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Managing Exploration Persistency in Ambidextrous Organizations -Case of Fujifilm and Kodak-

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Abstract

The concept of ambidextrous organization, which is allowing exploration and exploitation to coexist within an organization, has attracted considerable interest and is useful in understand the corporate transformation process. We aim to advance the framework of ambidextrous organization by incorporating the aspect of exploration persistency. Our in-depth case study revealed contrasting persistence of exploration for new technology and new business between Fujifilm and Kodak through analysis of patent data from 1982 to 2012. Also, we discuss how the degree of exploration persistency is influenced by the effects of exploitation and knowledge accumulation within ambidextrous organization.

Keywords: Fujifilm, Kodak, technical change, ambidextrous organization, exploration persistency

1. Introduction

Fujifilm and Kodak competed for photographic film business until the global demand for film plunged with the advent of digital cameras (digicam) in the 2000s. The fates of these two companies differed: Kodak filed for bankruptcy protection in 2012 but Fujifilm developed new businesses to become a "total healthcare company" centered on medical care. Having competed for the same business over many years, they had similar core technologies. Their top five technical fields in terms of cumulative patent applications between 1983 and 2012 were identical: optics, audio-visual, textile machines, basic materials, and computers. The changes in their ratios of applications in these five fields followed similar patterns and they displayed similar patent application behaviors while retaining similar core technologies, as described later. Even if companies have the same capacity at some time point and compete in the same market environment, their fates may differ.

Some recent academic research on these two companies has been published and valuable lessons can be learned from investigation of these companies. For example, Kodama and Shibata (2016) proposed the concept of knowledge convergence through boundary vision from an in-depth case study of Fujifilm. Also, Ho and Chen (2018) suggested there was a systematic way for incumbent firms to navigate technological disruption by comparative case studies of Fujifilm and Kodak. They showed that disruptive technological change does not necessarily render all technological competences embedded in a firm's products obsolete. In addition, Shibata *et al.* (2019) advanced the framework of ambidextrous organization by incorporating the concept of product substitutability through an in-depth case study of Fujifilm, and they showed the corporate transformation process can be understood effectively from the perspective of ambidextrous organization.

This paper aims to advance the framework of ambidextrous organization through a comparative case study of Fujifilm and Kodak by incorporating the aspect of persistency. An ambidextrous organization exhibits simultaneous exploration and exploitation. Exploration, an innovative corporate activity, involves identifying the seeds of new businesses and/or markets and nurturing them. Exploitation entails refinement and development of existing knowledge, know-how and experience accumulated in a company's current core businesses to develop improved products and services (March, 1991; O' Reilly and Tushman, 2004; He & Wong, 2004; Govindarajan & Trimble, 2005; Markides & Charitou, 2004; Adler *et.al.*, 1999; Holmqvist, 2004; Katila & Ahuja, 2002). Within the ambidextrous concept, compared with exploitation, exploration is an experimental or trial-and -error process carrying the nature of uncertainty.

Therefore, undertaking exploration requires time and costs. This nature of exploration requires difficult decision making regarding whether the company should maintain its original exploration and direction. Companies have to change their direction of exploration if they realize they are heading in the wrong direction. The degree of pursuing a direction with a definite goal in exploration is called exploration persistency in this study.

Also, an ambidextrous organization has the natural tendency to transfer some management resources from exploration to exploitation due to short term results of exploitation, compared with exploration which requires long term endurance. As a result, exploitation activity tends to hinder an ambidextrous organization from doing exploration activity persistently. Therefore, shedding light on exploration persistency will be useful for advancing the framework of ambidextrous organization.

On the other hand, there have been studies of the persistency of innovation in general, which has long remained an important research topic (Guarascio and Tamagni. 2019). At the firm level, innovation persistency can be understood as a fundamental source of long-run competitive advantage. However, existing research on innovation persistency has not distinguished between exploration and exploitation although there is a broad consensus that exploration and exploitation are necessary different elements in a firm's innovation process (March, 1991, 1996, 2006). Therefore, more in-depth consideration focusing on exploration persistency is useful for advancing our understanding of innovation persistency.

Nevertheless, existing literature has not fully investigated exploration persistency in the context of an ambidextrous organization. Our aim is to propose the effectiveness of exploration persistency to enhance the framework of ambidextrous organization as well as innovation persistency. To illustrate this, the present paper mainly draws on patent data to assess the degree of persistency in exploring new technology. Through case studies of Fujifilm and Kodak, we found contrasting strategies of persistency of exploration from as early as the 1980s until 2010. For example, although Kodak and Fujifilm embarked in the same direction of exploration toward digital cameras and medical care, Fujifilm maintained a persistent direction of exploration, whereas Kodak frequently changed direction, as described later. Thereby, this study provides an alternative explanation to the very well-studied and extensively discussed Kodak and Fujifilm case.

Here, we show persistency matters when a company explores new technology and new business as an ambidextrous organization. Accordingly, incorporating this aspect of exploration persistency should advance the usefulness of the ambidextrous concept. Also, we argue how exploration persistency is influenced within an ambidextrous organization, and we discuss two factors, a knowledge accumulation effect and an exploitation effect.

The rest of this paper is structured as follows: Section two describes theoretical considerations while reviewing related studies. Section three explains our methods and data. Section four demonstrates an in-depth case study using patent data and shows that unlike Kodak's, Fujifilm's exploration was persistent. Section five summarizes findings and discusses the effectiveness of the aspect of exploration persistency.

2. Ambidextrous organization and exploration persistency

2.1 Ambidextrous organization

Sustainable corporate growth requires two types of corporate activities, exploration and exploitation, which differ in objective and character (March, 1991). Exploitation addresses issues including efficiency, control, certainty, and variance reduction, whereas exploration addresses research, discovery, autonomy, and innovation (March, 1991). Biases toward exploration will have a negative impact on company profitability due to the costs and time involved. Conversely, biases toward exploitation can enhance short-term profits while being detrimental to long-term competitiveness, due to neglect in fostering new business. Thus, balance between exploration and exploitation is important (McCarthy and Gordon, 2011; Gibson and Birkinshaw, 2004).

In general, however, biases towards exploitation can occur easily, as exploitation is directly linked to business performance. Rather than engage in time- and resource-consuming exploration, inertia arises by focusing on improving and upgrading existing core businesses. Yet, without undertaking exploration, firms may fail in the face of change. Organizational ambidexterity refers to the ability of an organization to both explore and exploit (O'Reilly and Tushman, 2013). Achieving both is difficult, as each requires different skills, capability and structures.

Structural ambidexterity requires the separation of divisions specializing in exploration and exploitation of a firm's main business, with activities of these divisions pursued autonomously and concurrently. Because the objectives and types of activities involved in exploration and exploitation differ, the mechanisms for incentivizing staff, employee characteristics, leader characteristics, business processes, and learning and organizational culture should differ (Junni et al., 2015; Mom et al., 2015; Dixon, Meyer and Day, 2007). For instance, ambidextrous organizational culture consisting of diversity and shared vision has been conceptualized (Wang and Rafiq, 2012). Lack of a suitable mechanism connecting exploration and exploitation activities may result in isolation of the former from the company's main lines of business, leading to interdivisional conflicts within a company.

Also, structural ambidexterity requires skilled management of strategic contradictions (Smith and Tushman, 2005) and top management shared leadership (Mihalache et al., 2014). This organizational model should focus on creating synergies rather than discord between divisions. Some studies reported the importance of upper management in presenting organizational visions to both entities and supervising the allocation of resources (Tushman and O'Reilly, 1997; Lubatkin et al., 2006). Others emphasized the importance of information sharing and communication by middle management and front end staff (Govindarajan et al., 2005).

Although studies of structural ambidexterity have not yielded completely consistent results, they generally confirm that a combination of exploration and exploitation is positively associated with the sustainable competitiveness of a company (He and Wong, 2004; Govindarajan and Trimble, 2005; Junni et al., 2013; Turner and Lee-Kelley, 2012).

Also, two types of ambidextrous organizations, the cannibalistic type and the complementary type, have been proposed, and it has been shown how these two types of ambidextrous organizations effectively explain the corporate transformation process of Fujifilm (Shibata *et al.*, 2019). The ambidextrous concept has proven to be useful for understanding transformation processes.

This paper aims to contribute to these existing studies by shedding light on the role of persistency during exploration.

2.2 Nature of exploration

Studies of the relationship between organizational competency and exploration of closely related areas revealed that companies form structured internal organizational routines to increase efficiency (Cyert and March, 1963; Nelson and Winter, 1982; Cohen and Levinthal, 1990; Singh and Fleming, 2010; Benner and Tushman,2002; Rothaermel and Deeds, 2004)) and end up focusing on activities associated with closely related areas, limiting their exploration to certain areas.

