Review

Digitalization, Open Innovation, Ambidexterity, and Green Innovation in Small and Medium-Sized Enterprises: A Narrative Review and New Perspectives

Keisuke Kokubun *

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Digitalization, Open Innovation, Ambidexterity, and Green Innovation in Small and Medium-Sized Enterprises: A Narrative Review and New Perspectives

Keisuke Kokubun

Graduate School of Management, Kyoto University, Kyoto 606-8501, Japan; kokubun.keisuke.6x@kyoto-u.jp

Abstract: Ambidexterity is one of the major themes in business administration in recent years, and ambidexterity is being actively studied in small and medium-sized enterprises (SMEs), which are considered difficult to achieve due to lack of resources. However, there have been no consistent results on the impact of ambidexterity on performance such as corporate earnings, making it difficult to argue that ambidexterity should be pursued at any time and in any circumstances. Therefore, this study provides a narrative review of related papers from January 2020 to the present, and confirms that SMEs and open innovation (OI) are involved in ambidexterity, and that their combination may lead to the solution of contemporary issues through green innovation, etc. This suggests that when discussing the pros and cons of ambidexterity in SMEs, the conclusions differ depending on whether one places emphasis on micro, short-term goals such as increasing immediate sales, or macro, long-term goals such as solving national and global issues, and therefore ambidexterity should be treated as an axis for finding a compromise between individual players and the whole. This study shows the legitimacy of the government providing financial or human support for open innovation and digitalization to support ambidexterity in SMEs.

Keywords: digitalization; green innovation; open innovation; resource; small and medium-sized enterprises

1. Introduction

In business, ambidexterity refers to combining both incremental, efficiency-oriented innovation and radical, novelty-oriented innovation for short-term success and long-term survival [1,2]. As companies face increasing global competition, the importance of ambidexterity is increasingly recognized. However, ambidexterity is sometimes difficult to achieve because exploration and exploitation compete for scarce resources, and attempting to achieve them simultaneously can create tensions within the company [1]. Furthermore, small and medium-sized enterprises (SMEs) are at a disadvantage compared to larger companies in terms of management expertise and access to capital, talent, and resources, making ambidexterity difficult [3]. SMEs are unable to develop separate units for exploration and exploitation, and they lack management systems to reconfigure resources to adapt to changing environments [4,5]. As a result, the search for new opportunities is perceived as a suboptimal option, resulting in overcommitment of internal resources [6,7].

Therefore, many researchers have argued that SMEs, especially those with limited resources and capacity, perform better when they specialize in either exploitation or exploring [8–11]. However, other researchers have provided evidence that SMEs can achieve ambidexterity by integrating the conflicting demands of exploration and exploitation [5,12,13]. Meanwhile, a study of 500 Russian SMEs found that exploration improves firm performance but reduces reliability, and exploitation reduces firm performance but increases reliability, during a crisis, and argued for the need to use ambidexterity differently depending on the situation [14]. The low consistency in the relationship

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between ambidexterity and performance makes the recommendation of ambidexterity less persuasive. With the current accumulated research, it is no longer possible to claim that ambidexterity is the optimal strategy at any time and in any situation. Should SMEs engage in ambidexterity? If so, what makes ambidexterity possible and what are the benefits of engaging in it? Although it has not yet been fully addressed, the materials to address this issue are already in place. Therefore, in this study, we review recent papers on ambidexterity in SMEs and confirm that open innovation and digitalization hold the key to its success or failure. We also summarize the relationship between ambidexterity, open innovation, digitalization, and contemporary issues such as green innovation, and confirm that ambidexterity should be addressed when judging from a macro rather than a micro perspective, or a long-term rather than a short-term perspective.

