait Ratio (HTMT)

	Auto	FA	GA	GC	RPS	ToR
Auto						
FA	0.493					
GA	0.513	0.792				
GC	0.443	0.896	0.823			
RPS	0.241	0.504	0.467	0.469		
ToR	0.428	0.810	0.674	0.738	0.503	

Finally, as for the common method variance, neither the Harman Single Factor method nor the common latent factor method revealed any concern. The Harman Single Factor method, which found 35% variance for a single factor using factor analysis in SPSS and the common latent factor method, which found a 28% variance using measurement model in AMOS, both have values that are less than the generally accepted benchmark of 50% (Podsakoff & Organ, 1986; Eichhorn, 2014).

Hypotheses Testing and Results

The hypothesized relationships were tested using the structural equation modeling (SEM) procedure (Anderson & Gerbing, 1988; Bagozzi & Yi, 1988; Bentler & Chou, 1987; Bollen, 1989; Jöreskog & Sörbom, 1996). The bootstrap technique was also applied to measure the statistical significance of the indirect (mediation) relationships (Preacher & Hayes, 2004; Hayes, 2009). Figure 2.2 presents the SEM Model tested (the error terms of ε and δ are not shown). Table 2.6 shows the results of the SEM analysis. The global fit indices of the model (Anderson & Gerbing, 1988; Bagozzi & Yi, 1988; Bentler & Chou, 1987) are within acceptable limits for the model 1 (χ^2 = 556.598; df=241; p-value=0.000; CMIN/DF=2.31; RMSEA=0.053; NFI=0.89; CFI=0.93; GFI=0.91; AGFI=0.89). The model fit indices are presented below in Table 2.6. The structural relationships are all significant and in the hypothesized direction except for H1b, and hence provide support for all but one of the hypothesized relationships:

> **H1a:** With its payment/reward scheme, PBC is positively associated with supplier goal alignment with the buyer. (**Supported—positive γ; t-statistics = 8.364**).
>
> **H1b.** With its payment/reward scheme, PBC is positively associated with supplier goal commitment. **(**Not Supported—negative γ; t-statistics = -0.731).
>
> **H2:** Supplier goal alignment with the buyer is positively associated with supplier goal commitment. **(Supported—positive γ; t-statistics = 6.781**).
>
> **H3a:** Felt accountability of supplier is positively associated with the supplier goal commitment. **(Supported—positive γ; t-statistics = 10.088).**
>
> **H3b:** The autonomy provided by PBC is positively associated with the felt accountability of supplier. **(Supported—positive γ; t-statistics = 3.214).**

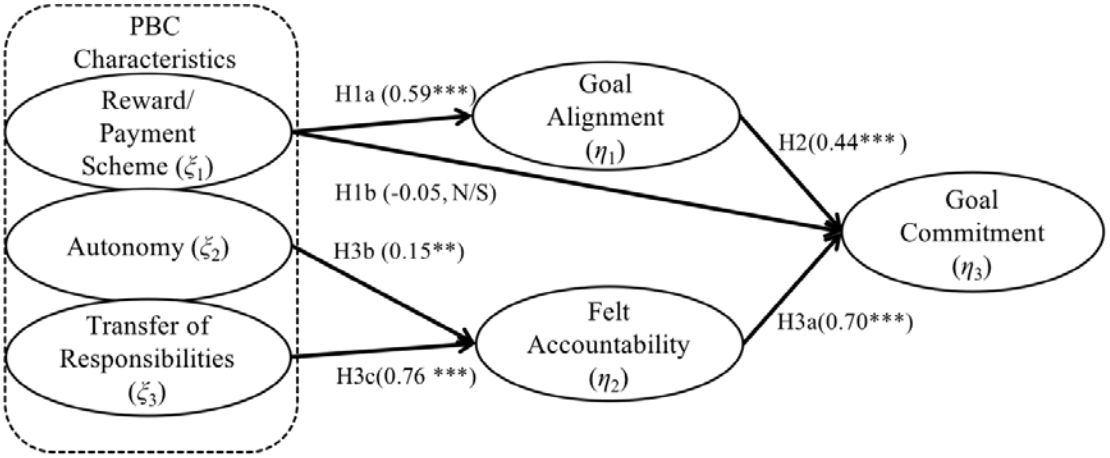
H3c: With the transfer of nearly whole responsibilities to the supplier, PBC is positively associated with the felt accountability of supplier. **(Supported—negative β; t-statistics = 10.866).**

Moreover, the indirect relationships (mediation) between exogenous constructs of reward/payment scheme, autonomy, transfer of responsibilities, and endogenous construct of goal commitment were examined. Though the direct effect of reward/payment scheme on goal commitment seems statistically insignificant, its indirect effect on goal commitment is positive and statistically significant at a 95% confidence level (p=0.001). That is, there is a statistically significant full mediation between these two constructs through goal alignment. As for the autonomy, it has a statistically significant positive indirect effect on the goal commitment at a 95% confidence level (p=0.008). Lastly, the transfer of responsibilities also has a statistically significant positive indirect effect on the goal commitment at a 95% confidence level (p=0.001).

Table 2.6: Test of hypotheses: Estimates of SEM

Parameters		Std. Estimate	t-value
Direct effects	H_{1a}: Reward/Payment Scheme (ξ_1) to goal alignment (η_1)	0.59	8.364
	H_{1b}: Reward/Payment Scheme (ξ_1) to goal commitment (η_3)	-0.05	-0.731
	H_2: Goal alignment (η_1) to goal commitment (η_3)	0.44	6.781
	H_{3a}: Felt accountability (η_2) to goal commitment (η_3)	0.70	10.088
	H_{3b}: Autonomy (ξ_2) to felt accountability (η_2)	0.15	3.214
	H_{3c}: Transfer of responsibilities (ξ_3) to felt accountability (η_2)	0.76	10.866
Indirect (mediated) effects	Reward/Payment Scheme (ξ_1) to goal commitment (η_3) through goal alignment (η_1)	0.26	p-value= 0.001
	Autonomy (ξ_2) to goal commitment (η_3) through felt accountability (η_2)	0.11	p-value= 0.008
	Transfer of responsibilities (ξ_3) to goal commitment (η_3) through felt accountability (η_2)	0.53	p-value= 0.001

Global model fit diagnostics: chi-square = 556.598; df:241; p-value:0.000; CMIN/DF = 2.310; RMSEA=0.053; NFI=0.89; CFI=0.93; GFI=0.91; AGFI=0.89. Note: Figure 2.2 also presents the parameters and the results.



Indirect effect of Reward/Payment Scheme on Goal Commitment through Goal Alignment (0.26***) (Full mediation)
Indirect effect of Autonomy on Goal Commitment through Felt Accountability (0.11**)
Indirect effect of Transfer of Responsibilities on Goal Commitment through Felt Accountability (0.53***)
NOTE: *** significant at 0.999 confidence level ** significant at 0.99 confidence level

Figure 2.2: Structural equation model results.

Conclusion and Discussion

PBC continues to change the way firms contractually engage in business. PBC is specifically with relevant to sustainment-dominant systems, where the vast majority of a system's lifecycle costs occur after it is produced. As a consequence, there is ample time during a system's operational and sustainment lifecycle phases to make significant performance improvements. With its applicability to operational and sustainment activities, PBC directly impacts logistics and supply chain management. In accordance with PBC tenants, the preponderance of risk shifts from buyers to the suppliers as the suppliers strive to achieve performance outcomes, specified by buyers. Therefore, supplier performance plays a significant role in the success of the contracted work and in the effectiveness of buyer outcomes. Though PBC is an active research stream, the behavioral implications of PBC on supply chain stakeholders are understudied. For all we know, this is the first research that puts forth a conceptual framework with multiple, testable hypotheses that frames the relationship between PBC and supplier goal commitment through the lenses of AT, GST and JCT theories. This research aims to delineate the effects of PBC on the supplier goal commitment, which is

a primary prerequisite for supplier performance using a survey method. Specifically, this study highlights the role of PBC characteristics such as payment/reward scheme, autonomy provided to the supplier, and transfer of responsibilities/risks to the supplier on the supplier goal commitment. Furthermore, it puts forth the mediating role of goal alignment between supplier and buyer and felt accountability of the supplier between PBC characteristics and supplier goal commitment.

As theorized, PBC has positive effects on the supplier goal commitment, which is crucial for supplier performance. The reward/payment scheme has a statistically significant positive direct impact on goal alignment and statistically significant indirect effect on goal commitment (i.e., its impact is fully mediated by goal alignment as its direct effect becomes statistically insignificant with the inclusion of goal alignment). In terms of autonomy, it has a statistically significant effect on felt accountability, as does the transfer of responsibilities. These two constructs also have a statistically significant positive indirect effect on goal commitment. As for the mediating constructs, goal alignment between supplier and buyer, and felt accountability, both have a statistically significant direct effect on goal commitment.

This study has both theoretical and managerial implications. Theoretically, this study extends the extant PBC research through the lens of AT, GST, and JCT theories. We believe this is the first study that examined the behavioral implications between a buyer and a supplier engaged in a PBC. Specific theoretical contributions are as follows. First, this study applies GST and JCT theories in an inter-organizational context and introduces goal alignment and felt accountability as new antecedents of goal commitment. Second, this study introduces a new validated construct, transfer of responsibilities. Third, this study highlights the importance of contracts, which governs the inter-organizational relations and transactions, in organizational motivation and work performance.

In terms of managerial implications, this study presents new, validated insights for

contract type selection. Since contract selection and contract management have a profound effect on competitiveness, the behavioral effect of PBC on supplier performance is a novel finding that might impact the contract selection decision-making process in a firm. Decision-makers are encouraged to consider the effect of PBC on supplier goal commitment when evaluating competing contract mechanisms. Lastly, being aware of the effect of PBC on supplier goal commitment, decision makers are now in a position to pay more attention to the key tenets of a successful PBC implementation to enhance supplier goal commitment.

This study has several limitations as well. First, it only explores the buyer-supplier relationship from the supplier standpoint. Future studies may also examine the buyer viewpoint or take a dyadic approach to the model and extend it. Second, this study focuses on goal alignment and felt responsibility as mediators. Future studies may also focus on relational aspects such as trust and collaboration, and their influences on goal commitment. Lastly, this study can be improved by applying triangulating methods.