The explorations of successful companies have a path dependency naturally biased toward closely related technologies and knowledge already accumulated (Helfat, 1994; Stuart and Podolny, 1996). Consequently, products released by companies that build on past achievements tend to be more similar to their existing products than products released by start-up companies (Martin and Mitchell, 1998; Benner and Tushman,2002).

Companies foster innovation by technically exploring new areas that differ from those of their core technologies. Exploration activities in closely related areas are considered advantageous to strengthen and refine a company's accumulated core technologies and competencies. However, companies may become attached to their accumulated competencies, despite change in the external environment demanding new technologies. Thus, core technologies may inhibit flexible responses to change and ultimately bring about rigidity. Companies in this situation are said to have fallen into "competency rigidity" or a "competency trap" (Leonard-Barton, 1992; Levitt and March, 1988). Therefore, companies must broaden their exploration activity beyond closely related technologies. However, this involves costs and uncertainties. Uncertainties in activities involving technological innovations are driven by the exploration activity itself (Fleming, 2001).

To describe uncertainties caused by exploration activities, several frameworks have been proposed. One involves exploration depth and exploration scope (Katila and Ahuja, 2002). Depth refers to the frequency at which accumulated knowledge is used, and scope reflects the degree to which new knowledge is sought. Excessively wide or deep explorations are counterproductive to product development, whereas explorations with a certain degree of both scope and depth are the most effective for product development (Katila and Ahuja, 2002).

Previous studies have attempted to classify exploration scope, depending on whether an exploration crosses certain technological and organizational boundaries (Rosenkopf and Nerkar, 2001). Crossing a technological boundary to integrate technologies in different technical areas and crossing an organizational boundary to cooperate with different organizations require different skills, know-how, and knowledge. Therefore, analyses of exploration activity should distinguish between explorations of technology and organization, and by using a two-dimensional matrix exploration activity can be classified into four types (Rosenkopf and Nerkar, 2001). For example, exploration beyond both technological and organizational boundaries and exploration of technologies within an organization in a technical area different from its core technologies constitute different types of exploration demanding different skills and know-how.

2.3 Research gap

There have been many studies concerning ambidextrous organization and the nature of exploration. However, these existing studies do not fully explain why companies still fail with exploration. For example, as our in-depth case study describes later in this report, both Kodak and Fujifilm embarked in the same direction of exploration toward digital cameras and medical care. They both explored identical technological and business areas. However, their fates differed. Existing studies on ambidextrous organization and exploration do not fully explain why they cause different fates. There is a gap to be bridged between existing academic literature and the actual business phenomenon. This means the necessity of pursuing another dimension to explain their different fates. We argue that it must be persistency in exploration by ambidextrous organizations which has been overlooked and not fully investigated in existing literature. Actually, Kodak and Fujifilm showed contrasting persistency of exploration. The research gap this study aims to bridge is whether or not exploration persistency matters to ambidextrous organizations, and thereby this study provides an alternative explanation to the fates of Kodak and Fujifilm.

Also, this study can be positioned in the intersection of research on innovation persistency and ambidextrous organization.

The topic of persistence in innovative activities has been discussed in previous studies. Any firm that consistently obtained patents in a certain field of technology was regarded as persistent (Malerba and Orsenigo, 1999; Suzuki and Kodama, 2004). Previous studies suggested to maintain innovative activities, persistence rather than R&D expenditure is important (Cefis and Orsenigo, 2001; Suzuki and Kodama, 2004). Also, previous studies have discussed effects of persistence such as 'knowledge accumulation' (Malerba and Orsenigo, 1999; Suzuki and Kodama, 2004). Thus, persistency matters for innovative activities in general.

On the other hand, there is broad academic consensus that innovation activities consist of two different elements, exploration and exploitation (March, 1991, 1996, 2006). An ambidextrous organization employs exploration and exploitation in parallel, and there must be two types of persistency, exploration persistency and exploitation persistency. Existing studies on persistency have not investigated exploration persistency from the specific aspect of persistency. Therefore, this study focused on exploration persistency within the context of ambidextrous organizations, which can be positioned in the intersection of these research areas.

2.4 Exploration persistency and Exploitation effect within ambidextrous organization

Here, we define exploration persistency as maintaining an original exploration area and direction, regarded as the degree of pursuing and insisting on the same direction with a definite goal within the ambidextrous organization. Similarly, we define exploitation persistency as maintaining the current technology and business domain.

In the case of exploitation, inertia arises by focusing on improving and upgrading current core businesses, and bias toward exploitation can occur easily (McCarthy and Gordon, 2011; Gibson and Birkinshaw, 2004). In this sense, by exploitation persistency, maintaining the current technology and business is natural. Persistency becomes more important when a company explores new technology or seeks new business, because exploring new areas demands costs rarely retrieved in the short term, compared with exploitation.

In particular, we argue that ambidextrous organizations experience the exploitation effect, which is a unique force working in ambidextrous organizations that impedes exploration. In an ambidextrous organization, exploitation of core business can bring short term results while exploration requires long term endurance (McCarthy and Gordon, 2011; Gibson and Birkinshaw, 2004). In theory, this asymmetry between exploration and exploitation tends to induce a transfer of management resources from exploration to exploitation, as a result hindering exploration. Thus, existence of exploitation activity itself has a tendency to weaken the degree of exploration persistency within an ambidextrous organization, which is referred to as the exploitation effect in this study. The strength of an exploitation effect will increase the difficulty of decision making about exploration persistency.

Therefore, exploration persistency needs to be managed carefully within an ambidextrous organization. This study proposes that managing exploration persistency matters for an ambidextrous organization, and illustrates the validity and usefulness of exploration persistency through a case study of Fujifilm and Kodak.

3. Method and Data

This study has exploratory aspects, including extracting details about the organizations involved in corporate transformation, gathering data regarding processes associated with these activities, and analyzing these data. The method included case study analysis using patent data. This research methodology gathers and analyzes abundant data, while introducing a new theoretical framework (Eisenhardt, 1989).

We analyzed the direction of exploration by using patent data (Dutta and Weiss, 1997; Henderson and Cockburn, 1994; Rosenkopf and Nerkar, 2001). Patents contain information about the inventor, the company to which the patent is assigned, and technological antecedents of the invention, all accessible in computerized form. Every patent is assigned to a technical class, which we used to identify the technical areas being explored by the company.

We analyzed patent data as follows.

Most existing studies of technological diversity or technological concentration by companies employ an index based on the weighted sum of shares of each technological category. The pioneering papers in this field (Traijtenberg *et. al*.,1997 and Hall *et. al*., 2001) use Herfindahl index of the concentration of USPTO patent classes. This index is basically similar to Shannon index or Simpson index which is calculated from the 'variety' and 'balance' of given categories. However, Stirling, 2007 pointed out that "variety and balance cannot be characterized without first considering disparity". Disparity refers to the manner and degree in which the elements may be distinguished (Runnegar, 1987). It seems that Traijtenberg *et. al*. had made an implicit assumption that the "classes" in the USPTO patent classification system are distinguishable and the inner product between them equal to zero. But the problem with IPC system which we can use for this study from this point of view is somewhat overlapping top "sections". The "sections" in IPC system are defined like this:

Section A: Human Necessities

Section B: Performing Operations

Section C: Chemistry

Section D: Textiles

Many industrial technologies can be classified into multiple sections. For example, pharmaceutical technologies are typically classified into section A and section C. In order to address this problem, we converted IPC codes into relevant industrial classes following Schmoch, 2008 in the first step. Then, in the second step, we calculated Herfindahl index based on distribution among the classes to obtain a diversity index for each firm by year.

Patent data was drawn from European Patent Office Worldwide Patent Statistical Database (PATSTAT) 2017 spring edition. Our sample comprises patent applications by Fujifilm (including Fuji Photo Film) and Kodak from 1982 to 2012. We extracted 172,646 patent applications by Fujifilm and 60,033 by Kodak. Most of these patents have multiple International Patent Classification (IPC) subclass (4-digit) codes (1.97 codes per patent on average). We used IPC-Technology Concordance Table (January 2015 edition) published by World Intellectual Property Organization (WIPO) in order to integrate IPC subclass codes into 35 broad technology fields defined by WIPO. Also, Herfindahl–Hirschman Index(HHI), a commonly accepted measure of concentration, was calculated by squaring the share of each technology field and then summing the resulting numbers.