2. Method

A literature review of narratives on digitalization, open innovation, ambidexterity, and green innovation in small and medium-sized enterprises was con-ducted following the recommendations of Green et al. [15]. The literature search in Scopus, PubMed, Web of Science, PsychINFO, and Google Scholar databases focused on articles published between January 2020 and March 2025 and aligned with the objectives out-lined in the previous section. However, studies from before 2019 were also included if deemed relevant. The keywords used were “digitalization”, “green innovation”, “open innovation”, “resource”, and “small and medium-sized enterprises” in various combinations connected with AND and OR, as well as in combination with the words “review” or “meta-analysis”. The search was performed in the title and abstract. In other words, this review focused on digitalization, open innovation, ambidexterity, and green innovation in small and medium-sized enterprises, as well as on these general reviews. In case multiple reviews or articles on the same topic were identified, the most recent and/or most cited ones were given priority. In addition, the reference sections of the selected papers were examined to check for possible additional research. Also included were reports from authoritative international organizations, relevant consensus statements and documents, and empirical studies that were specifically relevant to this topic. In addition, the method used in this study was a narrative review, not a systematic review, and therefore related literature studies were not covered comprehensively. Therefore, for example, studies that dealt with obesity but did not discuss it from the perspective of discrimination or vicious cycles, or did not provide any suggestions, were not included in this review.

3. SMEs and Ambidexterity

Compared with large enterprises, SMEs often lack adequate coordination mechanisms and resources, such as human and financial capital [16,17]. Therefore, considering the enterprises’ strategies and the potential risks of ambidextrous innovation, SMEs must choose between incremental and radical innovation [18]. Exploitation generally improves the enterprises’ productivity and efficiency [19,20]. However, it is impossible to develop all technological and market capabilities through exploitation, since the success of exploitation depends on the availability of capabilities, assets, or resources under the enterprises’ control [21,22]. On the other hand, exploration helps enterprises adapt to changes with a long-term perspective in a rapidly changing business environment [1,25]. This is because exploration, which leads to the continuous discovery of new markets and technological capabilities, is very effective in helping enterprises reorganize their own knowledge base, develop new products, and achieve competitive advantages in niches [24,26,27].

The choice between exploration and exploitation depends on the context in which SMEs find themselves. A study of 150 German medium-sized companies in the engineering industry showed that to survive and gain competitive advantage, they need to prioritize exploration over exploitation to create radically new knowledge, products and services [9]. This result may reflect the context of the German engineering industry, which is characterized by fierce competition, active research and development, and radical innovation to stay competitive [28]. Similarly, a study of 150 Spanish

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agribusiness companies, known for their high level of competition (146 of which are SMEs with fewer than 200 employees), revealed that innovation ambidexterity affects performance, and that exploratory innovation has a stronger impact on market and financial performance compared to exploitative innovation [29].

However, most SMEs are exploitative [30]. Exploitation can be a good and useful strategy to stay focused in a stable environment [30]. In addition, an analysis collected based on the annual reports and financial data of 367 Taiwanese companies showed that companies adopting exploitation strategies during crises are more likely to survive than those adopting exploration or ambidextrous strategies by making efficient use of limited resources [31]. However, relying on a specific technology and specializing in exploitation may make it difficult to adapt to changes in the times and reduce a company's competitive advantage in an industry driven by innovation and research and development [28]. Relatedly, a study of young technology-based companies in the UK showed that dependence on key customers has a significant negative impact on the survival of companies, including by reducing their motivation to develop products [32]. Today, due to the fragmentation, complexity, and increasing unpredictability of needs caused by the transformation of the industrial structure, it is becoming increasingly important for SMEs to break away from subcontracting structures and utilize information from a wide range of sources beyond their existing networks, as well as to engage in innovation activities that agilely connect technological seeds to new businesses [33]. In addition, the wave of ICT in the wake of the COVID-19 pandemic and the growing awareness of the global environment in the wake of the Sustainable Development Goals (SDGs) are forcing corporate managers to make changes, increasing the risk of sticking to traditional methods. Furthermore, from the perspective of risk diversification, i.e. portfolio investment, it is necessary to have a large number of innovation activities within the country [33]. In other words, even if ambidexterity is unprofitable and does not directly lead to short-term sales for a single company, it may be rational to pursue it from the perspective of the country as a whole.

