Implications of the "momentum" theory of digitalization in accounting: Evidence from Ash Cloud

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ABSTRACT

We aim to demystify digitalization in accounting (DIA) based on the case study of Ash Cloud, a digital factory in Shenzhen, China. From the perspective of dynamic capabilities, we develop the "momentum" theory of DIA to illustrate that firm and executive characteristics drive digital transformation and organizational capabilities. Ash Cloud's CEO values and cultivates an organizational culture of transparency and openness, while the firm is characterized by cost pressures. Organizational capabilities shape digitalization in business processes and different approaches to DIA. Our findings suggest that the core competence of Ash Cloud is its capability for systems integration, which includes knowledge of redesign, reconfiguration and redefinition. Ash Cloud stands out because of its knowledge extending beyond the firm's boundaries.
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1. Introduction

With digital and intellectual technology development, enterprises are paying increasing attention to digitalization in accounting (DIA). The core of DIA is to realize accounting automation and management intelligence, with the aim of empowering firms' decision-making abilities. However, to date, very few firms have achieved DIA (Accenture, 2021).[1] As reported in the Harvard Business Review, 70 % of all digital transfor-

mation initiatives do not reach their goals (Tabrizi et al., 2019).[2] Kane et al. (2015, p.3) argue that a digital strategy drives digital maturity; in other words, "Strategy, not technology, drives digital transformation." Determining the critical success factors of DIA is an important issue that calls for more research. As few studies explore this issue, our study aims to determine these factors.

First, we develop a theoretical framework, namely, "momentum" theory, to identify approaches to DIA. Digitalization in the business process is analogous to streams in relation to DIA, which represents the ocean. Just as streams merge to form rivers, and rivers eventually end up flowing into the ocean, the achievement of DIA can be a natural outcome of digitalization in the business process. In our conceptual model, firm and executive characteristics help to form the momentum and willingness to transform digitally. Accordingly, we propose two determinants of successful DIA: (1) organizational capabilities and (2) digitalization in the business process. Without these two determinants, it is virtually impossible for a firm to realize DIA. Finally, we distinguish four approaches to DIA along two dimensions, architectural knowledge and component knowledge. Incremental and radical approaches are two extreme points on the spectrum, with modular and architectural approaches in the middle.

Next, we apply "momentum" theory to analyze the DIA of Ash Cloud, a digital factory in Shenzhen, China. We choose Ash Cloud because it is one of the first firms to develop an iOS-based enterprise resource planning (ERP) system worldwide. Related information and videos are available on the Apple website.[3] The digital factory of Ash Cloud is an excellent example of the way that digitalization can help the real factory run faster and more transparently than before, and it has attracted many visitors from all over the world, including representatives from Foxconn, the Ministry of Economy, Trade and Industry of Japan, LG Corporation and the Massachusetts Institute of Technology.[4]

Our study makes three main findings. First, the CEO of Ash Cloud highly values and intentionally cultivates an organizational culture of transparency and openness. The firm's business is primarily characterized by cost pressures but, at the same time, this feature matches the CEO's characteristics, which make him focused on minimizing cost and controlling risk. Second, from the evidence of Ash Cloud, we find that DIA is a natural outcome of digitalization in the business process, which is consistent with the "momentum" theory of DIA. Since the launch and development of its internal ERP system, Ash Cloud has accomplished the goal of real-time management of assembly lines. As such, every Ash Cloud employee is engaged in data gathering and entry, and no one oversees the preparation of financial statements, which are automatically generated. Third, Ash Cloud strives to maintain its systems integration capability (Brusoni et al., 2001; Pavitt, 2003) by acquiring knowledge beyond the firm's boundaries. Such core competence enables Ash Cloud to accumulate knowledge on redesign, reconfiguration and redefinition.

Our findings contribute to the literature on DIA, as few studies explore the critical success factors of digitalization or DIA (Finny and Corbett, 2007). Importantly, "momentum" theory can be generalized beyond the specifics of our case study. Referring to our 2×2 matrix of approaches to DIA, Ash Cloud takes the architecture approach, whereas Alibaba and Midea follow the incremental approach and the modular approach, respectively. The second contribution is that our case study provides a vivid description of how a Chinese manufacturing firm succeeds in DIA. As accounting studies that offer in-depth empirical findings on DIA and its effects remain scarce (Knudsen, 2020), our study expands this literature. A growing number of manufacturing firms have realized the importance of digital transformation, and our findings offer different approaches to achieving their potential.

The remainder of this paper is organized as follows. We develop the "momentum" theory of DIA and a conceptual model of DIA in Section 2. Section 3 describes the research design and methodology. Section 4

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[2] Specifically, of the US$1.3 trillion that was spent on digital transformation in 2019, approximately US$900 billion was wasted investment; the primary message for businesses from this experience is to figure out the business strategy before investment (Tabrizi et al., 2019).

[3] Source: https://www.apple.com/ae/business/success-stories/manufacturing/ash-cloud/ (accessed 5 June 2022).