In addition, our analysis of Fujifilm included semi-structured interviews with executives, internal information provided by Fujifilm, data prepared by Fujifilm for the public, and publicly available materials including books and magazines written by third parties. The analysis of Kodak included publicly available materials, books, magazines, and academic papers.

Because, the aim of this study is to propose a new theoretical aspect and framework, it has an exploratory nature. Therefore, qualitative analyses including interviews can effectively complement quantitative patent data analysis, thereby enrich in-depth case analysis through gathering data widely from multiple resources.

The semi-structured interviews involved two Fujifilm executive directors and five directors of related departments, conducted July 17, 2015, January 29, 2016, and July 14, 2016. Before the interviews, we developed a profile of the company using public sources. The interview goal was to understand Fujifilm's corporate transformation process as a whole from film company to digital camera and health care company in terms of strategy and organization. The main topics of semi-structured interviews were how to deal with emergence of digital cameras and how to develop new technologies and business through exploration.

To obtain a comprehensive picture of the company, we also spoke with staff in related functional areas. Each interview lasted over 1-hour, with some individuals interviewed multiple times. Interviews were recorded, and transcribed by a professional service. When clarification was necessary, interviews were followed-up by email. The report, prepared based on information from the interviews and written sources, was reviewed by Fujifilm to ensure validity.

Table 1. Cumulative numbers of Fujifilm patent applications in technical areas ranked 1 to 13 (1982 to 2012)

Technical area	Cumulative number	Rank	Share	Accumulated share
Optics	109326	1	30.4%	30.4%
Audio-visual	47790	2	13.3%	43.7%
Textile machines	36806	3	10.2%	53.9%
Basic materials	19099	4	5.3%	59.2%
Computer	17007	5	4.7%	63.9%
Semicon	15800	6	4.4%	68.3%
Macromolecular	14465	7	4.0%	72.3%
Other machines	13453	8	3.7%	76.1%
Surface tech	12356	9	3.4%	79.5%
Medical tech	10837	10	3.0%	82.5%
Measurement	9826	11	2.7%	85.3%
Organic chem	8973	12	2.5%	87.8%
Elec_mach	8678	13	2.4%	90.2%

Technical areas ranked 1 to 5 represent the core areas of Fujifilm. About 2/3 of patent applications during this period were in technical areas 1 to 5.

Technical areas ranked 6 to 13 represent peripheral technical areas of Fujifilm.

Table 2. Cumulative numbers of Kodak patent applications in technical areas ranked 1 to 13 (1982 to 2012)

Technical area	Cumulative number	rank	share	Accumulated Share
Optics	36203	1	31.2%	31.2%
Textile machines	14226	2	12.3%	43.4%
Audio-visual	13419	3	11.6%	55.0%
Computer	7883	4	6.8%	61.8%
Basic materials	4727	5	4.1%	65.9%
Macromolecular	4264	6	3.7%	69.5%
Organic chem	4123	7	3.6%	73.1%
Semicon	3910	8	3.4%	76.4%
Measurement	3837	9	3.3%	79.7%
Handling	3110	10	2.7%	82.4%
Elec_mach	2984	11	2.6%	85.0%
Surface tech	2935	12	2.5%	87.5%
Chemical eng	2405	13	2.1%	89.6%

Technical areas ranked 1 to 5 represent the core areas of Kodak. About 2/3 of patent applications during this period were in technical areas 1 to 5.

Technical areas ranked 6 to 13 represent peripheral technical areas of Kodak.

The cumulative number of patent applications by Fujifilm between 1982 and 2012 in technical areas ranked 1 to 13 accounted for over 90% of all their applications during this period (Table 1). About two-thirds were in technical areas 1 to 5, which we regarded as core technical areas of Fujifilm. We regarded areas 6 to 13 as peripheral technical areas. Similarly, we counted Kodak's patent applications and identified their core and peripheral technical areas (Table 2). Because the cumulative number does not represent the ranking of applications at any specific time, we determined the changes over time in ratios of patent applications in the top five fields of Kodak and Fujifilm (Figures 1 and 2). Both companies applied for patents in the same top five technical fields: optics, audio-visual, textile machines, basic materials, and computers. Also, their ratios followed similar patterns.

Fig. 1. Kodak's patent application ratio trends in its top five fields

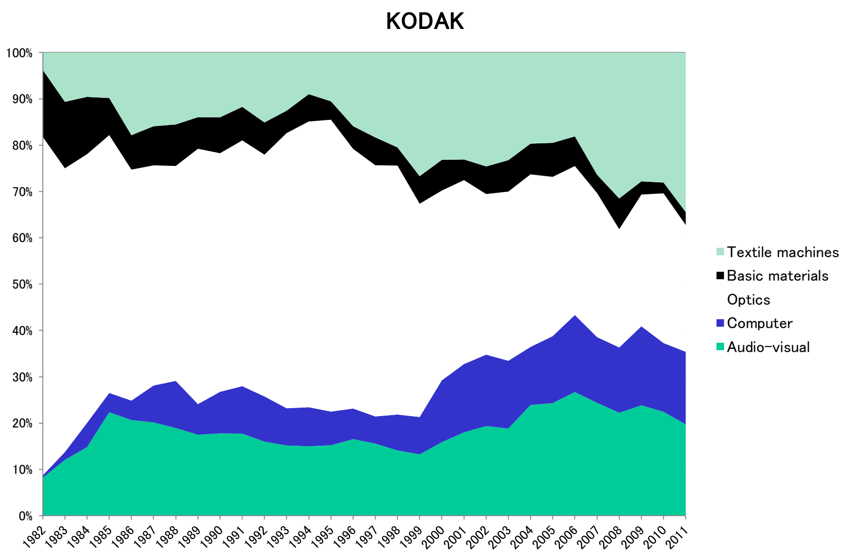
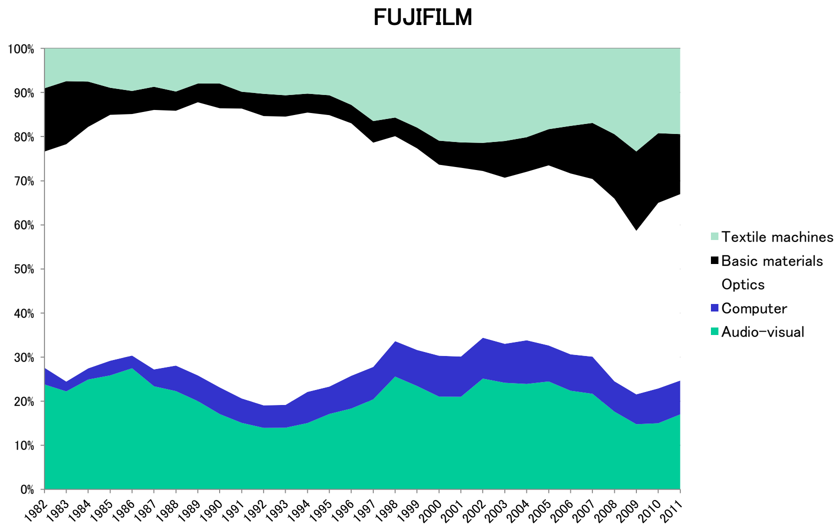


Fig. 2. Fujifilm's patent application ratio trends in its top five fields



4. Exploration Persistency of Fujifilm and Kodak

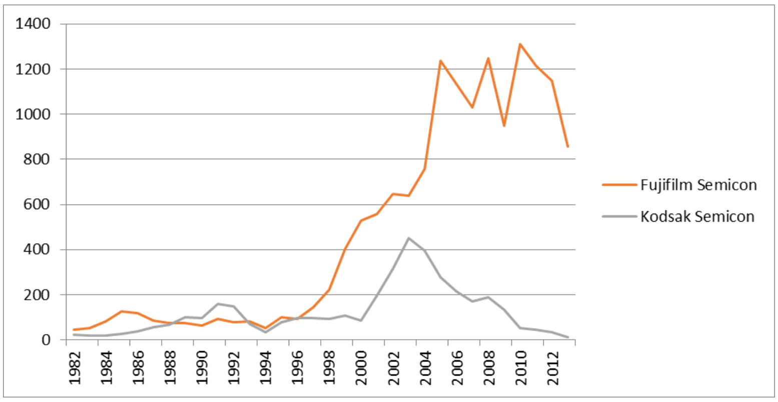
A previous study suggested the usefulness of dividing Fujifilm's corporate transformation process from 1970s to 2010s into two phases of exploration, the first involving digital camera exploration and the second involving systematic and aggressive exploration for diversification into nondigital camera business (Shibata et al., 2019). The present study adopts the same method for this period. The first phase, ending around 2000, was a period when core technologies incorporated into digicams were explored and commercialized. During this period, the main areas of exploration were evident and inevitable, and companies pursued the pressing issue of digitalization. During the second, when it became clear that the digicam business could not make up for the loss of photographic film business, survival of the companies required further exploration for diversification. Because new business areas were unclear, their choice of areas of exploration became strategically important.