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Appendix: Instruments for the Constructs

Construct	Definition	Survey Items	Resource
Reward/Payment Scheme (Bratton & Gold, 2007, pp.358)	Reward system refers to “all the monetary, non-monetary and psychological payments that an organization provides for its employees in exchange for the work they perform”.	Payment is based on a comparison between achieved performance against the contractual requirement(s).*	Jacopino, 2018
		Compensation is clearly specified based on our performance in the contract.*	Jacopino, 2018
		Payment is made based on the results we provide.	Jacopino, 2018
		Compensation is directly tied to our performance.	Jacopino, 2018
		When we fall short of specified performance expectations, we face negative consequences.*	Adapted from Oliveira & Roth, 2012
		We are rewarded on the basis of how well we perform the specified performance outcome(s)/goal(s).	Adapted from Schulz et al., 2010
		For us, recognition is based on exceeding performance expectations.*	Adapted from Schulz et al., 2010
		We receive higher compensation when we exceed specified performance outcome(s)/goal(s).*	Adapted from Schulz et al., 2010
Autonomy (Hackman & Oldham, 1976, pp.258).	“The degree to which the job provides substantial freedom, independence, and discretion to the individual in scheduling the work and in determining the procedures to be used in carrying it out”.	We have significant autonomy in determining how we achieve performance outcome(s)/goal(s).*	Adapted from Spreitzer, 1995
		We can decide on our own how to go about doing our work.	Adapted from Spreitzer, 1995
		We have considerable opportunity for independence in how we do our job.	Adapted from Spreitzer, 1995
		We have a lot of say over how we achieve performance objectives.	Adapted from Beehr, 1976
		We have enough authority to do our best.*	Adapted from Beehr, 1976
		The contract allows us to make a lot of decisions on our own.	Adapted from Beehr, 1976
		We have enough freedom as to how we do our work.	Adapted from Beehr, 1976
		We have a chance to use our judgment in carrying out the work.	Adapted from Idaszak, & Drasgow., 1987
Transfer of Responsibilities (Developed by the authors based on the PBC literature)	Transfer of Responsibilities refers to the extent to which a contract assigns the responsibilities regarding the work from the buyer to the supplier. That is, it shows the level of responsibilities suppliers assume. Since the supplier is assigned to provide performance outcomes, PBC transfers most of the responsibilities regarding the work from the buyer to the supplier. PBC involves wide-ranging supplier responsibilities to provide specified performance outcomes.	Almost all of the responsibilities related to the achievement of performance outcome(s)/goal(s) lies with us.*	Randall et al., 2010; Glas & Essig, 2008; Ng & Nudurupati, 2010; Sols & Johannesen, 2013; Böhm et al., 2016
		We assume the full range of responsibilities regarding the performance outcome(s)/goal(s) of the contract.	Randall et al., 2010; Glas & Essig, 2008; Ng & Nudurupati, 2010; Sols & Johannesen, 2013; Böhm et al., 2016
		The completion of tasks required to attain performance outcome(s)/goal(s) is fully our responsibility.	Randall et al., 2010; Glas & Essig, 2008; Ng & Nudurupati, 2010; Sols & Johannesen, 2013; Böhm et al., 2016
		All of the necessary tasks pertaining to the attainment of performance outcomes rest on our shoulders.	Randall et al., 2010; Glas & Essig, 2008; Ng & Nudurupati, 2010; Sols & Johannesen, 2013; Böhm et al., 2016
		We need to take control of all processes required to attain performance outcome(s)/goal(s).	Randall et al., 2010; Glas & Essig, 2008; Ng & Nudurupati, 2010; Sols & Johannesen, 2013; Böhm et al., 2016
		The burden of all the tasks needed to achieve performance outcome(s)/goal(s) is on us.*	Randall et al., 2010; Glas & Essig, 2008; Ng & Nudurupati, 2010; Sols & Johannesen, 2013; Böhm et al., 2016

Construct	Definition	Survey Items	Resource
Goal Alignment (Cao & Zhang, 2011)	Goal alignment between the buyer and the supplier is the extent to which both the buyer and the supplier achieves their objectives through attaining mutual goals.	We have very similar contract-related goals.*	Adapted from Stephen & Coote, 2007
		We have compatible contract-related goals.*	Adapted from Jap, 1999
		We support each other's objectives.	Adapted from Jap, 1999
		We generally agree upon contract-related goals.	Adapted from Jap, 1999
		Our attitudes towards what needed to be achieved are very similar.	Adapted from Stephen & Coote, 2007
		Our goals are in close alignment.	Adapted from Stephen & Coote, 2007
		We do not have conflicting goals.*	Adapted from Stephen & Coote, 2007
Felt Accountability (Hall & Ferris, 2011)	Felt accountability, which is also used as accountability, has been defined as a "perceived expectation that one's decisions or actions will be evaluated by a salient audience and that rewards or sanctions are believed to be contingent on this expected evaluation" (Hall & Ferris, 2011). On the other hand, felt responsibility, which is usually accepted as a subcomponent of accountability in the related literature (Schlenker et al., 1991), is a key psychological state indicating the extent to which "the individual feels personally accountable and responsible for the results of the work he or she does" (Hackman & Oldham, 1976: 256).	Buyer holds us accountable for the outcomes we provide.*	Adapted from Hochwarter et al., 2003
		If things in the contracted work do not go the way that they should, we will hear about it from the buyer.*	Adapted from Hochwarter et al., 2003
		To a great extent, the achievement of performance outcomes rests on our shoulders.	Adapted from Hochwarter et al., 2003
		Our performance plays a significant role in buyer's total performance.	Adapted from Hochwarter et al., 2003
		In the grand scheme of things, our efforts associated with the contracted work are very important.	Adapted from Hochwarter et al., 2003
		Besides the buyer, our competitors, and the public also closely scrutinize our performance.*	Adapted from Hochwarter et al., 2003
		We feel responsible to bring about change pertaining to the contracted work.*	Adapted from Morrison & Phelps (1999)
		It's up to us to bring about improvement pertaining to the contracted work.	Adapted from Morrison & Phelps (1999)
		We feel obligated to try to introduce new procedures pertain to the contracted work where appropriate.*	Adapted from Morrison & Phelps (1999)
Goal Commitment (Locke et al., 1981)	Goal commitment, the determination to try to reach a goal and the perseverance in following that goal over time (Locke et al., 1981), is a key construct in goal-setting theory (GST) (Klein & Wright, 1994). It involves the effort put in for the achievement of a goal and underlines a reluctance to abandon or to lower that goal (Campion &Lord, 1982; Hollenbeck & Klein, 1987).	We are strongly committed to pursuing specified performance outcome(s)/goal(s).	Adapted from Klein et al., 2001
		We feel specified performance outcome(s)/goal(s) is (are) good to shoot for.	Adapted from Klein et al., 2001
		We are willing to put in a great deal of effort to achieve specified performance outcome(s)/goal(s).	Adapted from Klein et al., 2001
		It is hard to take specified performance outcome(s)/goal(s) seriously (R).*	Adapted from Klein et al., 2001
		It wouldn't take much to make us abandon the specified performance outcome(s)/goal(s) (R).*	Adapted from Klein et al., 2001
		Quite frankly, we do not care if we achieve specified performance outcome(s)/goal(s) or not (R).*	Adapted from Klein et al., 2001

* Dropped based on EFA and CFA analyses.

ESSAY 3

OPTIMAL PERFORMANCE-BASED CONTRACT DESIGN

Introduction

There has been a substantial change in the business model (i.e., contractual relationship between buyers and suppliers) through the use of performance-based contracting (PBC). Traditionally, buyers and suppliers have embraced transactional relationships and associated contracting approaches for post-production support of high capital-intensive systems in various industries such as aerospace, defense, energy, healthcare, highway/railway, etc. (Sols, Nowicki, & Verma, 2007). This contractual approach has been replaced by PBC, which is characterized with an emphasis on the delivery of performance outcomes, cost avoidance strategies, increased profit margins, and autonomy for suppliers through longer-term contracts (Randall, Pohlen, & Hanna, 2010).

PBC, also known as "Performance Contracting" (Hansen, 2006), "Availability Contracting" (McEwan & Butterfield, 2011), "Contract for Availability" (Hockley, Smith, & Lacey, 2011), "Performance-based Service Acquisition" (Gansler, Lucyshyn, & Vorhis, 2011), "Performance-based Logistics (PBL)" (Boyce & Banghart, 2012), and "Outcome-based Contracting (OBC)" (Sandborn, Kashani-Pour, Goudarzi, & Lei, 2017), aims to make a supplier deliver performance outcomes as specified by key performance indicators for the contracted work while creating incentive schemes through longer contracts and opportunities for cost avoidance (Kim, Cohen, & Netessine, 2007). For example, Rolls-Royce launched "power-by-hour" for the engines of its airplanes where it is responsible for the availability of the engines that requires maintenance, repair, and overhaul, and it is paid per hour of flight (Sandborn et al., 2017).

As a contractual approach, the popularity of performance-based contracting (PBC) has increased in multiple businesses and across public and private domains (Hypko, Tilebein, &

Gleich, 2010; Selviaridis & Wynstra, 2015). PBC has been used in the areas of procurement and maintenance of highway and railway infrastructure (de la Garza & Arcella. 2013; Radović, Mirković, Šešlija, & Peško, 2014; Gajurel, 2014; Famurewa, Juntti, & Kumar, 2011), health and social care (Zeng, Cros, Wright, & Shepard, 2012), energy (Papalexopoulos & Andrianesis, 2012; Wang, Zhao, & Guo, 2019), manufacturing (Hypko et al., 2010), defense (Kratz & Diaz, 2012), and aerospace (Kim, Cohen, Netessine & Veeraraghavan, 2010). DoD has been using PBC as the preferred sustainment strategy since 2001 (Guidebook, PBL, 2014). The current PBC practices in different sectors have resulted in a 25–40% increase in product reliability and a 10-20% reduction in the cost per unit of performance along with an improvement of availability (Guajardo, Cohen, Kim & Netessine, 2012; Boyce & Banghart, 2012).

Since there is an inherent agency problem in buyer-supplier relationship, PBC aims to align the goals and reduce the friction between the both parties through its structure and incentives. Traditional contracting approaches weigh a transactional view in which supplier's profit is dependent on revenue from the sale and sustainment of the product/system separately. Namely, the more the service transactions (i.e., the more need for maintenance, repairment and overhaul-MRO), the more the supplier profit. Therefore, the supplier does not have the required incentive to invest in improvement of the system reliability, supply chain optimization, maintainability in the traditional contracting approaches (Alexander et al., 2002; Bundschuh & Dezvane, 2003) Eventually, this structure serves the benefits of the supplier whereas it increases the total cost of ownership (TCO) and reduce the availability of the product/system for the buyer, which leads to misalignment of the goals and fragile relationship. In contrast, PBC ties the supplier's reward/payment scheme to the achievement of specified performance outcomes such as availability, reliability, maintaining cost of the system. Namely, the more the system/product available and reliable, the more the supplier profit. In this contracting approach,

the supplier assumes more risks and responsibilities related to the performance of the system/product with opportunities of increased level of autonomy, steady flow of cash for longer terms, and exercising cost avoidance strategies which would lead to higher profits and lower TCO (Vitasek et al., 2006). On the other hand, PBC meets the buyer's needs through delivery of specified performance outcomes with lower costs and logistics footprint (Vitasek et al., 2006). Thus, PBC offers a "win-win" structure for both parties and leads to goal alignment between the supplier and the buyer (Kim et al., 2007).

