Chapter 1
Introduction

With the ongoing technological advancements in manufacturing, health delivery systems, information technologies etc., numerous industrial entities become reliant on sophisticated product delivery systems for provision of revenue generating operations. For example, fuel-efficient aircraft engines are essential for airlines to provide affordable transportation services; mining companies operate large interdependent mining equipment units for extraction of hundreds truck loads of ores everyday; oil refineries construct groups of fractionating columns to produce various crude oil products; sophisticated flexible manufacturing systems enable manufacturing companies to machine different types of parts with high efficiency at low costs; data server arrays are the backbone of real-time electronic transaction systems operated by banks and credit card companies; advanced office printing and scanning equipment is indispensable for efficient information collection and dissemination in large companies, universities and government agencies.

There are common characteristics shared by the equipment units of sophisticated product delivery systems. First, the equipment units are mission-critical such that no revenue is generated when the equipment units fail. Second, these units are assumed to operate in a reliable mode with short downtimes relatively to their uptimes. Third, the units are usually of a specialized nature that requires expert maintenance/service providers. It is known for the owner of such systems to outsource the maintenance and repair of her equipment units to an independent supplier of specialized repair services. Therefore the main topic of this paper – the analysis of the contractual details that have to be addressed in the agreement between the system's owner and the supplier of maintenance and repair services.

In this paper we examine the contractual options between the owner (principal, she) of a revenue generating unit and a service provider (agent, he) in a framework of principal-agent economic model. Although our initial framing of the principal-agent problem follows Kim et al. (2010), our analysis is significantly different from Kim et al. (2010) and is much more extensive than their analysis. First, the

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agent is assumed to be risk-neutral or risk-averse in Kim et al. (2010) while our analysis includes risk-seeking agent also. Second, our analysis of the principal-agent contract covers the value of exogenous parameters exhaustively, while Kim et al.'s (2010) assumptions of a reliable equipment unit and negligible downtimes (compared to uptimes) require that the values of certain exogenous parameters fall into a narrow range. Finally and the most important, we derive explicit formulas for optimal principal-agent contract under any market and industry conditions without imposing any additional constraint, while Kim et al. (2010) is able to provide only one explicit formula when Service Time Target Constraint is binding.

In a counter-distinction to Kim et al. (2010) we model the principal-agent system of a risk-neutral principal with risk-neutral, risk-averse, or risk-seeking agent as a Markov process with an undetermined time horizon instead of a contract for a finite horizon normalized to 1. In addition, we replace Kim et al.'s (2010) representation of agent's risk as variance of his revenue stream with a piece wise linear function in a steady state probability of failure as a proxy for a measure of agent's revenue risk.

Our analysis is restricted to a single risk-neutral principal who owns one unit of revenue generating entity and a single agent.