4.1 First phase: Exploration and commercialization of digicams

In the late 1970s and 1980s, signs of the advent of digital technology appeared. In 1975, Steve Sasson of Kodak invented the first digicam (Lucas and Goh, 2009). Because the number of pixels was only about 10,000, the image quality was poor, so the cameras did not replace film cameras. By 1993, Kodak had invested $5 billion in digital technology R&D (Lucas and Goh, 2009).
In 1977, Fujifilm started a digicam project at its Central Research Institute and established a microelectronics laboratory in 1981 which developed a charged coupled device (CCD), a semiconductor that captures images in digicams. Kodak showed similar trends.

The progress of technological exploration can be traced by reviewing patent applications. The trends of applications for semiconductor patents by Fujifilm and Kodak (Figure 3) show they both started engaging in exploration of this field around 1985. Between 1989 and 1993, Kodak applied for more patents than Fujifilm, a sign that Kodak proactively engaged in exploration of digital technology. After a relatively stable period, the number of patent applications by Fujifilm rapidly increased, beginning around 1997.

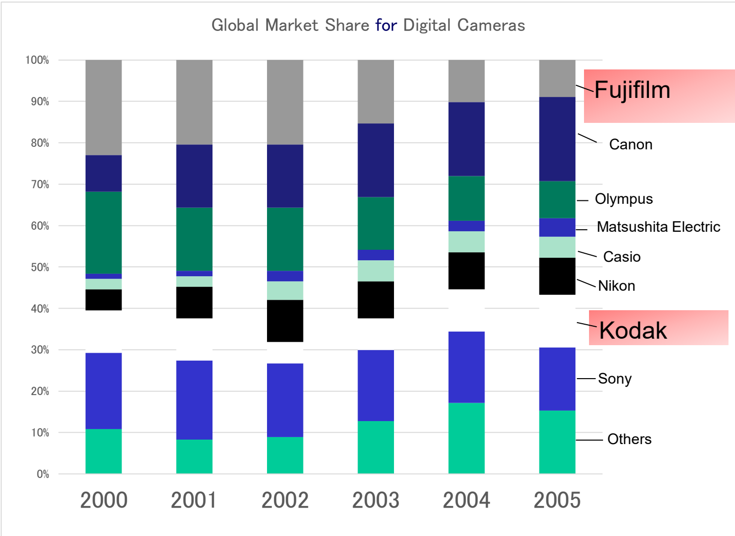
Fig. 3. Semiconductor-related patent application trends for Fujifilm and Kodak



Data from the EPO Worldwide Patent Statistical Database. The number of annual patent applications related to semiconductors (IPC:H01L) was aggregated based on WIPO's IPC and Technology Concordance Table.

The advent of a growing digicam market in 1995 was Casio's one-million pixel QV-10 model. Such image quality could replace film cameras. In 2000, Fujifilm's digicam (Fine Pix4700Z) with its Super CCD Honeycomb, accounted for 23% of the global and 28% of the domestic market share. The Super CCD Honeycomb enabled the camera to capture 60% more light per square inch. By 2000, the two companies dominated the worldwide digicam market (Figure 4). In April 2001, Kodak launched its digicam EasyShare, which could upload images to a computer at the click of a button, and which had a longer battery life than its competitors' digital cameras. Within two years, Kodak dominated the American digicam market (Christensen, 2006).

Fig. 4. Global market share trends for digital cameras



Source: Gavetti, Tripsas, Aoshima 2010)

Both companies engaged in technology exploration. However, their exploration trajectory differed markedly. While Fujifilm persisted in exploring digicam technology for about 20 years, the CEO of Kodak, George Fisher formerly of Motorola, returned Kodak to photographic film with investments in emerging markets in 1993. In 2000, however, Fisher was replaced by Daniel Carp, who accelerated Kodak's development of digicams.

4.2 Second phase; Exploration in the post-digicam era

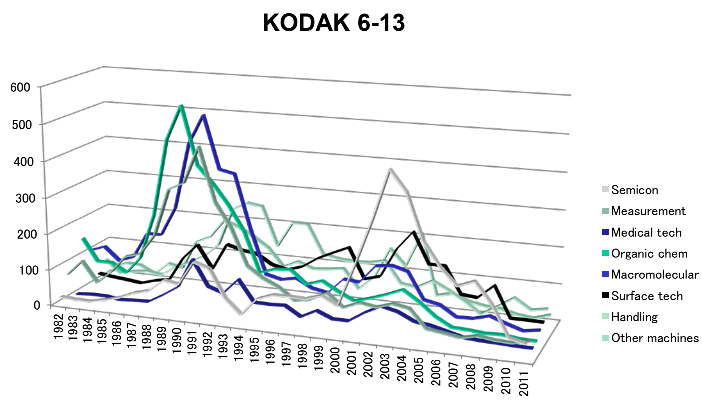
Many companies across industries entered the digicam market, making it competitive. Canon entered in 1999, followed by Matsushita Electric. Under such competition, Fujifilm's market share decreased to 10% by 2004. Kodak suffered similarly. To compensate for the downturn in the film market, exploration of new businesses was deemed urgent by both companies. Decisions about which technological and business areas to explore resulted in different outcomes for Fujifilm and Kodak.

Although Fujifilm and Kodak initially followed the same exploration strategy, they took different trajectories. Kodak strayed from their initial direction during the second stage, while Fujifilm persisted. All three indicators, patents of peripheral technologies, the Herfindahl–Hirschman Index (HHI), and patents of medical- care related products revealed contrasting persistency between the companies as follows:

Patent applications for peripheral technologies

Exploration persistency is defined as maintaining the original exploration area and direction and is regarded as the degree of pursuing and insisting on the same direction with a definite goal. Exploration beyond core technologies can be assessed by proxy through patent applications for peripheral technologies. Accordingly, the long-term direction of patent applications for peripheral technologies indicates the degree of persistency of exploration.

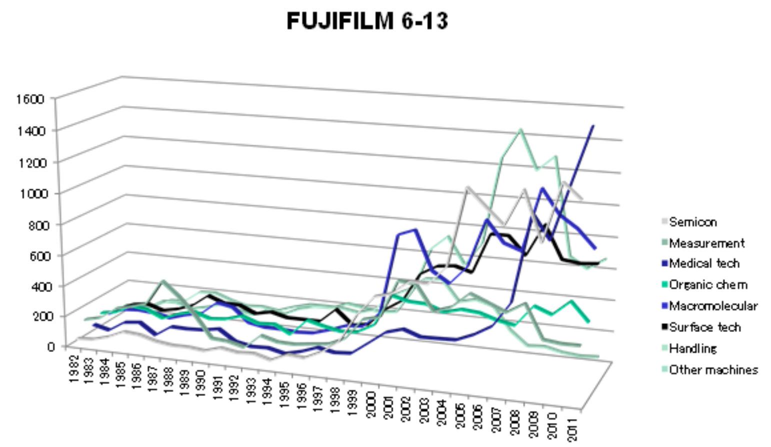
Fig. 5. Kodak patent application trends, positions 6–13



From the EPO Worldwide Patent Statistical Database.
The number of annual patent applications in top fields 6 to 13 containing many Kodak applications from among 35 technical classes, aggregated based on WIPO's IPC and Technology Concordance Table.

Both companies shared similar patent application patterns in their five top-ranked fields. However, (cumulative) patent applications from 1983 to 2012 in technical fields ranked 6–13 showed different trends for Kodak (Figure 5) and Fujifilm (Figure 6). Fields 6–13 represent exploration beyond the boundaries of core technologies.

Fig. 6. Fujifilm patent application trends, positions 6–13



From the EPO Worldwide Patent Statistical Database.
The number of annual patent applications in top fields 6 to 13 containing many Fujifilm applications from among 35 technical classes, aggregated based on WIPO's IPC and Technology Concordance Table.