The rise of PBC in many industries across public and private sectors has drawn substantial attention in the extant literature. Scholars have examined the PBC in many angles, and put forth the key tenets of successful implementation of PBC (Sols et al., 2007), explored the superiorities of PBC (Kim et al., 2007), and focused on the current practices(Keating & Huff, 2005, which are mostly qualitative. As literature of PBC emerges and qualitative research explores the various dimensions of PBC, quantitative research should build on the qualitative research and provide deeper insight regarding PBC. At this point, our research aims to achieve this objective and develops a PBC pricing model finding the optimal solutions for pricing, contract length, and the amount of investment that concurrently maximizes supplier profit and meet buyer's requirements. This study adopts the subscription model approach (Fruchter, & Sigué, 2013) and extends the model by Nowicki et al. (2009). It applies different distributions (i.e., triangular distribution and uniform distribution) for buyers' reservation fees and compares their impact on the investment, pricing, and length of the contract, which will provide different insights for different markets. Furthermore, this research analyzes the effects of multiple parameters on the optimum investment, optimum contract length, optimum periodic contract price, reliability, and supplier profit for different contexts. This study provides theoretical and managerial contributions. While it contributes the extant literature of PBC, it also presents the efficiencies and benefits of PBC for both the supplier and the buyer.

The remaining of the study continues as follows. Section 2 presents the literature review, while section 3 introduces the theoretical background. Then, section 4 goes through the development of the PBC pricing model. Section 5 delves into the optimal solutions for pricing, investment, and contract length. Section 6 runs the model with an illustrative scenario, and section 6 presents the discussion and conclusions.

Literature Review

This section goes through the relevant extant literature on both PBC and traditional transactional approaches specifically mathematical modeling regarding reliability, pricing, and other related areas. While PBC has become known as a successful contractual approach in multiple businesses and across private and public areas (Fowler, 2008; Keating & Huff, 2005; Geary & Vitasek, 2008), related research has grown remarkably in the recent decade (Selviaridis & Wynstra, 2015). According to the PBC literature review of Selviaridis & Wynstra (2015), while health and social care and defense are the top leading sectors, mathematical modeling and case study are the top two research methods in PBC research.

PBC has altered the way of doing business and offered a new business structure creating a "win-win" solution for both parties (Hypko et al., 2010). Suppliers' reward/payment scheme is tied to achievement of assigned performance outcomes. PBC transfers almost all of the responsibilities and risks from buyers to suppliers (Keating & Huff, 2005) while providing increased level of autonomy and flexibility to suppliers in the way of doing business. Suppliers strive to reduce the cost to maximize their profits through the investments improving reliability, maintainability, supply chain optimization, etc. (Vitasek et al,. 2007; Gansler & Lucyshyn, 2006). PBC creates opportunities for higher profit margins for suppliers through cost avoidance strategies. Randall, Pohlen & Hanna (2010) reveal how PBC fosters innovation. While traditional contract types have an intrinsic incentive deficiency, where the suppliers profit from system failures (Randall, Nowicki & Hawkins, 2011), PBC removes this deficiency by

amortizing suppliers' potential cost evasion employing a return-on-investment (ROI) governance system (Kratz & Diaz, 2012), where suppliers get profit as the total cost of ownership decreases due to investment in innovations. Moreover, guaranteed funding provides the incentive that boosts investments, which in turn improve system reliability and availability, reduce costs, and increase profitability (Randall et al., 2010).

In the recent decade, there has been a growing trend in quantitative models to investigate the interplay among the key variables (e.g., investment strategies, reliability, supplier profit, contract length, availability, maintainability, contract price, inventory of spare parts, etc.) in PBC. Sols et al. (2008) develop a PBL model including multiple metrics, while Nowicki et al. (2006) investigate allocation of inventory in a PBL context. Kim et al. (2007) explore the implications of PBC through a principle-agent model in the context of a single buyer and multiple suppliers. Kumar et al. (2007) develop a multi-objective optimization model that examines maintainability, reliability, and supportability dimensions. Nowicki et al. (2008) investigate the spare asset allocation through an optimization model under three different revenue functions. Kim et al. (2010) develops applies a principal-agent approach to examine the downtime and put forth that implementation of PBC may end up with a high agency cost if highly reliable equipment exists as disruptions happen rarely. Mirzahosseinian and Piplani (2011) analyze the effects of component reliability, inventory management, and maintenance facility on system availability. They propose that suppliers should improve component reliability and repair time rather than increase the stock levels of spare parts to achieve targeted system availability. Jin et al. (2012) examines the effects of interaction among reliability investment, system cost, and spare parts on the system availability, and put forth the substantial impacts of these three factors on system availability. In a comparative analysis (i.e., PBC vs. resource-based contract-RBC), Bakshi et al. (2015) investigate reliability signaling and the supplier investment in spare parts inventory through a game-theoretic model. They

conclude that PBC is more effective than RBC in terms of reliability signaling, and it is more acceptable for buyers when mature technologies rather than emerging technologies are available for the purchased products/systems. Kim et al. (2017) compare PBC with a traditional material-based contracting approach using a game-theoretical model to examine the interaction of reliability investments and the level of spare parts. They find that with its incentive structure, PBC urges suppliers to invest in reliability improvements, thereby reducing the total cost of spare assets, whereas suppliers invest more in inventory and less in reliability under the material-based contracts. Using a multi-objective modeling approach, Uvet et al. examine the effects of fleet size and contract duration on spare part inventory, reliability investment, total annual cost of the system, and supplier's profit in an PBC context. Patra et al. (2019) develop an optimization model for product/system availability while maximizing supplier's profit. Similarly, Wang et al. (2019) present a new maintenance policy for system availability while maximizing supplier's profit. We believe our study considerably expands these studies by concurrently predicting the optimal periodic contract price, amount of investment, and duration of contract to maximize the profit to the supplier and satisfy buyer needs.

One of the central topics for newly introduced or remanufactured/redesigned products and services in the marketing literature is pricing (Rao, 1984; Nagle & Holden, 1994; Marn, Roegner, & Zawada, 2003). There are three approaches widely used to determine prices, including return-on-investment (ROI), cost-plus, and perceived value pricing. In the ROI pricing approach, the desired ROI determines the product/service prices (Pride, Hughes, & Kapoor, 2008) while prices are set to cover all the product/service-related costs plus the targeted profit in the cost-plus pricing approach (Hanson, 2006). The most challenging of the three is the perceived value pricing approach as it involves surveying consumers to measure their willingness to make payment for a service/product (i.e., their reservation fees), and then setting the price of products or services accordingly (Breidert, 2006). The pricing literature in

marketing is mostly dominated by optimal pricing models for goods rather than services, and to our knowledge, there is a dearth of research in pricing models for PBCs.

In the relevant literature, traditional material/time-based maintenance approaches have been broadly investigated (Stremersch, Wuyts, & Frambach, 2001; Sherif & Smith, 1987; Levery, 2002). Nevertheless, the models developed in this literature are not appropriate for PBC as they do not concurrently optimize contract pricing, investment strategies, contract length while maximizing supplier profit and meeting buyer requirements. Murthy & Yeung (1995) examine the optimal maintenance approaches applying a game-theoretic approach. They presume that the buyer decides the maintenance time while the supplier determines related costs and controls the spare parts inventory. Using a game-theoretic approach, Asgharizadeh & Murthy (2000), and Murthy & Asgharizadeh (1999) develop models and assume that a buyer is supposed to decide whether to agree on a contract with fixed payments or a contract with varying payments for the cost of repair/replacement of failing equipment. Moreover, they presume that the supplier determines both the repair cost and the contract price. And, Jackson & Pascual (2008) examine maintenance contract pricing and optimize the number of service buyers while maximizing supplier profit.

The reliability of a system is one of the key parameters for the sustainment of that system over time in PBC. Reliability is the likelihood that a system/product performance will be appropriate with its intended function under a prescribed set of conditions over a specified time. Reliability is generally accepted as a quality component (Murthy & Blischke, 2006). The most of research regarding reliability investments investigate the known trade-off between the product reliability and timing of the product to enter the market in a traditional time/material-based contracting context (Lilien & Yoon, 1990). They presume that profit is dependent on the comparative product quality in the market. Cohen, Eliashberg, & Ho (1996) analyze the process of product quality improvement using a multistage model to optimize market entry

timing and targeted performance. Levesque (2000) examine the impacts of funding on product quality and determine optimal stopping rules to develop a new product using an analytical framework. Murthy et al. (2009) establish a framework to get optimal solutions for the trade-off between the cost of undesirable results of insufficient product reliability and the cost of reliability investment.

As obvious from the literature review, there is a need for quantitative research specifically for mathematical models to determine simultaneously optimum amount of reliability investment, optimum contract length and optimum periodic contract price while maximizing supplier profit and satisfying buyer demand. For all we know, this research is the first to fill this gap.

Theoretical Background

Buyer-supplier relation in the configuration and management of PBC is a matter of control and governance (Ring & Van de Ven, 1992). To control and govern the buyer-supplier relationship, Agency Theory (AT) examines contracts as mechanisms to arrange benefits and risks (Mitnick, 1973). AT strives to establish the most effective contract through the lens of principals (buyers) where an uncertain environment and information asymmetry exist (Jensen & Meckling, 1976). AT tries to address two types of problems. First, is the adverse selection due to the hidden information where the agent (supplier) misrepresents itself to win a contract or get beneficial terms from the principal (Bergen, Dutta, & Walker, 1992). The second is the "hidden action" suggesting "moral hazard" where the agent just follows its own goals (Ross, 1973). The buyer (principal) can cope with these problems by selecting the right supplier (agent), designing an appropriate contract, and collecting information (Bergen et al., 1992).