Moreover, even if ambidexterity is not perceived as beneficial for SMEs in the short term, it may be beneficial in the long term. That is, when exploitation is combined with exploration, SMEs may act outside the box and innovate, not for short-term gains, but for the long term, ultimately achieving positive results [30]. This is because ambidexterity plays a key role in integrating the conflicting demands of exploration and exploitation [5]. Ambidextrous SMEs have the ability to manage exploitation and exploration to improve efficiency without losing the ability to develop novel ideas, products, and processes. Moreover, these SMEs can make important decisions quickly and flexibly about their financial structures, for example, to explore new and different markets through internationalization or to launch new products and brands [34,35]. Therefore, ambidextrous SMEs may have a higher resilience, such as more easily identifying opportunities to recover from crises [30]. Thus, clarifying how SMEs with few resources can achieve ambidexterity is likely to become an important topic from a macro or long-term perspective. Therefore, below we will consider the conditions for SMEs to achieve ambidexterity.

4. Ambidexterity and Open Innovation

To overcome scarcity of internal resources and become ambidextrous, SMEs need to rely more on external resources. Innovation leveraging external resources is called open innovation (OI) [36]. The objectives of OI often differ between large companies and SMEs: large companies adopt OI to take advantage of their partners' assets and capabilities, while SMEs resort to OI to offset scarcity of internal assets [37–40]. SMEs usually suffer from a significant shortage of financial and human capital resources, managerial and technical skills, and know-how, and therefore see networking as a way to broaden their technological capabilities [41,42]. By leveraging external collaboration, SMEs can reduce the costs associated with innovation investments and successfully adapt and reconfigure their innovation processes [41,42]. Collaboration with external organizations, which involves OI, is a good approach to expand the portfolio of innovation activities, increase knowledge complementarity and improve productivity, thus positively impacting SMEs' innovation capabilities [43–46]. By embracing

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OI, SMEs can benefit financially by leveraging existing capabilities, resources and structures, strengthening an already trusted network of relationships, and by reducing knowledge waste [47–49].

In contrast to multinational enterprises that are not interested in a particular region and move around in search of the best location, SMEs are often historically tied to specific locations and local residents for multiple generations [50,51]. For example, SMEs located in BW, Bavaria and North Rhine-Westphalia, home to 70% of the world's leading German SMEs, are rooted in a specific influential local social capital context and leverage their ties to surrounding communities, companies and universities to effectively enter international markets [52]. Thus, SMEs may have an advantage in that they can conduct OI by leveraging their local networks. The results of a survey of 615 SMEs in six regions in Thailand found a significant positive relationship between the implementation of OI and ambidextrous innovation practices, suggesting that the adoption of OI can enhance ambidextrous innovation [53].

However, OI often involves orchestration [54]. The costs of deploying OI are an important consideration, especially for financially constrained SMEs [40,55]. OI entails the risk of losing internal assets, as well as agency and transaction costs and the costs of managing partnerships [6,56]. The results of a study of 377 European SMEs show that OI is a cost to SMEs, at least in the short term [42].

5. Ambidextrous and Digital

Therefore, in conjunction with OI, SMEs are also required to save costs. One of the most important ways to achieve this is through digitalization. Digitalization can help SMEs with fewer resources in terms of time, money, and manpower to acquire external knowledge, thereby increasing their knowledge base [57,58]. Compared to incremental innovation, radical innovation as a higher-level innovation type involves more tacit knowledge and external heterogeneous resources, which may far exceed the firm's existing knowledge base [59,60]. In this case, digitalization provides SMEs with a valuable opportunity to filter what is available in the market and determine the cutting edge of their industry. This allows SMEs to be more proactive in implementing radical innovation. In addition, sharing dynamic information and knowledge with partners contributes to the generation of new ideas and content, which helps improve the firm's innovation performance [61–63]. In addition, SMEs with limited resources have a low risk tolerance, which creates an incentive to avoid radical innovation, which involves greater uncertainty and risk compared to incremental innovation [64,65]. Digitalization helps companies discover, identify and prevent uncertainties [66] and reduce the degree of risk [67], thus encouraging SMEs to carry out radical innovations [68].