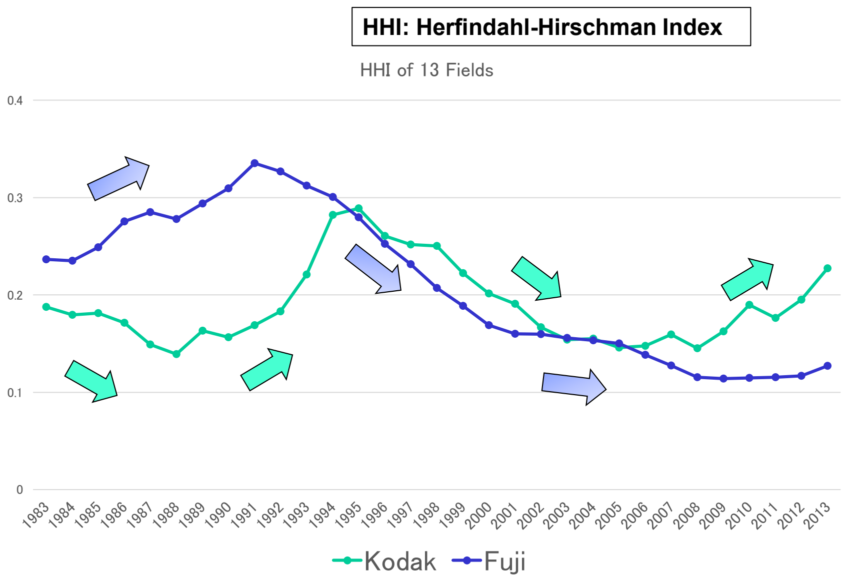
The number of patent applications by Kodak showed two peaks. The first and higher, around 1989 and 1990, included applications in organic chemistry, macromolecules, and measurement methods, whereas the second, between 2002 and 2004, involved semiconductors and surface technology. The technical fields of these two peaks differed, indicating Kodak's lack of persistency in technical exploration.

In contrast, patent applications by Fujifilm showed an upward trend in almost all technical fields, beginning in 1998. Since then, Fujifilm has consistently explored these technological fields, including its core and peripheral technologies. Whereas Kodak's exploration lost direction, Fujifilm's technology exploration beyond core technologies showed long-term consistency.

Herfindahl–Hirschman Index (HHI)

Second, the trends in diversification and concentration for explorations by both companies can be assessed using HHI, which measures the distribution of patent applications. A higher HHI indicates a higher concentration level, whereas a lower HHI indicates greater diversity. Figure 8 shows the HHI trends for the top 13 technical fields of the companies. The technological endeavors of Fujifilm remained concentrated throughout the 1980s, peaking in 1991 and 1992, but showed greater diversification of technological development from 1990. The progress of diversification slowed around 2009, becoming steady in recent years. In comparison, Kodak started diversifying its technological endeavors in the early 1980s but showed increased concentration in the early 1990s. During the first half of the 2000s, Kodak showed greater diversification of technology development but again began increased concentration in 2005.

Fig.7 Trends in HHI indices for Fujifilm and Kodak



From the 1980s to the 1990s, Fujifilm showed concentrated technological development in the optical field, catching up with Kodak. Beginning in the 1990s, Fujifilm showed consistent technological exploration and promoted diversification of its businesses. In contrast, beginning in the 1980s, Kodak prepared for the advent of digital technology by investing in technological exploration of pharmaceutical products and medical care equipment. In the early 1990s, Kodak started to concentrate its technological development. During the second half of the 1990s, when digicams started to threaten photographic film, Kodak started technological exploration in a variety of fields. In 2005, however, Kodak started concentrating its technological resources on the inkjet and printer businesses. These transformations demonstrate the contrast between the strategies employed by Fujifilm and Kodak.

Medical Care Products

Both companies started to explore similar medical care areas at roughly the same time. A statement by Fujifilm CEO Shigetaka Komori confirms this: "Naturally, Kodak had also foreseen the arrival of the digital era and was cautious about it. With regards to diversification, they took steps similar to Fujifilm when they set out to develop pharmaceuticals."[1]

Fujifilm is currently investing resources in the medical care field and transforming into a "total healthcare company". Therefore, comparing the histories of technical exploration by Kodak and Fujifilm in this field is useful to understand the difference in degree of persistency between Kodak and Fujifilm.

The present study assessed the technical exploration of both companies in the medical care field, focusing on two sub-fields: medical equipment and pharmaceutical products. We examined when Fujifilm began its exploration in the field, and how Kodak explored this area.

Figure 8 shows trends in the number of patent applications for medical care equipment by both companies. These patents ranked tenth and thirteenth among the cumulative number of patent

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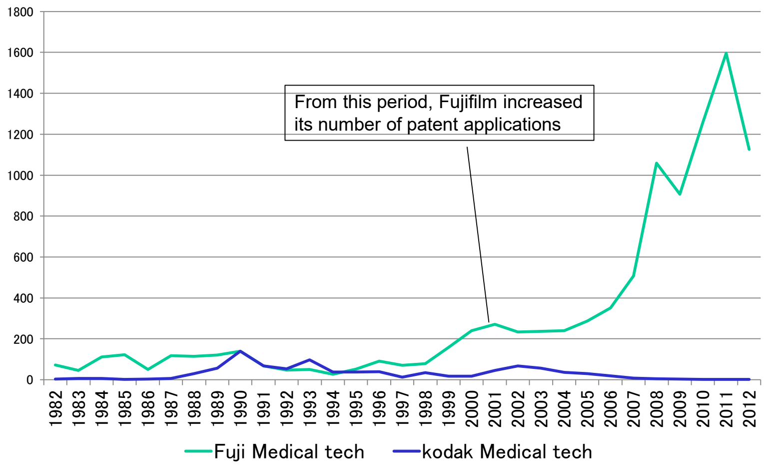
[1] Shigetaka Komori, "Spirit of Management."

applications for Fujifilm and Kodak, respectively. Figure 8 shows Fujifilm has explored in this field for a long time.[2] Beginning in 2002, Fujifilm increased its number of patent applications and exploration of this technology. Kodak started exploring this field several years after Fujifilm. Between 1990 and 1995, both companies filed similar numbers of patent applications in this field, but the number filed by Kodak markedly decreased thereafter.

Fig. 8. Trends in patent applications related to medical-care equipment



From the EPO Worldwide Patent Statistical Database. Aggregated based on WIPO's IPC and Technology Concordance Table.

The same trends were found in the number of patents filed for pharmaceutical products. As Figure 9 shows, Kodak began exploring pharmaceutical technology earlier than Fujifilm, filing patent applications in 1986. In 1996, Kodak ceased this exploration, and decreased its number of patent applications. In contrast, Fujifilm started filing increased numbers of patent applications little later than Kodak, around 1990. Beginning in 2002, the number of applications surged, after

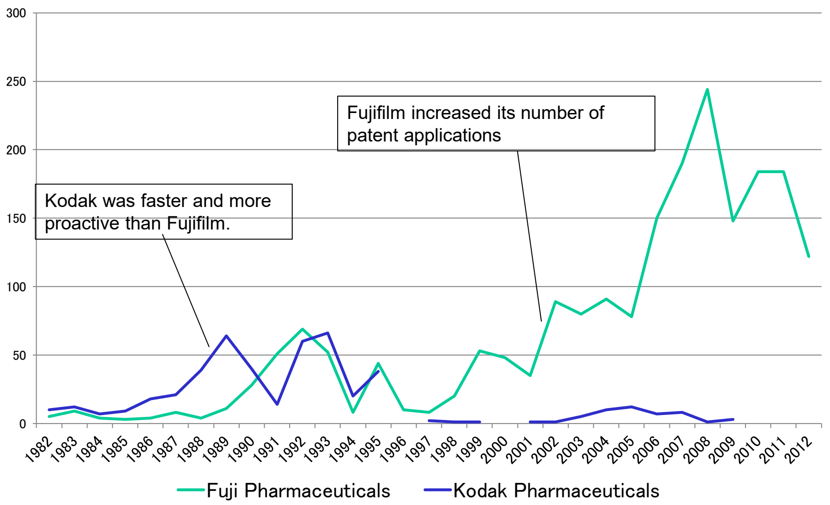
[2] Fujifilm started to develop FCR (Fuji Computed Radiography), its digital X-ray image diagnostic system, in 1974 and released it in 1983. This was an alternative to the traditional analog method using X-ray film.

a stable application period of over 10 years.

In short, their subsequent development trajectories were completely different. While Fujifilm increased its medical care exploration in the 2000s shifting its business focus to this field, Kodak withdrew from it. Fujifilm has been persistent regarding both medical care equipment and pharmaceutical products for over 30 years. In contrast, Kodak persisted in both medical care equipment and pharmaceutical products for about 17 years, half that of Fujifilm.

Their merger and acquisition strategies reflected their respective exploration strategies. In 1988, Kodak purchased pharmaceutical company Sterling Drug for 5.1 billion dollars but sold it in 1994. In 2007, it sold its medical care equipment business and withdrew from the medical care field. Meanwhile, Fujifilm purchased Toyama Chemical in 2008 making it a consolidated subsidiary. This was followed by its 2012 acquisition of SonoSite, a large American manufacturer of portable ultrasound devices. Through these ventures, Fujifilm injected management resources into its medical care business.

