



Management analysis for the space industry



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ABSTRACT

The objectives of this study are to review prior research which analyzes the space industry from management perspectives and to show that there is much more scope to analyze it for providing suggestions about management in the industry growth. There are two clusters of prior research, focusing on risk management and technology management. Certain other research themes are dispersed across several fields and do not form clusters. As conclusions, the two suggestions are provided about those fields that require increased research attention in future; first is organizational behavior to improve efficiency of business operations and to get business opportunities, and second is public support for designing appropriate business environments, which facilitate firms to generate new business in the space industry.

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1. Introduction

The space industry has been attractive for researchers from management perspectives in recent years. The foci of prior research in this industry have included political and legal issues, as well as management issues. As the business environment alters due to an increasing number of new entrants, there is a growing demand for analysis from management perspectives. New entrants attack existing firms by providing competitive products at lower prices and supplying new products and services. The objective of this study is to review prior research focusing on the space industry

from management perspectives and delineate those fields that require increased research attention in future.

There are two main clusters of prior research, which analyze the space industry from management perspectives: risk management and technology management.

Research on risk management is motivated by identifying the causes of space shuttle accidents, and it aims to provide recommendations in order to avoid accidents; the foci of analysis are organizational systems and decision making processes.

On the other hand, technology management research is driven by changes in research interests following the end of the Cold War; researchers have extended their interests from the inside of the organization, to the outside. The main reasons for the change are that firms in the space industry are forced to manage technology in

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consideration of profitability, as governmental subsidies have decreased and new entrants have appeared. Firms have to secure new sources of funding under tight financial restrictions. Some select technical cooperation with external organizations to save research expenses, and others secure new sources of funding by having external organizations utilize existing technology. Along with changes in organizational behavior, researchers' interests began to be directed toward technology management.

As noted, certain other prior research is not included in the two main clusters but there is not sufficient research activity to demarcate a cluster, or clusters.

The overarching aim is to contribute to future research on management for growing space relevant businesses, and on industry policy pursuant of space industry growth-by delineating issues, which have been insufficiently studied. This study develops logic through the following two steps.

Firstly, this study shows that the transition of source of demand in the space industry has added management perspectives to researchers' interest. There is a peculiar characteristic regarding source of demand in the space industry, which is that the proportion of public demand has been higher than private demand. The high percentage of public demand has depended not only on security but also on business characteristics that a huge investment is necessary to build infrastructures. For example, in the case of a communication satellite, government has created infrastructures including relevant knowledge base on the physical nature and phenomena of space, a set of space system such as launch vehicle, and the institutional framework [1]. However, business environments have changed since the 1970s when the Soviet Union withdrew from the competition with the United States [2]. Public investment in the space industry has decreased. Hall [3] describes that the incentives of innovation at NASA changed from winning the space race with the Soviet Union in 1960s to being technology sources of scientific knowledge for space development. In addition to that, new entrants such as SpaceX have come to focus on another dimension as competitive advantages like price reduction since 2000s. The transition of source of demand brought about a change in research focus.

Secondly, this study shows that there is room to accumulate knowledge about business processes and organizational behavior to harness business opportunities in the space industry. For example, reduction of launch costs and miniaturization of satellites have increased business opportunities utilizing space for private demand in recent years. However, there is a lack of research into analyzing business and management issues in the space industry, excepting technology management. Unless knowledge based on analysis of business processes and organizational behavior accumulates, resource allocation for business development will be inefficient, and policy makers have insufficient information in order to provide optimal public support to the industry growth. Therefore, future research is required to analyze business and management issues in the space industry. Such research could offer

suggestions about the location of business opportunities and enable optimal resource allocation for business development and industry growth.

In the next section, prior research on risk management is reviewed. Then, in section three, prior research on technology management is reviewed. In section four, prior research about other factors, which influence business performance, is reviewed. In the final section, this study concludes that future research is required to accumulate knowledge of analysis about business processes and organizational behavior from management perspectives.

2. Risk management

Risk management has been one of the main issues in prior research since the space shuttle accidents. The focus of research is placed on the reasons why the accidents happened, and the objective is to give suggestions about management for building an organizational system designed to avoid future accidents. Prior research points out two causes of organizational failure which led to the accidents. First is project structure, which makes information sharing difficult, and second is complex decision making processes under political pressure and time constraints.

Table 1 lists major research in the risk management domain. Firstly, Vaughan [4] and Carroll et al. [5] analyze project structure for launching the space shuttle and regard causes of the accidents as project structure, which makes information sharing difficult. Vaughan (1988) focuses on the Space Shuttle Challenger accident and analyzes regulating systems for safety at NASA. Carroll et al. [5] analyze project processes of organizational redesign at NASA.

Vaughan [4] analyzes official documents gathered by the Presidential Commission on the Space Shuttle Challenger Accident. Data for analysis is collected by interviews with organizational members who are responsible for regulating system for safety at NASA and journalists who investigated NASA's safety system. The conclusion is that the Challenger accident was caused by the regulating system for safety, which failed to identify technology problems. The reason the regulating system missed critical problems is that it lacks an appropriate mechanism for sharing information about technology problems. There are three units internal to NASA and external contractors, which are involved in regulating system for safety. Internal units and external contractors are in a difficult position to point out technology problems. As the internal units are interdependent with members who cause technology problems, it is difficult for them to objectively and strictly point out their problems. On the other hand, as external contractors are autonomous organizations that are independent from NASA, it is difficult for them to obtain information, which is detailed enough to recognize technology problems. Therefore, both organizational interdependence and dependence obscure technology problems, which are causes of space shuttle accidents.

Carroll et al. [5] focus on project processes of organizational redesign, which were carried out at NASA after the Columbia

Table 1
Major prior research in the risk management domain.

Category	Literature	Sample	Main conclusions
Risk management	Vaughan [4]	The space shuttle accidents.	Both autonomous and interdependence of relevant organizations obscure effective regulation of causes of accidents at NASA.
	Carroll et al. [5]	The space shuttle accidents.	The misfit between organization design and task environment causes the space shuttle accidents.
	Hall [3]	The space shuttle accidents.	Reducing budgets causes shortage of management resources, which makes it difficult for engineers to solve problems carefully.
	Feldman [6]	The space shuttle accidents.	Emphasis on objective data causes overconfidence in quantitative data and ignorance of qualitative data, leading to overlook the root cause of problems causing accidents.

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