Results from a study of 253 technology-based SMEs in China [69], a study of 1,474 SMEs across industries in Germany [70], and a multi-site intervention study of SMEs in India and the United Arab Emirates [71] indicate that digitalization has a significant positive impact on both exploitative and exploratory innovation. Similarly, a study of 204 SME managers in Finland [72] showed that organizational ambidexterity mediates the relationship between digital orientation and growth strategies. These suggest that ambidexterity is more likely to lead to higher performance when accompanied by digitalization. However, the order of digitalization and ambidexterity may be reversed. A study of 366 small SMEs in Istanbul showed that digital transformation partially mediates the relationship between SMEs' ambidexterity and competitive advantage [73]. Similarly, a study using the 2019 World Bank Business Survey and follow-up surveys conducted in 2020 and 2021 among 8,928 companies in 21 countries indicates that organizational ambidexterity indirectly influences innovation through digital capabilities [74]. These findings suggest that organizational ambidexterity can increase a company's competitive advantage by enhancing digital capabilities. Although there are nuances in the causal relationships between these assumed variables across studies, there is a growing body of evidence that suggests that the combination of ambidexterity and digitalization enhances the performance of SMEs.

6. Digitalization and Green Innovation

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Furthermore, the use of digital technologies can improve the sustainability of companies. Despite the fact that SMEs account for 60-70% of the world's industrial pollution, they are less environmentally conscious than larger companies [75–77]. This is reflected in their insufficient knowledge of environmental technologies and laws [78,79]. Nevertheless, SMEs often undertake so-called green innovations, driven by stakeholder pressure and growing consumer demand to be more environmentally conscious [71,80]. Organizations can use digital tools to monitor resource usage in real time, optimizing processes, reducing waste and improving environmental efficiency [81,82]. For example, blockchain is used to prove that recycled raw materials are being used [83]. Digitalization can therefore improve environmental performance by facilitating the optimization of resource use and the implementation of circular economy and sustainable business models [84].

However, SMEs face unique challenges in implementing digital platforms, as they may lack the necessary resources, skills and commitment [85,86]. Therefore, human networks can be a key source of resources and facilitate SMEs' discovery of valuable opportunities [87–90]. For example, designing processes that handle production inputs consisting of used, recycled or recovered materials and transform them into customer value requires the involvement of partners, experts and customers who know about the benefits and limitations of materials in terms of the continuous circulation of materials and the reduction and elimination of waste [91–93].

7. Digitalization and Human Resources

In addition, highly educated employees, with a master's degree or higher, have a complementary influence on radical innovation [94]. Highly educated employees have rigorous logical thinking and decision-making abilities. Compared to employees without such education, they tend to be more interested in the long-term development of SMEs than in the short- and medium-term performance [95] and are therefore more motivated to carry out radical innovation. Their knowledge and capabilities help them adapt quickly to rapid changes, predict uncertainties more accurately and make timely adjustments [96]. They are able to absorb and integrate external knowledge acquired through digitalization into their internal innovation processes [97,98]. Thus, they can promote the adoption of new technologies and use them more flexibly to maximize the effects of digitalization. Digitalization can improve communication within and between companies, which allows highly educated employees to access new knowledge and resources for radical innovation [99]. This is especially important for SMEs with more constrained internal resources [100]. Digitalization also increases the efficiency and productivity of highly educated employees, allowing them more time to innovate [101]. Moreover, as digitalization reduces the workload of routine tasks, highly educated employees are able to take on more non-routine tasks [102]. These non-routine tasks are conducive to radical innovation, as they can stimulate the generation of new ideas and increase divergent thinking.