Fig. 9. Trends in patent applications related to pharmaceutical products



From the EPO Worldwide Patent Statistical Database. Aggregated based on WIPO's IPC and Technology Concordance Table.

We conclude that all three indicators, patents of peripheral technologies, HHI index, and patents of medical-care products, revealed contrasting persistency between Fujifilm and Kodak in second phase.

Finally, Table 3 summarizes our findings regarding the exploration persistency of Fujifilm and Kodak. In terms of degree of persistency in exploration, Fujifilm's persistency was high while Kodak's was low both in first phase and second phase.

Table 3. Exploration persistency of Fujifilm and Kodak

	Fujifilm	Kodak
Exploration of digicams	High level persistency as below Fujifilm persisted in exploring digicam related technology for about 20 years.	Low level persistency as below Georg Fisher returned Kodak to traditional film business in 1993. In 2000, Fisher was replaced by Daniel Carp, who accelerated digicam development again.
Exploration in the post-degicam Degree of persistency (All of 3 indicators showed contrasting persistency between Fujifilm and Kodak)	High level persistency as below. ・Patent of peripheral technologies showed a consistent upward trend. ・HHI index showed consistent diversification. ・Medical-care related products persisted for more than 30 years	Low level persistency as below. ・Patents of peripheral technologies showed two peaks. ・HHI index showed an inconsistent trend, diversification and concentration. ・Medical-care related products persisted for just about 17years.

5. Discussion, implications and conclusion

5.1 Effectiveness of aspect of exploration persistency

Prior studies have not shed light on the role of exploration persistency in an ambidextrous organization. This study theoretically proposes the importance of exploration persistency to ambidextrous organizations to bridge the research gap. The case study of Fujifilm and Kodak revealed they had different levels of exploration persistency for new technology and new business, as follows.

The core technologies of Fujifilm and Kodak were almost identical, and both faced the same market environment, especially regarding digital technology. Had both companies assessed their core technologies and looked for new areas to apply them, they may have explored identical technological and business areas. Between the 1980s and 1990s, both companies were exploring the same areas, including medical care equipment and pharmaceutical products. Nevertheless, Fujifilm and Kodak developed different exploration trajectories. Fujifilm maintained its direction of exploration with persistence while Kodak changed its direction lacking persistence. The case study illustrates the effectiveness and usefulness of incorporating the aspect of exploration persistency.

Furthermore, it can be inferred theoretically that two factors, exploitation effect and knowledge accumulation effect, will influence the degree of exploration persistency within an ambidextrous organization as follows.

The concept of ambidextrous organization allows exploration and exploitation activities to coexist within an organization. Exploitation refines and develops a company's existing knowledge, know-how accumulated in its current core business, exploitation persistency reflects the natural development of today's core technologies and businesses.

When exploring new technologies and new business, firms must maintain their direction if it seems right and promising. If they realize they are headed in the wrong direction, they must change their direction of exploration. Otherwise, persistency does more harm than good. Therefore, persistency is required until a company realizes it is headed in the wrong direction, and it requires difficult decision making, compared with exploitation.

This asymmetry between exploration and exploitation within ambidextrous organizations will cause an exploitation effect which tends to induce a transfer of management resources from exploration to exploitation, ultimately weakening the degree of exploration persistency.

Kodak's case illustrates the force of the exploitation effect. As the case shows, Kodak often changed the direction of their exploration. Did Kodak realize they were headed in a wrong direction? It is difficult to attribute their direction changes to Kodak believing they were headed in the wrong direction. Even in the first phase of their exploration into digicams, Kodak changed their direction and returned to the photographic film business, despite it being obvious and inevitable that the digicam was an emerging technology for the near future. Kodak's exploration for digicams must have been influenced by their exploitation of the traditional photographic film business. Their exploitation of film business must have induced a transfer of management resources from exploration of digicams to exploitation of film business, because film business could bring short term results. Kodak's change of direction of exploration was most likely caused by the exploitation effect.

In contrast, accumulation of knowledge about new technologies and business by an organization tends to strengthen its persistency of exploration, as existing literature shows the knowledge accumulation effect is a source of persistency (Malerba and Orsenigo,1999; Suzuki and Kodama, 2004).Through the exploration process within an organization as discussed below, organizational knowledge can be accumulated.

Exploration is an experimental or trial-and-error process leading to the acquisition of knowledge and learning (March, 1991). To acquire knowledge from exploration, it is necessary to define the exploration area or boundaries, regardless of the technology or market. Therefore, a company must determine the scope of the area to be explored, because it defines the direction of the exploration activity (Katila and Ahuja, 2002). It is necessary to determine which of multiple directions warrant further exploration. Thus, companies first explore broadly to find a range of options and subsequently narrow down the scope of their exploration (Katila and Ahuja, 2002; Fleming and Singh, 2010). Through this exploration process, knowledge about a new area will be accumulated within companies.

Thus, we discuss two factors that influence exploration persistency, an exploitation negative effect and a knowledge accumulation positive effect. The balance between these two factors in an ambidextrous organization will ultimately determine its degree of exploration persistency within an ambidextrous concept.

5.2 Managerial implication: Organizational initiative process and CEO initiative process

Based on above discussion, we can develop implication for managing exploration persistency in company. We classify the exploration process into two types, organizational initiative and CEO initiative for developing managerial implication.

With organizational initiative exploration processes, the exploration area is narrowed by organizational discussion and organizational-level agreement.

In this type, top management determine the destination, and middle managers choose the route and steer the ship by facilitating team-level interactions among employees (Nonaka, 1988; Nonaka and Takeuchi, 1995). In this process, both top and front-line managers are engaged in discussions to set the direction of exploration. Once the wide area of exploration is determined, subsequent explorations must follow within that scope. Knowledge in the exploration direction will be accumulated through discussion in the organization, and the selected exploration area will be shared and agreed among members of the organization.

Fujifilm adopted this exploration process(Shibata, Kodama, Suzuki, 2018). Actually, Fujifilm started with wide exploration, then narrowed down to a specific exploration, enabling Fujifilm to organizationally define the area of exploration through accumulated knowledge.

This type of exploration process provides high level persistency in the exploration direction, because this exploration process tend to accumulate organizational knowledge and knowledge accumulation effect exceed exploitation effect. Accordingly, this type is also resistant to change of CEO. In fact, Fujifilm did not change direction even when the CEO changed from Onishi to Komori in 2003. Our case study using patent showed that Fujifilm persistently explored the same technical areas including semiconductors and medical care-related technology throughout the period of our investigation from 1982 until 2012.

With CEO initiative exploration processes, the exploration process will be conducted under the initiative of the CEO. The exploration area is determined without front-line managers and in the absence of organization-wide discussion. Therefore, knowledge gained from this exploration process cannot be accumulated and shared within the organization.

There is a high probability that the area of exploration may change when top management is changed, because judgments about exploration area by CEOs are influenced by their cognitive capabilities which may, in turn, influence the success or failure of a business (Rosenbloom, 2000; Helfat and Peteraf, 2015).

It seems Kodak adopted CEO initiative exploration process. In fact, Antonio Perez likely shifted Kodak to the inkjet printer business due to his experience. As vice-president of HP, Perez managed its inkjet printer business. He increased the number of printers sold worldwide from 17- to 100-million and increased sales to over 10 billion dollars, which paved his way to Kodak CEO. Kodak's shift to the inkjet printer business was likely due to its new CEO's successful experiences.

Also, George Fisher recruited from Motorola CEO returned to the traditional photographic film business, which was influenced by exploitation effect seeking short-term results. Thus, in case of Kodak, it seems that exploration area have changed whenever CEO have changed, which is sharp contrast with case of Fujifilm.

This type of CEO initiative exploration process tend to accumulate less organizational knowledge, and therefore easily influenced by exploitation effect seeking short –term results. These will cause low level persistency in exploration, and actually our case study using patent data show the frequent change of technical exploration area of Kodak.

5.3 Conclusion

It is widely believed that Kodak's fate was caused by its failure to properly deal with the emergence of the digital camera market. However, this study provides an alternative explanation. This study revealed Kodak and Fujifilm had different levels of persistency in exploration for new technology and new business. The difference between Kodak and Fujifilm was not their timing of exploring new business but their degree of exploration persistency. Kodak was not late in starting to explore new businesses. The timing of Kodak's explorations in medical care equipment and pharmaceutical products were similar to those of Fujifilm. However, Kodak did not maintain a consistent persistent direction and withdrew from medical care equipment and pharmaceutical products. It turned out that exploration persistency matters to an ambidextrous organization.

