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# Application of Ambidexterity in Technology Innovation Management: A Literature Review

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**Abstract:** This paper aims to explore key theories in technology innovation management, including ambidexterity, the tragedy of the commons, the negative spiral, and the knowledge spiral, and analyze their practical applications in management. By balancing exploration and exploitation, effectively managing public resources, avoiding negative spirals, and dynamically managing knowledge, firms can achieve continuous innovation and competitive advantage in complex and rapidly changing environments. This study integrates research from various scholars to provide valuable theoretical foundations and practical guidelines for technology innovation management.

**Keywords:** Ambidexterity; Tragedy of the Commons; Negative Spiral; Knowledge Spiral

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## 1. Introduction

In today's rapidly changing technological environment, organizations face the challenge of balancing the exploration of new knowledge with the exploitation of existing knowledge. Ambidexterity theory posits that organizations must engage in both exploration and exploitation activities to maintain long-term competitiveness. This theory, first introduced by March, defines exploration as the pursuit of innovation and new knowledge, while exploitation refers to the application and refinement of existing knowledge.

The balance issue in technology innovation management is particularly prominent because organizations must continuously adapt and innovate in fast-changing markets. O'Reilly and Tushman highlight that high-tech companies must balance the development of new products with the improvement of existing products to ensure sustained market competitiveness. This balance requires strategic decision-making in resource allocation, as well as effective management of organizational culture and leadership.

In addition, other key concepts in technology innovation management, such as the tragedy of the commons, negative spirals, and knowledge spirals, also have profound impacts on management practices. The tragedy of the commons theory, proposed by Hardin, indicates that shared resources will be overused in the absence of effective management, leading to resource depletion. This theory is also reflected in technology innovation, such as in the issues of resource sharing and intellectual property protection in open-source projects.

Ostrom's research suggests that establishing clear rules and incentive mechanisms can effectively mitigate the tragedy of the commons. In technology innovation, managers need to develop reasonable resource allocation and knowledge-sharing policies to prevent the overconsumption of innovation resources. Research by Amabile and Kramer shows that negative spirals are common in high-pressure and high-risk technology innovation projects, where managers need to take proactive psychological interventions and incentive measures to help teams break out of negative spirals and rebuild confidence and motivation.

## 2. Literature Review

### 2.1 Overview of Ambidexterity Theory

Ambidexterity theory, first proposed by March, describes the dynamic balance organizations must achieve between exploring new opportunities and exploiting existing resources. March (1991) defines exploration as activities involving innovation and new knowledge acquisition, while exploitation refers to the application and refinement of existing knowledge. This theory emphasizes that organizations need to balance these activities to ensure long-term adaptability and competitiveness. Over the years, ambidexterity theory has evolved, with scholars contributing various perspectives and extensions that highlight its relevance across different organizational contexts.

Gibson and Birkinshaw (2004) further developed ambidexterity theory by introducing the concepts of structural ambidexterity and contextual ambidexterity. Structural ambidexterity achieves balance through the separation of organizational structures, with dedicated departments or teams responsible for exploration and exploitation, respectively. This structural approach often involves creating semi-autonomous units within an organization that focus exclusively on either exploration or exploitation. For instance, a firm may have an R&D department dedicated to exploratory projects while having a separate production unit focused on refining existing products.

## 2.2 Ambidexterity in Technology Innovation Management

In technology innovation management, ambidexterity theory is of significant application value, helping organizations balance the exploration of new knowledge and the exploitation of existing knowledge to achieve continuous innovation and competitive advantage. O'Reilly and Tushman (2013) argue that technology firms must balance the development of new products with the improvement of existing products to ensure market competitiveness and business sustainability. This balance involves not only reasonable resource allocation but also adjustments in organizational structure and culture.

Birkinshaw and Gupta (2013) found that ambidexterity in technology innovation management primarily manifests in three aspects: resource allocation, organizational structure, and cultural support. In terms of resource allocation, firms need to distribute limited resources between R&D and marketing to ensure stable revenue generation from existing products while continuously developing new products. Research indicates that the effectiveness of resource allocation directly impacts innovation outcomes and market performance.

Regarding organizational structure, Gibson and Birkinshaw (2004) introduced the concepts of structural ambidexterity and contextual ambidexterity. Structural ambidexterity achieves balance by allocating exploration and exploitation activities to different departments or teams, which is common in high-tech firms.

## 2.3 The Tragedy of the Commons and Technology Innovation Management

The tragedy of the commons theory, proposed by Hardin, describes the phenomenon where shared resources are overused in the absence of effective management, leading to resource depletion. This theory also applies to technology innovation management, where the sharing and management of innovation resources face similar challenges.