Inherently, PBC is well-positioned to handle these potential problems (Mouzas, 2016; Gordon, Morris, & Steinfeld, 2018; Patra, Kumar, Nowicki, & Randall, 2019). PBC addresses the adverse selection problem due to the misrepresentation of agents (Ross, 1973). In PBC, the

agent (supplier) is not expected to misrepresent as the compensation is tied to the achievement of performance outcomes. PBC also can mitigate the moral hazard problem where the agent (supplier) behaves opportunistically (Ross, 1973). Since the incentive/reward system is tied to achievement and/or improvement of performance outcomes, which is also the principal's (buyer) objectives, it would align the goals of the stakeholders and provide an incentive to the agent (supplier), so the agent will use its resources to achieve mutually beneficial goals (Gordon et al., 2018; Patra et al., 2019). All in all, PBC creates a win-win state for both parties and removes the weaknesses of traditional contracting approaches while leading to goal alignment between the buyers and the suppliers. Our study validates the efficiencies and the viability of PBC. While the suppliers maximize their profit with optimal reliability investment through optimal contract length, the buyers get specified reliability level of systems with decreasing total cost of ownership and longer-term relationship opportunities. Consequently, AT provides a theoretical framework for PBC research.

Methodology and Mathematical Model

This paper introduces a PBC pricing model that reveals the efficiencies and benefits of PBC for a wide range of contextual conditions using MATLAB. Specifically, the model provides decision insight into optimum amount of reliability investment, optimum contract length and optimum periodic contract price while maximizing supplier profit and satisfying buyer demand. Since there are more than two decision variables (i.e., multi-objective optimization), the genetic algorithms (GA) is utilized to determine the effect of each decision variable on supplier profit in PBC.

Genetic Algorithms

Genetic Algorithms (GA) have been the most widely used metaheuristic optimization technique with its evolutionary algorithms to determine optimal solutions in the context of

multi-objective design and optimization (Konak, Coit, & Smith, 2006). A database kept by Coello Coello presents that 4983 studies used evolutionary algorithms in multi-objective optimization problems between 1988 and 2017. It also reveals the popularity of GA, which have the largest proportion of algorithms being used (56% of applications). The concept of GA, inspired by Darwin's evolutionist theory and Mendel's inheritance theory (Wang & Sobey, 2019), was first introduced by Holland (1973, 1992). The capability of GA to concurrently search diverse regions of a solution space (i.e., the random population of solutions) facilitates solving multi-objective optimization problems (Konak et al., 2006).) After creating the random population of solutions, three evaluation operators (i.e., selection, crossover, and mutation) perform the process to find the optimal solutions (Houck et al., 1995; Razali & Geraghty, 2011). We would refer the reader to studies of Coley (1999) and Konak et al. (2006) for more detailed information regarding GA.

Mathematical Model

The model developed here extends the model by Nowicki et al. (2011), currently under review of EJOR, and adopts the subscription model approach (Fruchter, & Sigué, 2013) due to similarities between the mechanism of PBC and the subscription models. Specifically, in the subscription model, subscribers pay periodic fees for the services, and the providers assumes all the cost related to the services. The total profit of the suppliers depends on the cost avoidance strategies while satisfying buyers' needs as in PBC.

Let's think about a PBC scenario in which a supplier offers a system for sale with a post-production service option to its potential market with *M number of* buyers. When a buyer engaged in this contract, she pays a fixed periodic price *p* to receive the contracted sustainment services. The supplier has required capabilities to improve the system through an x amount of investment thereby enhancing the system's reliability from initial reliability r_0 to targeted reliability $r(x)$, ($r(x) \geq r_0$). Once the buyer accepts the contract, she gets the system with an

enhanced reliability of $r(x)$, and the supplier assumes all of responsibilities, costs and risks related to sustainment of the system properly during the contract duration k. Therefore, the number of M potential buyers who are willing to make a payment per period will expect to receive a system with a reliability r(x) for the during the contract duration k. A buyer will engage in the contract as long as the contract price (periodic) p is equal to or less than her reservation fee, the maximum amount of money she is ready to reimburse for the system with a reliability of $r(x)$ during the contract duration k. If we assume the probability density function (PDF) of buyer reservation fee, v, as $w_{r(x),k}(v)$, $v > 0$, then, the portion of the M potential buyers that will be willing to accept the contract of length k would be

$$W_{r,k}(p) = \int_{p}^{\infty} w_{r(x),k}(v)dv. \tag{1}$$

The supplier aims to maximize its total profit while meeting the buyer needs specified in the contract. When the supplier makes an x amount of investment to enhance the system's reliability, its expected discounted net pricing value of total profit would be

$$E[\Pi(x, p, k)] = M\sum_{j=1}^{k}\left(\frac{1}{(1+i)^{j}}\left[p - f(r(x))\right]\int_{p}^{\infty} w_{r(x),k}(v)dv\right) - x \tag{2}$$

where i is the interest rate, p is the periodic contract price, and $f(r(x))$ is the total sustainment cost per period, given the system reliability $r(x)$.

The developed model includes system's reliability r(x) specified in the contract, total cost of sustainment f(r(x)), which is dependent on the system reliability and usage rate per period, supplier investment x in reliability improvement, and the eagerness of a buyer to engage in the contract. The definitions of the variables and parameters, interrelationships among them, and assumptions are presented below.

Notation

- Indices

k is the contract duration (length of a contract), k=1, …, N

Decision Variables

x investment amount during the contract duration to enhance the system reliability and lower the sustainment cost.

p is the periodic contract price.

- Input Variables

r_0 is the initial system reliability for the mission time t_m.

μ_c is the average failure cost.

M is the number of buyers in the potential market.

m is the usage rate per period during the contract of length k.

γ is the parameter for marginal investment.

i is the interest rate.

d is the discount rate buyers expect to receive per period.

λ is the maximum fee that buyers are ready to pay per period if r(x) = 1.

N is the maximum contract length/duration.

- Intermediate Calculations

$w_{r(x),k}(v)$ is the probability density function (PDF) of buyers' reservation fees, v, where v > 0.

$W_{r(x),k}(p)$ is the portion of buyers ready to accept the contract with a system's reliability of r(x) during the contract duration k.

$\Pi(x,p,k)$ is the supplier's total profit dependent on the x amount of reliability investment during a k-period of contract with a periodic contract price p.

- Performance Metrics

r(x) is the the system's reliability achieved through the x amount of investment.

f(r(x)) is the total sustainment cost per period, given the system reliability r(x).

Assumptions

The model is founded on the four assumptions as follows, denoted by (A1)-(A4):

- (A1) Supplier's x amount of investment influences the system reliability *r as* follows:

$$r(x) = r_o + (1 - r_o)\left(1 - \frac{1}{x/\gamma + 1}\right) = \frac{x + r_o\gamma}{x + \gamma}, \quad (3)$$

where γ is the parameter for marginal investment (γ>0), which is required investment amount to accomplish an incremental increase in the reliability of system. The system reliability $r(x)$ function has an S-shaped curve, which may have any value between 0 and 1, which exhibits the underlying relationship between the system reliability and the investment as well as satisfies the assumption of $r(0) = r_0$ (Levesque, 2000).

- (A2) The expected sustainment cost of the system, which decreases with the reliability improvements whereas increases with the increase in the usage rate of the system, per period is:

$$f\big(r(x)\big) = \mu_c m\big(1 - r(x)\big). \quad (4)$$

where m is the usage rate, μ_c is the average failure cost, per period, and r(x) is the reliability of the system achieved through the investment.

- (A3.1) As for the buyers' reservation fees, we have two assumptions which may address different markets for the system. The family of the probability density functions (PDF) is as follows (Kirman, Schulz, Hardle, & Werwatz, 2005).

$$f(z) = \begin{cases} f_b + 2\frac{b-z}{b-a}\left(\frac{1}{b-a} - f_b\right) & \text{for } z \in (a, b) \\ 0 & \text{else} \end{cases}$$

where $f_b \in \left[0, \frac{1}{b-a}\right]$

When we set *fb = 1/(b − a),* we get the PDF of the Uniform distribution, while we get the PDF of the Triangular distribution for *fb = 0.* The corresponding cumulative distribution functions (CDF) is

$$F(z) = \begin{cases} 0 & \text{for } z < a \\ 1 - \left[f_b(b-z) + \{1 - f_b(b-a)\} \left(\frac{b-z}{b-a} \right)^2 \right] & \text{for } z \in [a,b] \\ 1 & \text{for } z > b \end{cases}$$

where z is buyers' reservation fee, a and b lower and upper boundaries of the z, and *fb* is the parameter regulating the distributions of buyers' reservation fee. Since this is the CDF, (1-CDF) gives the portion of the buyers willing to engage in the contract. When we put the parameters governing the buyers' reservation fee accordingly in our model, the portion of the buyers willing to engage in the contract when the uniform distribution is used for buyers' reservation fee is:

$$W_{r(x),k}(p) = \begin{cases} \frac{\lambda(1-d(k-1))r(x) - p}{\lambda(1-d(k-1))r(x)}, 0 \le p \le \lambda(1-d(k-1))r(x), \end{cases}$$

$$W_{r(x),k}(p) = \begin{cases} \frac{\lambda D_k r(x) - p}{\lambda D_k r(x)}, 0 \le p \le \lambda D_k r(x) \\ 0, \qquad o.w. \end{cases}, \tag{5}$$

where $D_k = (1 - d(k - 1))$.

- (A3.2) And, the portion of the buyers willing to engage in the contract when the triangular distribution is used for buyers' reservation fee is:

$$W_{r(x),k}(p) = \begin{cases} \frac{(\lambda(1-d(k-1))r(x) - p)^2}{(\lambda(1-d(k-1))r(x))^2}, 0 \le p \le \lambda(1-d(k-1))r(x) \end{cases}$$

$$W_{r(x),k}(p) = \begin{cases} \frac{(\lambda D_k r(x) - p)^2}{(\lambda(D_k r(x))^2}, 0 \le p \le \lambda D_k r(x) \\ 0, \qquad o.w \end{cases} \tag{6}$$

Here λ represents the maximum fee that buyers are ready to pay per period as long as the system reliability is to be enhanced to $r(x) = 1$. This formula also includes the discount rate *d* that buyers expect from the supplier when they engage in a multi-period contract, which is one of the key underlying assumptions of PBC economics (Randall et al. 2011). The

application of triangular and uniform distributions for buyers' reservation fees adheres to extant pricing literature (Kirman et al., 2005).

- (A4) The contract length, *k*, is an integer value defined in periods, with maximum length equal to *n* periods. That is to say, $k = 1, 2, \ldots, n$.