In the existing literature on ambidextrous organizations, four success factors have been proposed; namely 1) a clear strategic intent that justifies the needs for exploitation and exploration, 2) senior management commitment and support, 3) an ambidextrous architecture that deals with careful design of the organizational interface, and 4) common identity such as vision, values, and culture (O'Reilly and Tushman, 2016). In addition to these four factors, this study proposes the aspect of exploration persistency as another critical factor and adds to existing findings on ambidextrous organizations.

In conclusion, this study extends previous findings and contributes to advancing the ambidextrous framework by incorporating the aspect of exploration persistency. Also, this study argued that the negative exploitation effect and positive knowledge accumulation effect will influence the degree of exploration persistency within an ambidextrous organization. In particular, the exploitation effect is a unique force working in ambidextrous organizations. Therefore, for success of an ambidextrous organization, carefully managing exploration persistency is required

A limitation of this study is that it is based on a single case study. Analyses of additional cases may further enhance the relevance and effectiveness of the proposed aspect.

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Table 1. Cumulative numbers of Fujifilm patent applications in technical areas ranked 1 to 13 (1982 to 2012)

Technical area	Cumulative number	Rank	Share	Accumulated share
Optics	109326	1	30.4%	30.4%
Audio-visual	47790	2	13.3%	43.7%
Textile machines	36806	3	10.2%	53.9%
Basic materials	19099	4	5.3%	59.2%
Computer	17007	5	4.7%	63.9%
Semicon	15800	6	4.4%	68.3%
Macromolecular	14465	7	4.0%	72.3%
Other machines	13453	8	3.7%	76.1%
Surface tech	12356	9	3.4%	79.5%
Medical tech	10837	10	3.0%	82.5%
Measurement	9826	11	2.7%	85.3%
Organic chem	8973	12	2.5%	87.8%
Elec_mach	8678	13	2.4%	90.2%

Technical areas ranked 1 to 5 represent the core areas of Fujifilm. About 2/3 of patent applications during this period were in technical areas 1 to 5.

Technical areas ranked 6 to 13 represent peripheral technical areas of Fujifilm.

Table 2. Cumulative numbers of Kodak patent applications in technical areas ranked 1 to 13 (1982 to 2012)

Technical area	Cumulative number	rank	share	Accumulated Share
Optics	36203	1	31.2%	31.2%
Textile machines	14226	2	12.3%	43.4%
Audio-visual	13419	3	11.6%	55.0%
Computer	7883	4	6.8%	61.8%
Basic materials	4727	5	4.1%	65.9%
Macromolecular	4264	6	3.7%	69.5%
Organic chem	4123	7	3.6%	73.1%
Semicon	3910	8	3.4%	76.4%
Measurement	3837	9	3.3%	79.7%
Handling	3110	10	2.7%	82.4%
Elec_mach	2984	11	2.6%	85.0%
Surface tech	2935	12	2.5%	87.5%
Chemical eng	2405	13	2.1%	89.6%

Technical areas ranked 1 to 5 represent the core areas of Kodak. About 2/3 of patent applications during this period were in technical areas 1 to 5.

Technical areas ranked 6 to 13 represent peripheral technical areas of Kodak.

Table 3. Exploration persistency of Fujifilm and Kodak

	Fujifilm	Kodak
Exploration of digicams	High level persistency as below Fujifilm persisted in exploring digicam related technology for about 20 years.	Low level persistency as below Georg Fisher returned Kodak to traditional film business in 1993. In 2000, Fisher was replaced by Daniel Carp, who accelerated digicam development again.
Exploration in the post-degicam Degree of persistency (All of 3 indicators showed contrasting persistency between Fujifilm and Kodak)	High level persistency as below. ・Patent of peripheral technologies showed a consistent upward trend. ・HHI index showed consistent diversification. ・Medical-care related products persisted for more than 30 years	Low level persistency as below. ・Patents of peripheral technologies showed two peaks. ・HHI index showed an inconsistent trend, diversification and concentration. ・Medical-care related products persisted for just about 17years.

Fig. 1. Kodak's patent application ratio trends in its top five fields

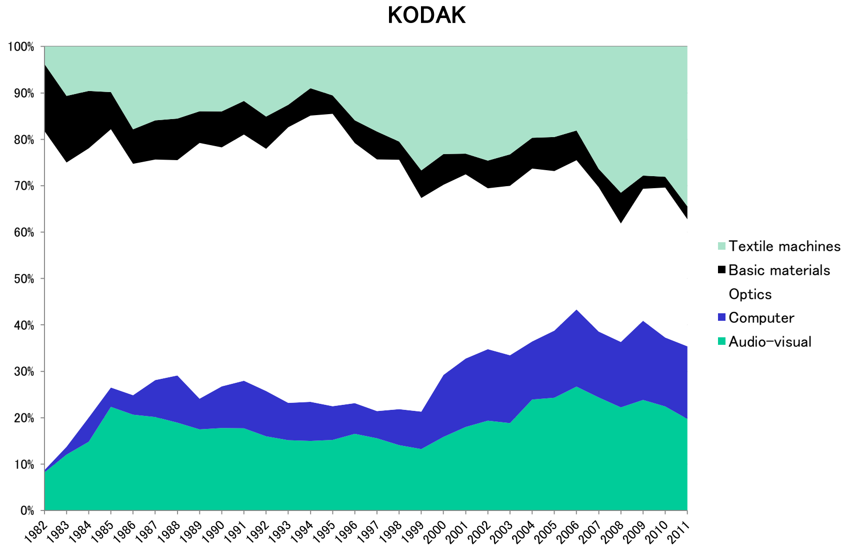


Fig. 2. Fujifilm's patent application ratio trends in its top five fields

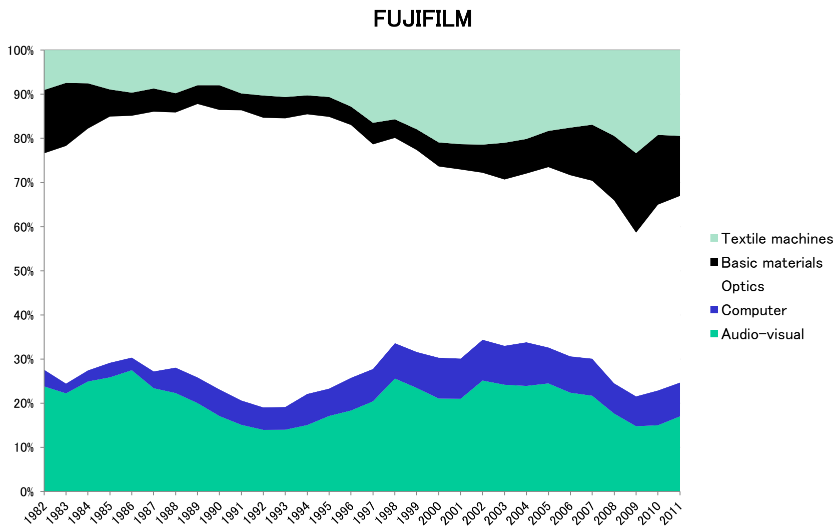
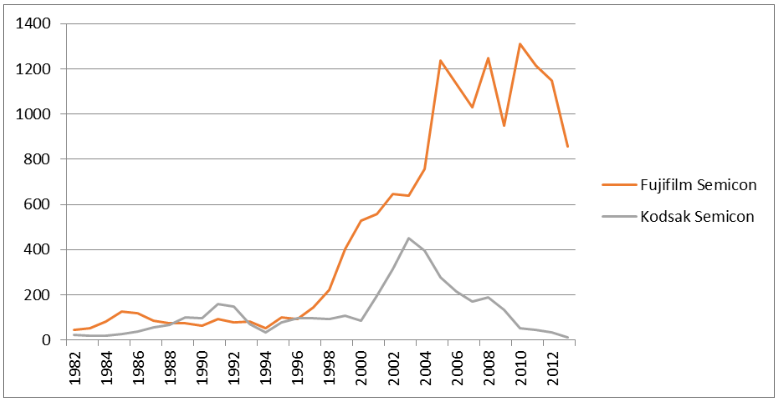
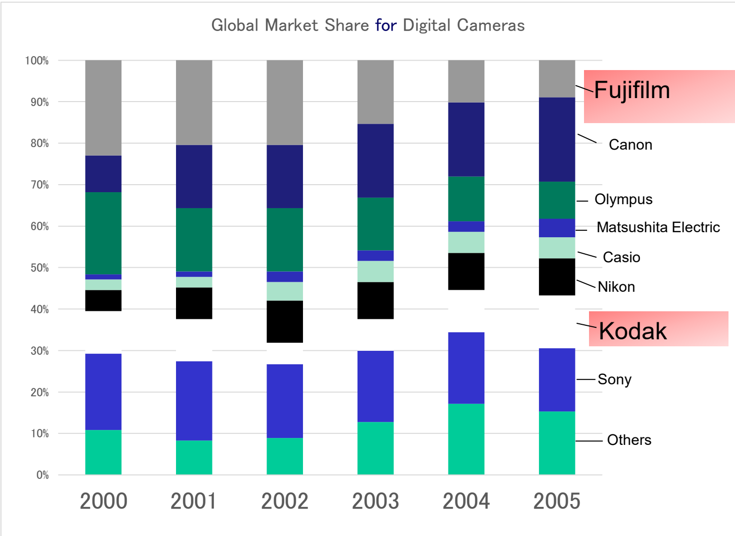