The ability to leverage versatile and cost-effective resources such as digital infrastructure is particularly important for SMEs with general resource constraints [103]. However, SMEs tend to face financial constraints, and financial obstacles are a serious problem when investing in innovative activities [104]. In particular, limited funds are one of the main challenges in implementing digitalization [105,106]. Therefore, there is a need for human resources in SMEs who are responsible for financing. By acquiring financial resources, companies can strategically invest in the innovations they need to develop competitive advantages [107]. Specifically, strategies such as having top management team members with strong financial backgrounds build good relationships with financial institutions through relationship networks, increasing access to financial resources and mitigating financial constraints are required [108,109]. A study of 1,303 listed manufacturing SMEs in China found that digitalization in SMEs promotes radical innovation more than incremental innovation, and that the employment of highly educated employees and the financial background of top management team members strengthen this relationship [68].

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8. Discussion

This study has shown that ambidexterity is linked to SMEs' resilience and green innovation to reduce environmental impact, and that the longer-term or more macroscopic perspective is taken, the greater the significance of SMEs adopting ambidexterity. What enables resource-poor SMEs to be ambidextrous is OI, which allows them access to external resources. However, OI is costly. Therefore, in order to enable ambidexterity, SMEs need to promote digitalization and be able to handle the costs required for OI. Digitalization also requires human or financial networks to support it. Ambidexterity carried out in such an environment contributes to the development of SMEs.

The digital revolution is increasingly requiring SMEs to pursue technological innovation and adhere to environmental sustainability goals [110]. However, SMEs remain cautious in adopting the solutions offered by digital technologies [110,111], and the smaller they are, the more so [112]. Underdeveloped investments and capabilities in automation, a lack of resources and perceived uncertainty are the main obstacles for SMEs to participate in digital manufacturing at the same rate as larger companies [113]. However, if SMEs can develop digital platform-related capabilities, the platforms could become a major growth driver [18].

Digitalization, by making ambidexterity possible, has the potential to enable innovations such as green innovation, which are necessary in the modern era. In Japan, one in four SMEs have received some kind of request from their business partners regarding decarbonization, and 70% of companies are taking measures toward decarbonization, mainly focusing on energy conservation. However, even these companies cite a lack of manpower and know-how, emissions measurement and visualization, and funds to work on emissions reduction as challenges, and therefore are not making sufficient efforts toward decarbonization [114]. This suggests that SMEs with fewer resources are not fully creating the environment necessary for green innovation. Therefore, there is a lot of room for SMEs to solve the challenges they face by increasing the efficiency of resource use through digitalization, enabling them to explore for green innovation while exploiting existing technologies.

It is difficult to say whether ambidexterity is beneficial for individual SMEs. Therefore, it may not be advisable to recommend it to underprivileged SMEs that are at risk of bankruptcy. However, apart from SMEs with such imminent risks, ambidexterity is worth pursuing as a future-oriented policy. This is even more true when viewed on a national or global scale beyond individual companies. Such discussions could greatly expand the existing ambidexterity research stream. That is, even if it is not necessarily the best for individual companies, ambidexterity may be judged as a recommended approach for SMEs when evaluated from a macroscopic, long-term perspective. Ambidexterity may be useful as a means for SMEs and countries, or the world, to find a compromise to address global challenges such as decarbonization. Therefore, further progress in digitalization and its dissemination among SMEs are necessary, and it is considered that national, local, and international organizations are required to provide related support as a matter of top priority.

Based on this research, in the future, national and local governments should use their budgets to promote open innovation and digitalization of SMEs. Uniform current and subsidy provision may encourage SMEs to exploit, which may contribute to their survival, but may not be effective in encouraging exploration and green innovation. In addition, to prevent OI from becoming too costly, the government should create opportunities for collaboration between companies, or between companies and specialized institutions such as universities, and promote the development of infrastructure for digitalization. This will lead to open innovation and digitalization, and innovation in line with the SDGs and trends of the times will help SMEs to gain global trust and make it easier to make profits.

9. Conclusions

Studies vary on the impact of ambidexterity on the performance of SMEs. This narrative review addressed the relationship between ambidexterity and open innovation, digitalization, and green innovation. Whether ambidexterity translates into short-term performance for individual SMEs

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depends on the circumstances. However, considering long-term national and global challenges such as decarbonization, ambidexterity should be promoted. Government support, including human and financial support, is needed for open innovation and digitalization in SMEs.

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