Optimization

In a PBC arrangement, the supplier must make decisions regarding the periodic contract price, contract length, and the investment amount for the improvement of system reliability. And, in this decision-making process, the supplier aims to find out the optimum investment amount of x^*, optimum contract price per period p^* and optimum contract duration k^* maximizing the expected profit to the supplier $E[\Pi(x,p,k)]$ during the contract duration k ($k = 1,\ldots,n$), where n is the maximum contract length:

$$E[\Pi(x^*, p^*, k^*)] = \max_{k=1,\ldots,n}\{E[\Pi(x^*, p^*, k)]\} \tag{7}$$

where

$$E[\Pi(x^*, p^*, k^*)] = \max_{\{x,p\}\in F_{x,p}}\{E[\Pi(x, p, k^*)]\} \tag{8}$$

with a set of achievable solutions:

$$F_{x,p} = \left\{\{x, p\} \mid x > 0, 0 \le p \le \lambda D_k r(x)\right\}, \quad \text{for each k.} \tag{9}$$

Here the upper boundary for the periodic contract price derives from buyers' reservation prices which are uniformly and triangularly distributed. An expected discounted net pricing value of total profit for uniformly distributed reservation prices is obtained based on the assumptions (A1)-(A4) as follows:

$$E[\Pi(x, p, k)] = M\sum_{j=1}^{k}\left(\frac{1}{(1+i)^j}\left[p - f(r(x))\right]\int_p^{\infty} w_{r(x),k}(v)dv\right) - x$$

$$E[\Pi(x,p,k)] = \left[MI_k \left\{ p - f(r(x)) \right\} \frac{(\lambda D_k r(x) - p)}{\lambda D_k r(x)} \right] - x$$

$$E[\Pi(x,p,k)] = \left[MI_k \left\{ p - \mu_c m(1 - r(x)) \right\} \frac{(\lambda D_k r(x) - p)}{\lambda D_k r(x)} \right] - x$$

$$E[\Pi(x,p,k)] = \left[MI_k \left\{ p - \mu_c m(1 - \frac{x + r_0\gamma}{x+\gamma} \right\} \frac{(\lambda D_k \frac{x + r_0\gamma}{x+\gamma} - p)}{\lambda D_k \frac{x + r_0\gamma}{x+\gamma}} \right] - x$$

$$E[\Pi(x,p,k)] = \left[\frac{MI_k \left\{ \frac{p(x+\gamma) - \mu_c m(1-r_0)\gamma}{x+\gamma} \right\} \left\{ \frac{\lambda D_k (x + r_0\gamma) - p(x+\gamma)}{x+\gamma} \right\}}{\lambda D_k \frac{x + r_0\gamma}{x+\gamma}} \right] - x$$

$$E[\Pi(x,p,k)] = \begin{cases} \dfrac{MI_k (p(x+\gamma) - \mu_c m(1-r_0)\gamma)(\lambda D_k (x + r_0\gamma) - p(x+\gamma))}{\lambda D_k (x + r_0\gamma)(x+\gamma)} - x, & 0 \le p \le \lambda D_k r(x) \\ 0, & o.w. \end{cases} \quad (10)$$

Similarly, an expected discounted net pricing value of total profit for triangularly distributed reservation prices is obtained using the same steps and the final equation is as follows:

$$E[\Pi(x,p,k)] = \begin{cases} \dfrac{MI_k (p(x+\gamma) - \mu_c m(1-r_o)\gamma)(p(x+\gamma) - \lambda D_k (x + r_o\gamma))^2}{\lambda^2 D_k{}^2 (x + r_o\gamma)^2 (x+\gamma)} - x, & 0 \le p \le \lambda D_k r(x) \\ 0, & o.w. \end{cases} \quad (11)$$

where $I_k = (1 + i - (1 + i)^{-k})/i$.

The first order derivatives (required terms) gives the critical points for both the optimum contract price per period (p^*) and the optimum amount of investment (x^*) for the contract duration (k) as follows:

$$\left. \frac{\partial E[\Pi(x,p,k)]}{\partial x} \right|_{(x^*,p^*,k)} = 0 \quad \text{and} \quad \left. \frac{\partial E[\Pi(x,p,k)]}{\partial p} \right|_{(x^*,p^*,k)} = 0, \quad (12)$$

or fall into the achievable set F_{xp}. For uniformly distributed reservation prices with equation (10), equations (12) reduce to

$$p = \frac{\mu_c m(1-r_0)\gamma + \lambda D_k X}{2(x+\gamma)}$$

Similarly, for triangularly distributed reservation prices with equation (11), equations (12) reduce to

$$p = \frac{2\mu_c m(1-r_0)\gamma + \lambda D_k X}{3(X-\gamma(1-r_0))}$$

and

$$4M\gamma I_k(1-r_o)\left(X\lambda D_k - \mu_c m(1-r_o)\gamma\right)^2(\mu_c m(3X+2(1-r_o)\gamma)+X\lambda D_k) - 27X^3\lambda^2 D_k{}^2(X+(1+r_o)\gamma)^2 = 0$$

where, $X = x + r_0\gamma$. As (x^*,p^*) are critical points, they should meet the second order sufficient terms:

$$\left.\frac{\partial^2 E[\Pi(x,p)]}{\partial^2 x}\right|_{(x^*,p^*)} < 0, \quad \text{and} \quad \left.\frac{\partial^2 E[\Pi(x,p)]}{\partial^2 p}\right|_{(x^*,p^*)} < 0, \tag{12}$$

and

$$\left.\frac{\partial^2\Pi(x,p)}{\partial^2 x}\frac{\partial^2\Pi(x,p)}{\partial^2 p} - \frac{\partial^2\Pi(x,p)}{\partial x\partial p}\frac{\partial^2\Pi(x,p)}{\partial p\partial x}\right|_{(x^*,p^*)} > 0, \tag{13}$$

The optimum solutions for optimum contract price per period (p^*) and the optimum amount of investment (x^*) are found numerically for each contract length k = 1,...,n and the optimum contract length k^* is found by equation (7).

Numerical Analysis

This part numerically determines the optimum periodic contract price p^*, optimum amount of investment x^*, optimum length of the contract k^*, and the expected supplier pprofit and the reliability $r(x^*)$ while examining how these variables change based on parameters M, d, λ, r_0, γ, *and* μ_c in a PBC scenario.

Let's assume that a warfighter jet engine manufacturer wants to introduce a new engine to its potential market consisting of 60 buyers (M = 60) with a PBC option. However, the

supplier is not sure about the distribution of the buyers' reservation fees as this will be the debut of the engine. Therefore, the supplier wants to develop alternate scenarios based on the distribution of buyers' reservation fees to maximize its profit while addressing the market needs. Let's say the maximum periodic fee that buyers are ready to pay during the contract is \$100,000 (λ = 100) with an expectation of 10% periodic discount during the contract (d = 0.10). The supplier has the capability to improve the engine's initial reliability (r_0 = 0.7), which necessitates an investment amount of \$100, 000 at least (γ = 100) to enhance engine's reliability up to 0.85 [r_0 + 1/2(1 - r_0)]. The expected cost of sustainment is \$20,000 (μ_c=20). Let's suppose that buyers use the engines 10 times per period (m = 10), and the periodic interest rate is 2% (i = 0.02). Table 3.1 exhibits the values of the parameters for this scenario.

Table 3.1: Baseline Scenario

Parameter	M	d	λ	r_0	γ	μ_c	m	i
Value	60	0.10	100	0.7	100	20	10	0.02

After running the model in the MATLAB, the results regarding optimum amount of investment, optimum periodic contract price, and length of contract maximizing the profit to the supplier well as the system reliability achieved through the investment are presented in the Figure 3.1 and Figure 3.2. As illustrated in this scenario, there is a positive relationship between the contract length and the optimum investment, whereas it is a negative one between contract length and the optimum periodic price. (See left top and left bottom of Figure 3.1 and 3.2, respectively). As seen in the right top of Figure 3.1 and 3.2, the relationship between contract length and system reliability is positive, and a longer contract duration leads to a higher system reliability received by the buyer. Lastly, while supplier profit increases with higher contract length, after a point it starts to decrease. In this scenario, when a triangular distribution is applied to buyers' reservation fees, the supplier can maximize its expected total profit through a 4-period contract and with an optimum investment amount of \$737,579 and an optimum

periodic contract price of $27,300. This contract yields to a system's reliability of 0.960 and an expected total profit of $1,322,400. On the other hand, when an uniform distribution is applied to buyers' reservation fees, the supplier can maximize its expected total profit through a 4-period contract and with an optimum investment amount of $867,712 and an optimum periodic contract price of $37,000. This contract yields to a system's reliability of 0.965 and an expected total profit of $3,170,500. As suggested by the economics of the PBC, the results of the developed model validates the economic win-win mechanism of PBC for both parties, and presents the appropriate structure to motivate the supplier for investment, which is consistent with agency theory that aims to find out mechanisms aligning interests of principal (buyer) and agent (supplier).