Fig. 3. Semiconductor-related patent application trends for Fujifilm and Kodak



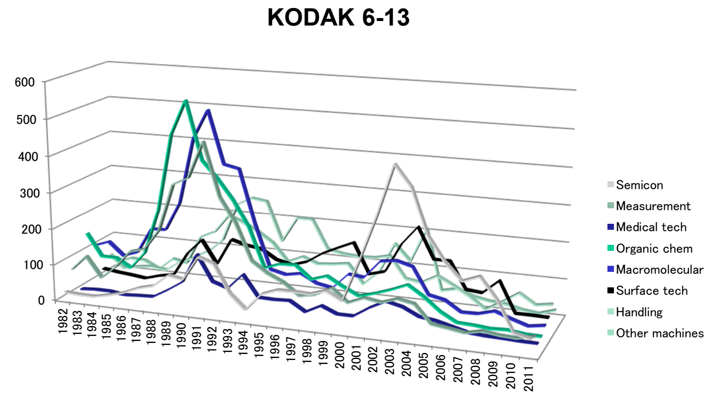
Data from the EPO Worldwide Patent Statistical Database. The number of annual patent applications related to semiconductors (IPC:H01L) was aggregated based on WIPO's IPC and Technology Concordance Table.

Fig. 4. Global market share trends for digital cameras



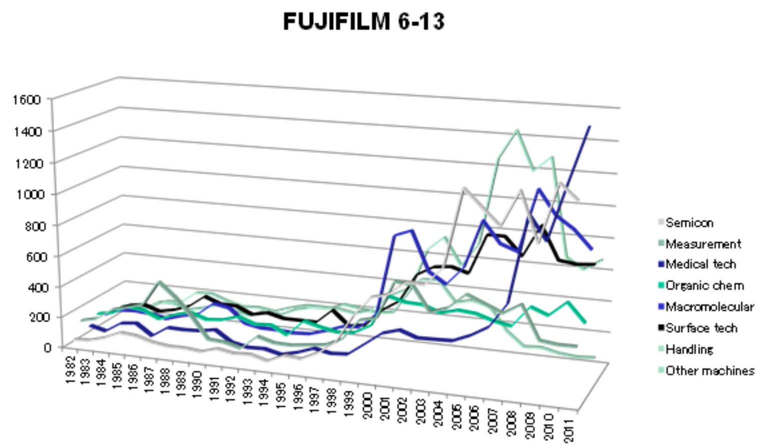
Source: Gavetti, Tripsas, Aoshima 2010)

Fig. 5. Kodak patent application trends, positions 6–13



From the EPO Worldwide Patent Statistical Database.
The number of annual patent applications in top fields 6 to 13 containing many Kodak applications from among 35 technical classes, aggregated based on WIPO's IPC and Technology Concordance Table.

Fig. 6. Fujifilm patent application trends, positions 6–13



From the EPO Worldwide Patent Statistical Database.
The number of annual patent applications in top fields 6 to 13 containing many Fujifilm applications from among 35 technical classes, aggregated based on WIPO's IPC and Technology Concordance Table.

Fig.7 Trends in HHI indices for Fujifilm and Kodak

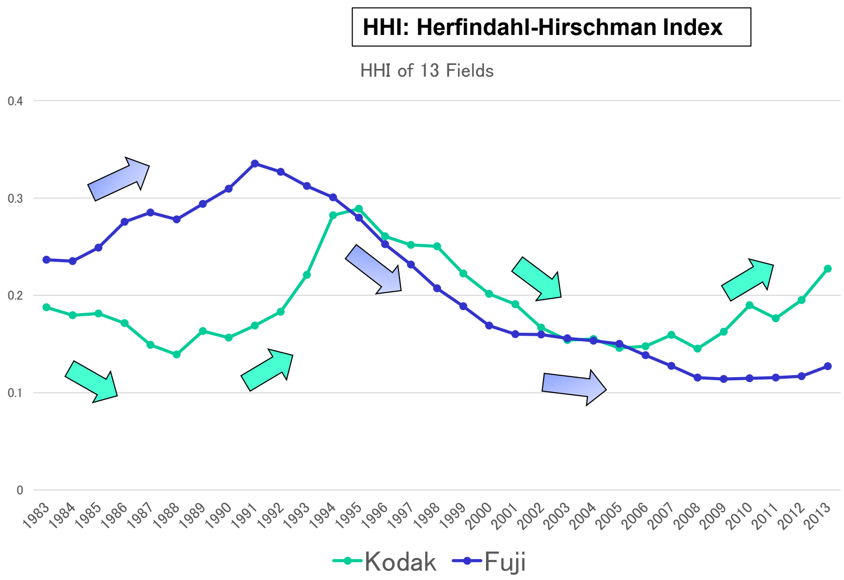
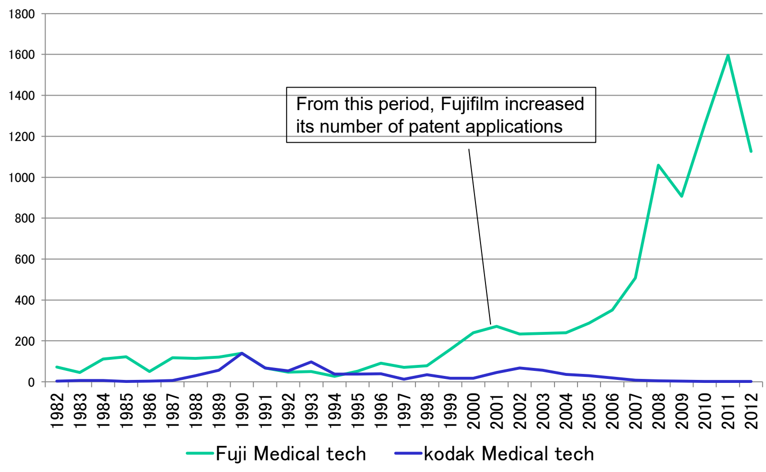
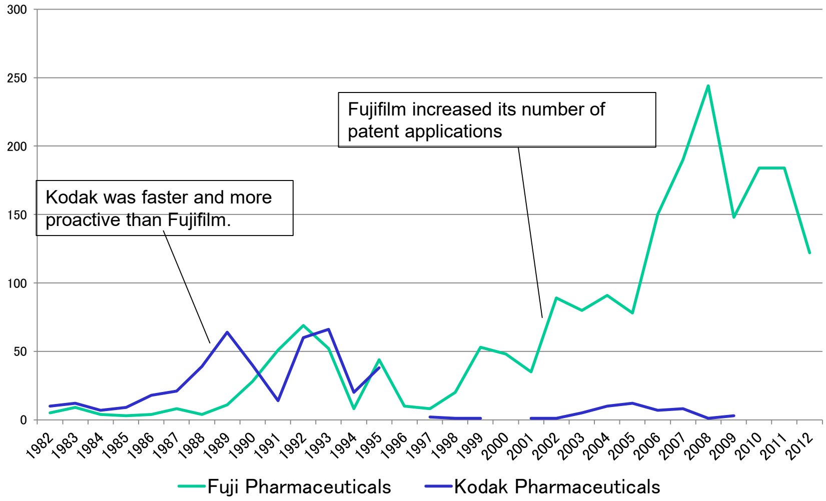


Fig. 8. Trends in patent applications related to medical-care equipment



From the EPO Worldwide Patent Statistical Database. Aggregated based on WIPO's IPC and Technology Concordance Table.

Fig. 9. Trends in patent applications related to pharmaceutical products



From the EPO Worldwide Patent Statistical Database. Aggregated based on WIPO's IPC and Technology Concordance Table.