A typical feature of technology innovation is the sharing and collaboration of knowledge and technology. Von Hippel (2005) points out that models such as open-source software development, open innovation, and user innovation communities are based on the sharing and collaboration of knowledge, but they are also prone to the tragedy of the commons. In these models, participants may overuse public resources for their own benefit, leading to the depletion of innovation resources.

In high-tech firms, the tragedy of the commons can also occur in R&D collaborations and alliances. Lavie and Rosenkopf (2006) found that trust and transparency between partners in technological alliances are crucial for preventing resource overuse. They discovered that establishing strong cooperation agreements and sharing rules can effectively reduce the occurrence of the tragedy of the commons, ensuring smooth cooperation and the sharing of innovation outcomes.

## 2.4 Impact of Negative Spirals on Technology Innovation

Negative spirals refer to the phenomenon where team or individual morale and performance gradually decline when facing failures and setbacks. This phenomenon is particularly common in high-pressure and high-risk technology innovation projects. Amabile and Kramer's research shows that managers need to take proactive psychological interventions and incentive measures to help teams break out of negative spirals, rebuild confidence and motivation.

Additionally, negative spirals lead to technology lock-in. Arthur (1989) pointed out that when firms invest heavily in a particular technology, they tend to continue investing due to sunk cost phenomena, even if the technology becomes outdated or uncompetitive. This phenomenon limits firms' ability to explore and apply new technologies, reducing market adaptability and innovation capability.

To avoid the negative impact of negative spirals on technology innovation, firms need to adopt proactive management strategies. Benner and Tushman (2003) suggest that by developing dynamic capabilities, firms can flexibly respond to market changes and technological advancements, avoiding negative spirals. Dynamic capabilities include identifying new opportunities, rapidly adjusting strategies, and reconfiguring resources, which are crucial for technology innovation.

## 2.5 Application of the Knowledge Spiral Model in Technology Innovation

In the knowledge economy era, managing knowledge has become a primary focus for firms, and implementing knowledge management strategies must align with strategic goals to achieve maximum benefits (Jiang Cuqing et al., 2005). The knowledge spiral model, proposed by Nonaka and Takeuchi, describes the dynamic conversion process between tacit and explicit knowledge. This model has significant application value in technology innovation management. Through effective knowledge management strategies, firms can continuously acquire new knowledge from practice and transform it into innovative outcomes. For example, Toyota continuously improves its production processes through the knowledge spiral model, achieving efficient innovation management.

The knowledge spiral model, proposed by Nonaka and Takeuchi (1995), describes the dynamic conversion process between tacit and explicit knowledge. In technology innovation, the knowledge spiral model provides an effective framework, helping firms drive innovation and competitive advantage through knowledge creation, sharing, and application.

The core of the knowledge spiral model is the SECI model, comprising socialization, externalization, combination, and internalization

processes. Through these four processes, tacit and explicit knowledge continuously convert, forming a dynamic knowledge creation system (Nonaka & Takeuchi 1995).

## 2.6 Comprehensive Analysis: Balancing Exploration and Exploitation

In technology innovation management, balancing exploration and exploitation is crucial for achieving continuous innovation. Gibson and Birkinshaw propose that by building ambidextrous capabilities, organizations can flexibly respond to exploration and exploitation needs in different environments. This balance requires strategic support, comprehensive coordination in organizational culture, structure, and leadership.

Balancing exploration and exploitation affects not only firms' short-term performance but also their long-term development capabilities. Raisch and Birkinshaw (2008) pointed out that firms need to simultaneously support exploration and exploitation in resource allocation and management practices to achieve organizational ambidexterity. This ambidexterity helps firms maintain flexibility in rapidly changing markets and enhances innovation capabilities.

However, overemphasizing exploration or exploitation brings potential risks. Gupta, Smith, and Shalley (2006) pointed out that overemphasizing exploration can lead to resource waste and short-term performance decline, while overemphasizing exploitation can lead to innovation stagnation and slow market response. Therefore, firms need to find a dynamic balance between exploration and exploitation to achieve continuous innovation and performance improvement.

## 3. Conclusion

Ambidexterity, the tragedy of the commons, negative spirals, and knowledge spirals are complex and interconnected concepts in technology innovation management. By systematically studying and applying these theories, managers can better understand and address the challenges in technology innovation, achieving continuous innovation and competitive advantage.

Overall, ambidexterity, the tragedy of the commons, negative spirals, and knowledge spirals provide rich theoretical foundations and practical guidelines for firms in technology innovation management. By balancing exploration and exploitation, effectively managing public resources, avoiding negative spirals, and dynamically managing knowledge, firms can achieve continuous innovation and competitive advantage in complex and rapidly changing environments. These theories not only reveal key challenges in technology innovation management but also offer corresponding management strategies and methods, providing valuable references for firms' innovation practices.

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