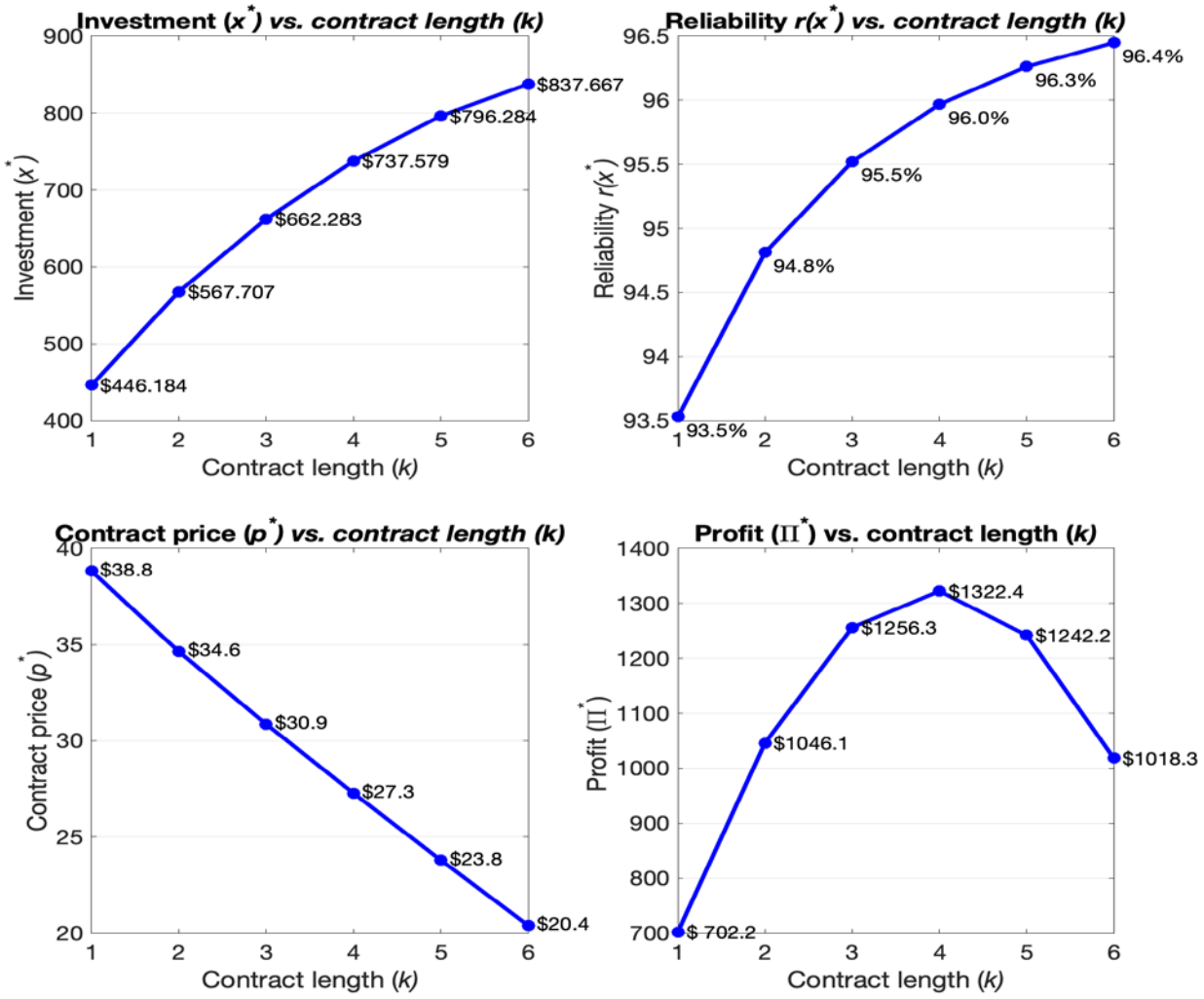

Figure 3.1: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the k varies (For buyers' reservation fee triangularly distributed).

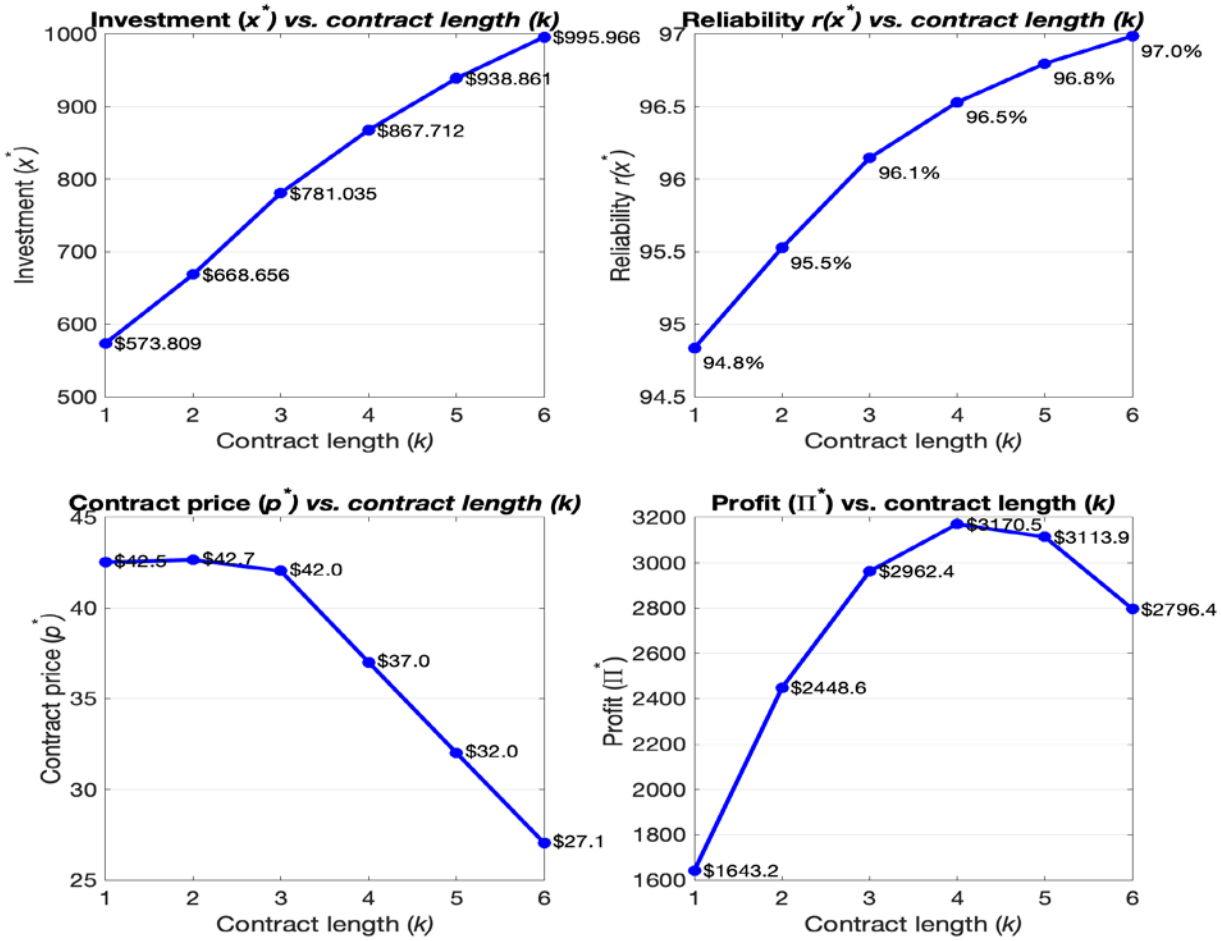

Figure 3.2: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the k varies (For buyers' reservation fee uniformly distributed).

This scenario is an illustrative one to understand the nature of the PBC mechanism. However, the contextual factors will change the scenarios and will provide different inputs for the parameters used in the model. Thus, these inputs will alter the decisions regarding investment. Pricing and contract length. To address the different contexts and enhance the generalizability of the model, we further investigate the sensitivities of the variables (i.e., optimum investment, periodic contract price, reliability and profit) for the changes in the input parameters under two different distributions of buyers' reservation fees. Based on the sensitivities of these parameters, both supplier and the buyer will be able to conduct a more informed negotiation process. Figures 3.3–3.9 display sensitivity analysis for x^*, p^*, Π^* and k^* as the usage rate, market size, M; buyers' willingness to pay, λ; discount per period, d; initial reliability, r_0; the expected failure cost, μ_c. and parameter for marginal investment, γ change.

Usage rate

The usage rate has positive relationship with the optimum investment, periodic contract price and achieved reliability. However, as the usage rate rises, total profit of supplier goes down (See Figure 3.3). That is, as the usage rate increases, the supplier will charge more the buyer to compensate the increased cost due to increased usage rate. The supplier would seek to increase the system's reliability through the higher investment to reduce the number of failures.

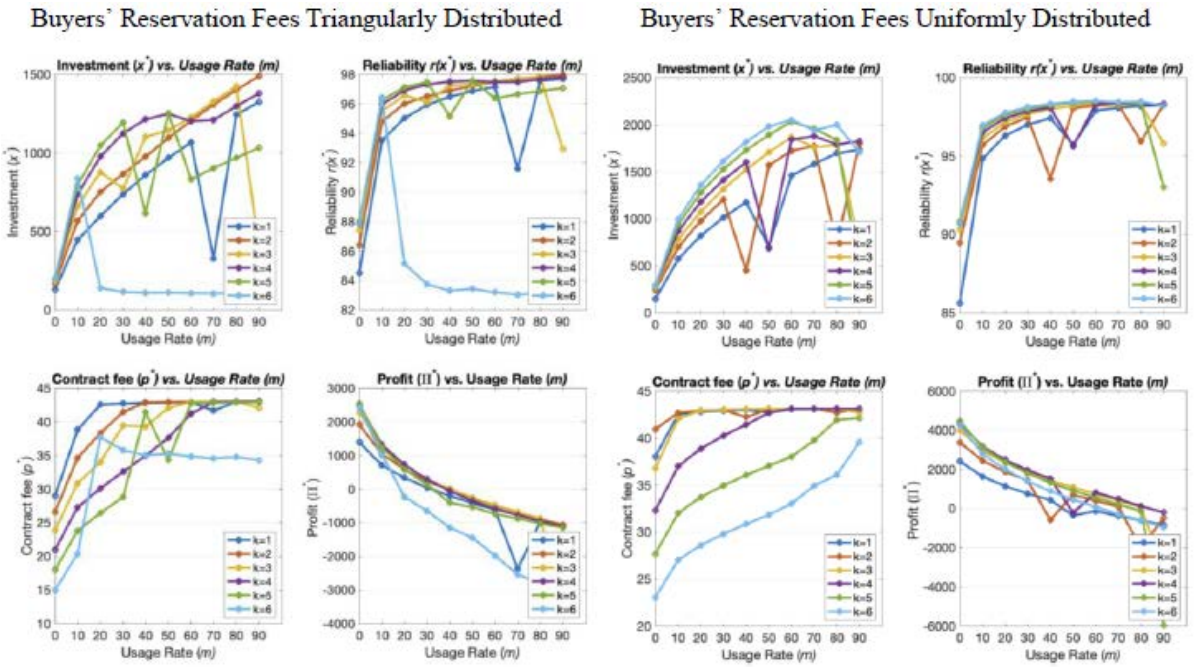

Figure 3.3: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the m varies (For buyers' reservation fee triangularly and uniformly distributed, respectively).

Market Size

As the market size increases, both the optimum investment and the contract length also increase, whereas the optimum periodic contract price decreases. Similarly, increase in the market will also yield to higher total profits (See Figure 3.4). The supplier will be willing to invest as much as possible to improve the system's reliability as this improvement will address larger market size. So that, the supplier can get return on investment during longer contract duration.

