Trial and error mindset of R&D personnel and its relationship to organizational creative climate

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A R T I C L E   I N F O

A B S T R A C T

This paper aims to reveal the mindset of corporate R&D personnel's behavior when they break through a difficult problem. In addition, we examine the relationship between that mindset and the organizational creative climate. We defined trial and error behavior as the process of continuous knowledge creation and acquisition until success is achieved, and constructed a model. We distributed a questionnaire survey on invention and discovery activities to 706 corporate R&D personnel who had received awards from leading Japanese science academies. The results of qualitative data analysis revealed six mindsets and approaches: (i) elimination approach, (ii) idea exploration-oriented mindset, (iii) cause exploration-oriented mindset, (iv) repetitive approach, (v) passion for trial and error, and (vi) experience-oriented mindset. In addition, the results showed that the creative climate did not have a significant impact on the exploration-oriented trial and error mindsets of R&D personnel, such as with (ii) and (iii). Technology-oriented firms cannot develop innovative achievements if they are not willing to encourage risk taking. Our findings indicate that managers should try to understand their employees' trial and error mindsets and create an effective organizational climate that goes beyond an organizational creative climate.

1. Introduction

Innovative achievements such as inventions and discoveries of new things by R&D personnel are very important for corporate growth. To encourage and forecast these achievements, it is necessary to understand the activities of R&D personnel [1,2]. Two analytical perspectives are dominant in academic research in terms of understanding the activities of R&D personnel; one is concerned with individual behavioral mechanisms [3], and the other with the organizational environment that affects individual behavior and the absorptive capability of knowledge [4]. In the process of invention and discovery, R&D personnel often face difficult problems that they need to overcome. Regarding individual behavioral mechanisms, studies have been conducted on R&D personnel's personal inspirations [5], intrinsic motivation [6,7], cognitive types [8], and serendipity [9] as factors contributing to the ability to discover important things by accident. However, few studies have been done that focus on the detailed activities of R&D personnel, including their everyday trials at work, regardless of the importance of understanding individual behavioral mechanisms.

R&D management studies have recently emphasized the importance of managing R&D personnel's trial and error activities [9–11], which consist of detailed tasks of R&D personnel. In Webster's dictionary, trial and error is "a finding out of the best way to reach a desired result or a correct solution by trying out one or more ways or means and by noting and eliminating errors or causes of failure and also means the trying of one thing or another until something succeeds." The concept of trial and error includes the process of knowledge creation to find the key knowledge that can lead to a breakthrough. This indicates that the concept of trial and error is a kind

of knowledge creation that includes repetitive actions carried out to reach a breakthrough. This paper focuses on the concept of trial and error and defines it as a continuous knowledge creation and acquisition process until something succeeds.

Many aspects of the organizational environment have been studied to determine the important catalysts that influence R&D personnel's behavior. These aspects include leadership [12–14], circumstances that influence R&D personnel, such as the organizational climate affecting the behavior of personnel [15–21], having a team leader [22], and corporate systems implemented to improve R&D personnel creativity [23]. In addition, the importance of team communication [24–26] and closeness of partners [27] is also widely acknowledged in research on factors leading to breakthroughs. These studies are valuable for analyzing the relationship between organizational factors and R&D personnel output. However, there is a need to further analyze organizational factors and detailed trial and error activities of R&D personnel in order to forecast an effective people management strategy in R&D settings.

Based on this background, we set two research questions to promote R&D management research focusing on generating innovative achievements. The first question was intended to determine what kind of mindset highly successful R&D personnel had when carrying out trial and error activities. The second one was intended to determine to what extent organizational factors including the organizational climate and the corporate system affected R&D personnel's trial and error behavior. The purpose here is to answer these questions. We set two research perspectives: trial and error behavior and the organizational creative climate. This paper first proposes a model of trial and error behavior based on knowledge creation behavior. Next, we analyze a questionnaire survey we distributed based on the model to find the reality of the trial and error mindset of accomplished corporate researchers who had made valuable inventions and discoveries. Then we analyze the relationship between R&D personnel's mindsets and organizational creative climate using structural equation modeling analysis.

2. Research perspectives

2.1. Trial and error behavior

Although trial and error behavior is relevant to the concept of knowledge creation, the relevant study focusing on corporate R&D personnel is in an early phase of academic research [9]. In general, researchers have expert knowledge and experience, and this includes tacit knowledge to "connect" their knowledge and experience. In problematic situations that the researchers have already dealt with, they often try to solve the problems using their existing experience and knowledge [28–30]. However, if researchers face a problematic situation that they have never experienced before, they need to carry out trial and error activities outside their realm of experience and knowledge.

Gourlay [31] addressed the concept of knowledge creation by organizing knowledge types using previous studies about knowledge concepts. He categorized knowledge by 'knowledge-what' as decontextualized knowledge and 'knowledge-how' as processual knowledge. In R&D settings, trial and error regarding knowledge-what corresponds to cause investigation. This means that researchers seek to generalize decontextualized knowledge by investigating the bottleneck of the problematic situation from various perspectives. In contrast, knowledge-how corresponds to exploring research methods or approaches. This means that researchers seek process-oriented knowledge [32] by searching for ways and strategies to improve the problematic situation. The quality of both types of knowledge depends on the definition of problematic situations. Learning has dealt with incremental improvements to adapt to an environment in technology management studies [33–36]. Argyris and Schon indicated the importance of problem definition using the term double-loop learning [37] when adapting to or creating an environment. As we already defined, trial and error is a process of continuous knowledge creation in which it is necessary to sophisticate a kind of "space" of thoughts consisting of knowledge and experience that a person already has. These studies about knowledge creation were the basis for three behavioral points we set that illustrate how to cross the knowledge space that someone already has: cause investigation, method and approach exploration, and problem definition.

Researchers generally aspire to achieve a goal using their own experiential knowledge and new knowledge gained through trial and error under the proper balance of three behavioral patterns [28]. This consists of four basic behaviors: implementing an idea with no specific strategies, exploring new approaches and implementing them, exploring new causes and trying to overcome hurdles, and exploring new causes and new approaches and implementing them. Researchers conduct these basic behaviors again and again, thereby creating knowledge. These strategies to traverse one's own known space lead to several potential types of trial and error. For example, one researcher may aspire to achieve a goal using their own experiential knowledge and new knowledge acquired through the trial and error of cause investigation and problem definition. Another researcher may aspire to achieve a goal by using their own experiential knowledge and new knowledge gained from the trial and error of method exploration and cause investigation under the same problem. The important points of trial and error behavior are related to retaining or changing existing ideas and exploring approaches for problem solutions or the cause of the problem. Thus, the ways of trial and error will differ depending on how the set of trial and error strategies was determined.

2.2. Organizational creative climate

The belief that a positive organizational climate is an important factor of success in R&D companies is widely accepted (e.g. [15]). Organizational climate is defined as an attribute of the organization — a conglomerate of attitudes, feelings, and behaviors that characterize life in the organization [16,17]. The concept of organizational climate refers to behavioral patterns that emerge on a daily basis in the organizational environment. Individuals in the organization experience, understand, and interpret these patterns [20,38]. Therefore, individuals can be affected by the climate and can change their motivation and behavior.