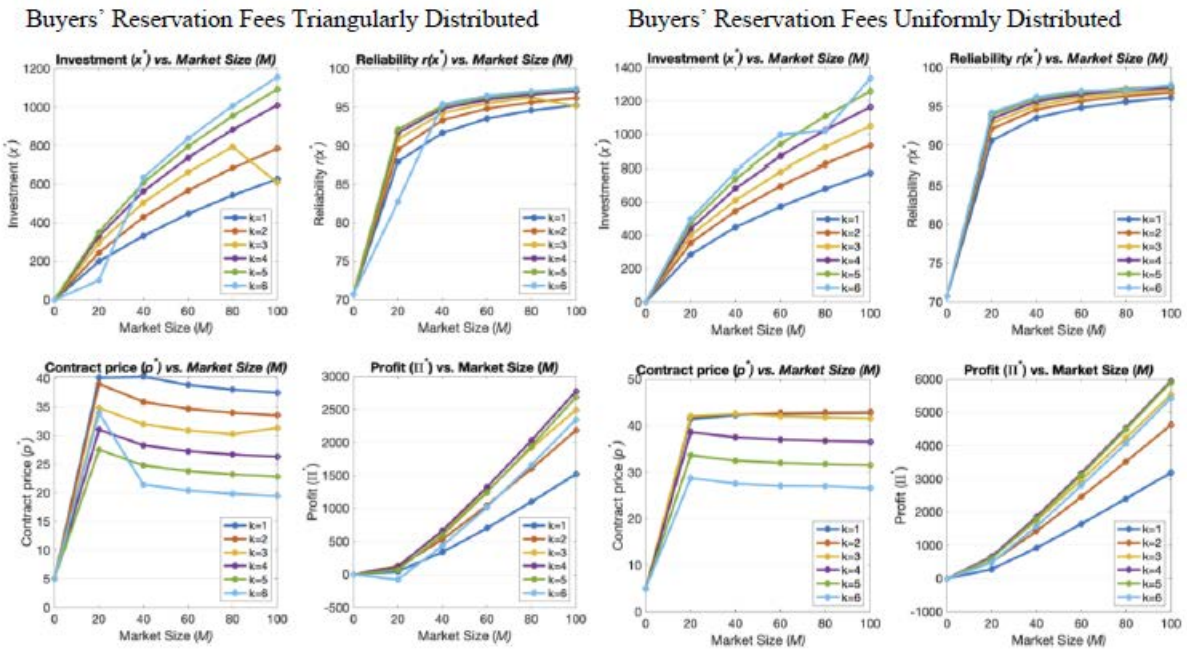

Figure 3.4: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the M varies (For buyers' reservation fee triangularly and uniformly distributed, respectively).

Maximum Buyer Fee

As the buyers want to pay higher prices per period, the optimum investment, contract's length, and optimum periodic contract price increase as well (See Figure 3.5). Namely, the supplier will be able to charge more as the buyers are eager to pay higher prices.

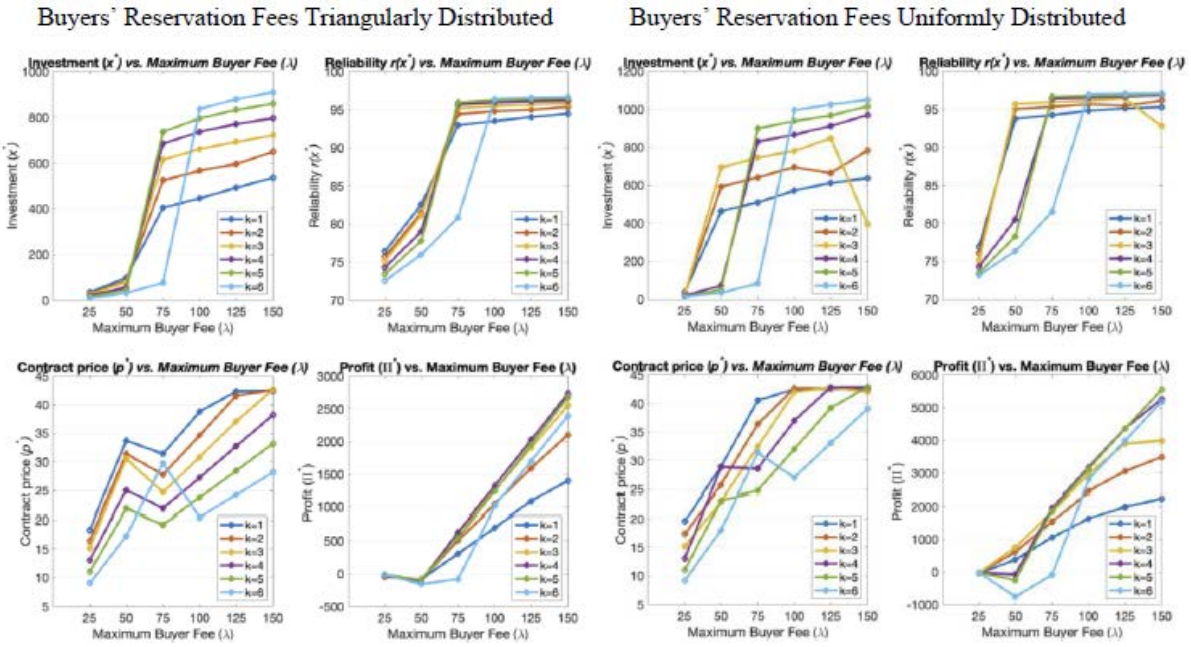

Figure 3.5: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the λ varies (For buyers' reservation fee triangularly and uniformly distributed, respectively).

Discount Rate

Discount rate expected by the buyers per period has negative effects on the optimum investment, contract length and the optimum periodic contract price and length (See Figure 3.6). Even though longer contracts may have benefits, in general, the supplier should consider the effects of the discount rate when it is high and negotiate for shorter contracts accordingly.

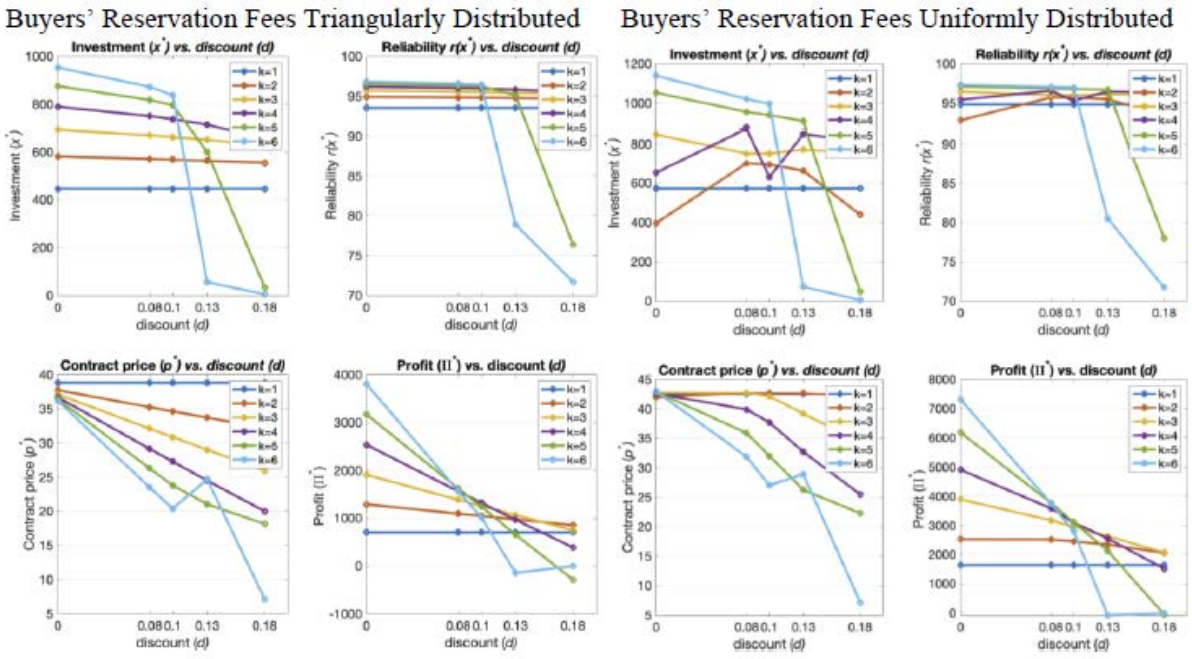

Figure 3.6: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the d varies (For buyers' reservation fee triangularly and uniformly distributed, respectively).

Initial Reliability

Initial reliability is the basis especially for the cost avoidance investments. And, initial reliability has negative effects on both the optimum investment and the optimum contract price (See Figure 3.7). Namely, the less the initial reliability the more supplier need to invest into improvement of the system's reliability and thus offer lower periodic contract price.

Expected Failure Cost

As the expected failure cost increases, both the optimum periodic contract price and the optimum investment increase as well (See Figure 3.8). Given the economics of PBC, supplier will be willing to invest into improvement of reliability and cost avoidance strategies as much

as possible to reduce the sustainment costs and increase total profit when the failure cost is high. Since the number of failures will be higher during the longer contracts, expected failure cost has a negative relationship with the optimum contract's length.

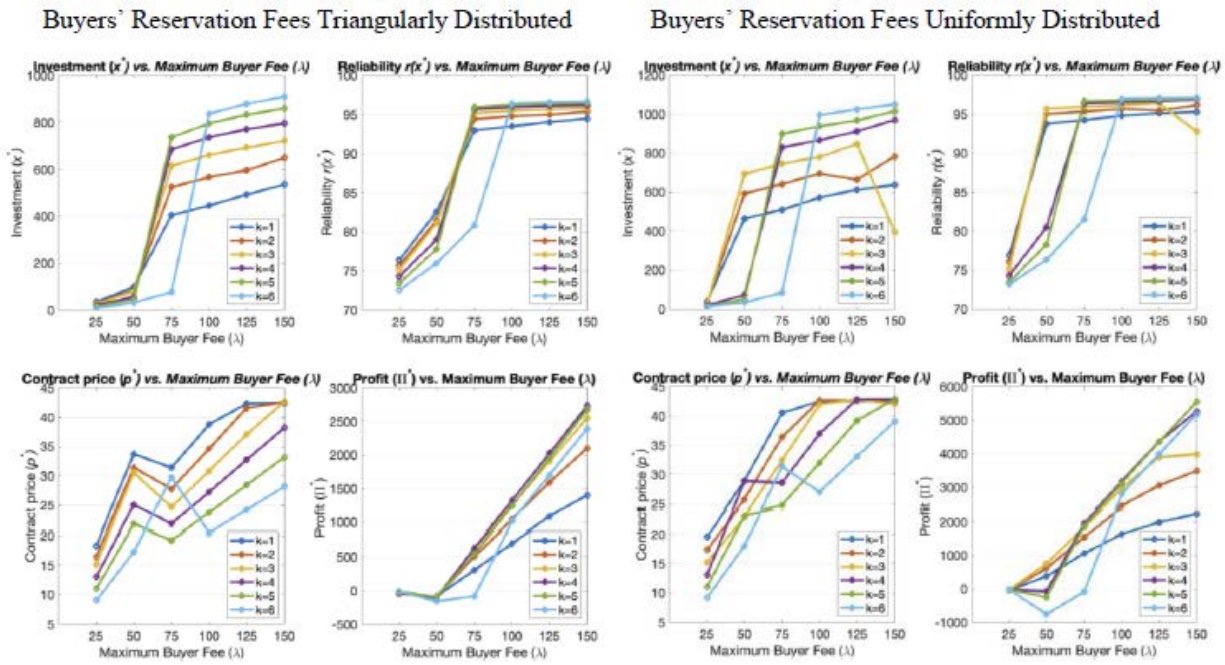

Figure 3.7: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the r_0 varies (For buyers' reservation fee triangularly and uniformly distributed, respectively).

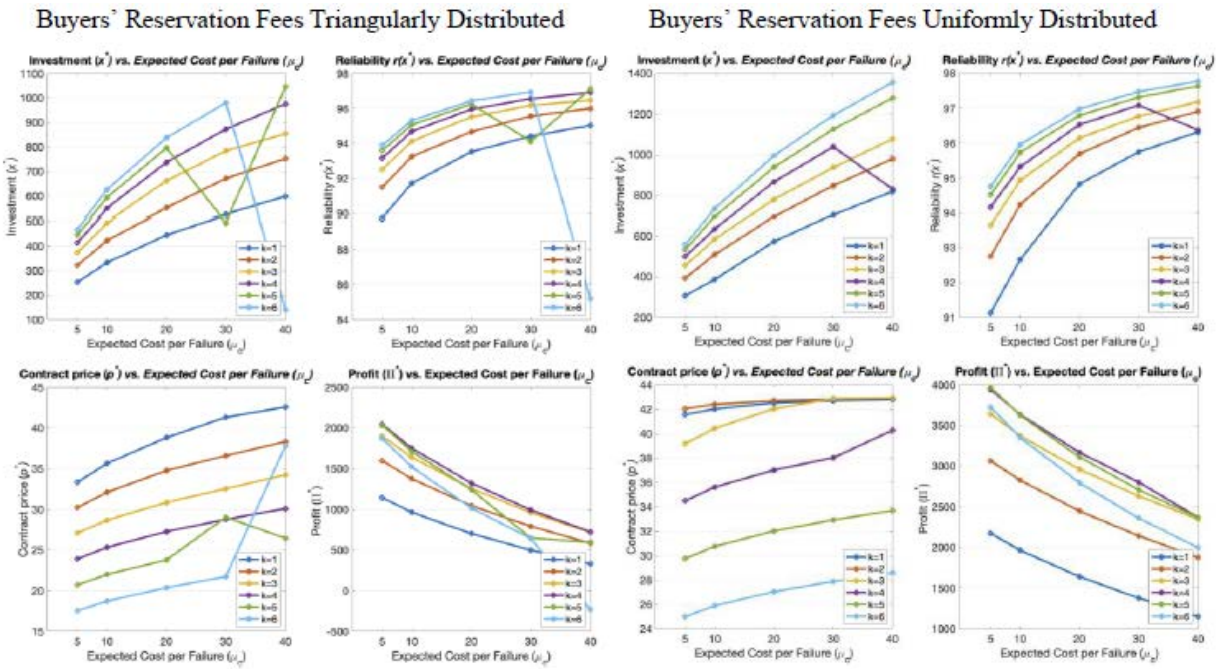

Figure 3.8: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the μ_c varies (For buyers' reservation fee triangularly and uniformly distributed, respectively).

Parameter for Marginal Investment

As the parameter for marginal investment increases, both the optimum amount of investment and optimum contract price per period increase, whereas the reliability and total profit decreases (See Figure 3.9). Namely, the harder to improve reliability, the more supplier needs to invest and charge more the buyer.

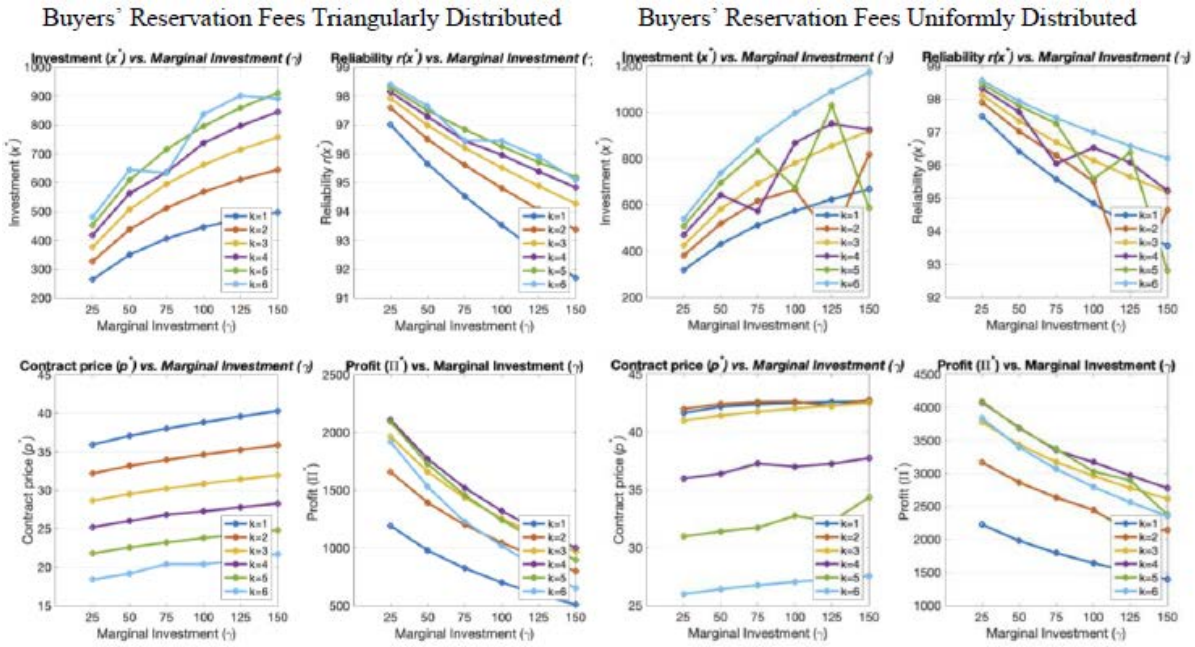

Figure 3.9: Sensitivity of x^*, $r(x^*)$, p^*, and π^* as the γ varies (For buyers' reservation fee triangularly and uniformly distributed, respectively).

Discussion and Conclusions

Since PBC has been gaining momentum, and business organizations face fierce competition in an uncertain environment, it has become essential for suppliers to design optimal PBCs maximizing supplier profit and satisfying buyer needs. This study focuses on the optimal PBC design and develops a pricing model to support both parties in their decision-making for PBC design. Furthermore, this paper examines the effects of various contexts under two different distributions for buyers' reservation fees on the PBC design, and thus, reveals the underlying efficiencies and benefits attractive to both the suppliers and the buyers. The findings can provide guidance for suppliers how to design PBC in terms of contract length, investment

amount, and periodic contract price, to maximize the profit. For all we know, this is the first study establishing a PBC pricing model along with solutions to define the optimum periodic contract price, investment amount, and contract duration that concurrently maximize the profit to the supplier and satisfy buyer needs.

The results indicate that the optimum contract length is 4 years as the total profit reaches the highest point at fourth year then it starts to decrease. It is evident from the results why longer PBC may attract buyers. While the optimum investment amount increases, the optimum periodic contract price decreases with the contract length (except for discount). In terms of the analysis of the impacts of the variations in the contextual parameters on the decision variables, the results also provide deeper insight for different contexts. Optimum amount of investment increases as the usage rate, market size, maximum buyer fee, parameter for marginal investment and expected cost per failure increase, while it decreases as the initial reliability and discount rate increase. On the other hand, optimum periodic contract price decreases as the market size, discount rate, and initial reliability increase while it increases with an increase in the usage rate, maximum buyer fee, parameter for marginal investment and expected failure cost. Taken together, these results helps the supplier to make more informed decisions regarding pricing and investment. Moreover, these results reveal how the structure of PBC creates a "win-win" atmosphere and leads to goal alignment between the buyer and the supplier, and thus serve the objective of agency theory by eliminating agency problems.

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CONCLUSION

Performance-based contracting (PBC) has changed the way of doing business and led to a paradigm change in business model for multiple industries and across private and public sectors. This shift is a movement from a traditional contractual approach focusing on return on sales and transactions towards a performance-based contractual approach prioritizing collaboration and return on investment. In PBC, the supplier reward/payment scheme is linked to the achievement of targeted performance outcomes such as system availability, reliability, etc. rather than to each transaction for maintenance, repair, and overhaul. Therefore, PBC has many implications for diverse aspects of supply chain management.

The first essay explores the effects of PBC on SCRES which is one of the top priorities of supply chain stakeholders to address the negative effects of disruptions and make supply chains more robust. This research highlights the key characteristics of PBC and its implications on SCRES. It proposes that with its low term specificity, risk/responsibility transfer, and incentive schemes, PBC has positive effects on SCRES in terms of visibility, risk management, and innovation. It points out the moderating role of risk propensity of the organizations and contract length between PBC and SCRES.

The second essay's overall objective is to develop and test the effects of key PBC characteristics (i.e., reward/payment scheme, increased supplier autonomy, and transfer of responsibilities) on supplier goal commitment. This study extends Goal-setting theory (GST) to determine its significance on supplier goal commitment as PBCs explicitly define the buyer-supplier relationship, linking goals with performance. By underlining this significance, GST also reveals the possible antecedents of goal commitment. This study develops a conceptual model that identifies the key characteristics of PBC and examines their implications on goal commitment of suppliers through the lenses of agency theory, job characteristics theory, and GST. A survey was created to collect data, and structural equation modeling was used to

establish a validated measurement instrument to test the hypotheses of the conceptual model. The findings reveal that key characteristics of PBC have positive effects on the supplier goal commitment, which is crucial for supplier performance. This study also validates the mediating role of goal alignment and felt accountability/responsibility on the goal commitment of suppliers.

The third essay examines the structure of PBC through the lens of Agency Theory framework presents a PBC pricing model that predicts the efficiencies and the benefits of PBC for various contextual conditions. Specifically, the model provides decision insight into the optimal solutions for contract length, reliability investment, and contract pricing strategies, which concurrently maximizes the supplier profit while satisfying the buyer requirements. This study extends the research on post-production support of capital-intensive systems; it also contributes to the growing extant literature on PBC and research on collaborative buyer-supplier relationships in general.

To conclude, this dissertation with three essays investigates the implications of PBC on numerous aspects of logistics and supply chain management. While the first essay applies an exploratory and systems thinking approach and reconciles PBC and SCRES concepts and reveals the relationship between them, the second essay focuses on the behavioral effects of PBC and investigates supplier goal commitment in a PBC context. Lastly, the third essay develops a pricing model for optimal PBC design in terms of pricing, investment, contract length which in turn maximizes supplier profit and satisfies buyer needs. This dissertation provides substantial theoretical and managerial contributions. It extends the theories used and extant literature of the topics and presents new insights for the decision-makers.

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