[4] In addition, a video clip from a program (China 2025) that was initially broadcast on CCTV (China Central Television) introduced the CEO of Ash Cloud as a pioneer of smart manufacturing. It is available at https://www.iqiyi.com/v_19rr9ynvms.html (accessed 5 June 2022).

presents the case study description and background. Section 5 analyzes what makes Ash Cloud successful. Section 6 discusses implications and concludes the paper.

2. Research framework: "Momentum" theory

We develop our research framework and conceptual model based on dynamic capabilities in strategy management (Teece et al., 1997; Dosi et al., 2000). The interdisciplinary foundations include evolutionary economics (Nelson and Winter, 1982), technological innovation (Teece, 1986) and transaction costs (Williamson, 1975; 1985). From the lens of dynamic capabilities, knowledge and competence are essential sources of competitive advantages. Meanwhile, organizational capabilities are endogenous, continuous and accumulated. Similar to the resource-based view (Penrose, 1959; Wernerfelt, 1984; Barney, 1986), the dynamic capabilities framework regards knowledge and competence as essential resources that are valuable, rare, inimitable and non-substitutable (Barney, 1991). As such, we argue that DIA could be analogous to the "momentum" theory discussed in the next subsection.

2.1. The "momentum" theory of DIA

We propose the "momentum" research framework as an attempt to understand DIA, which may assist in providing insights from an analysis of Ash Cloud or other case studies. Fig. 1 maps the four elements involved in the "momentum" theory of DIA: high hills, flows, sluices and the ocean. Digitalization is the flow, moving from the high hills to the ocean. In other words, digital transformation or digitalization is an inevitable trend; going with the flow is much easier for firms than attempting to move against the flow.
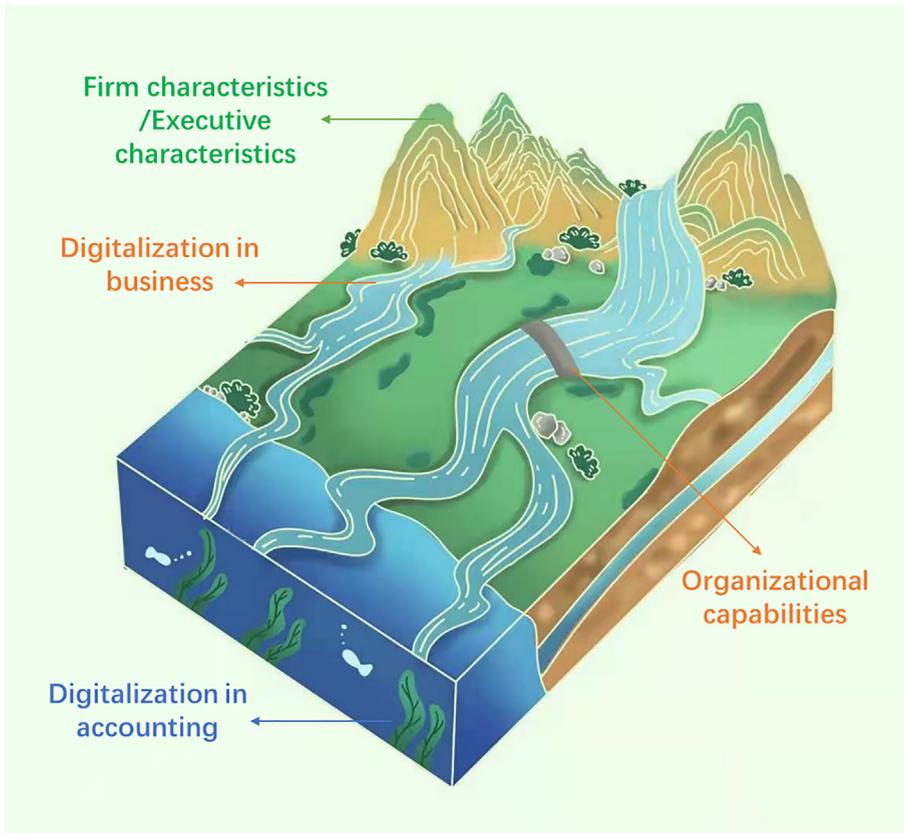

Fig. 1. Conceptualization of DIA.

Specifically, high hills in the upper part of the illustration (Fig. 1) represent firm and executive characteristics, which shape the momentum of digital transformation. They represent the firm's or the management team's willingness to allocate resources (the flows in Fig. 1). Next, the sluice gates represent organizational capabilities, which control the flow and the water level. Firms might be motivated to invest in digital initiatives, but they cannot successfully achieve digitalization without organizational capabilities.

In Fig. 1, digitalization in business is comparable with the streams, whereas DIA is comparable with the ocean. As we know, streams merge to form rivers, while rivers eventually flow into the ocean. Digitalization within a firm often starts with business processes because digitalization in business supports business operations. Business operations are expected to create cash flow and are thus under tremendous pressure. Put differently, no matter what achievements firms have made in business digitalization, "exits" (or outputs) of digitalization are needed, and the exits are DIA. All activities in business operations and all relevant data will merge in the finance office and ultimately realize DIA. Thus, we propose the "momentum" theory of DIA to develop the conceptual model discussed in the next session.

2.2. A conceptual model of DIA

Under the "momentum" theory of DIA, we build a conceptual model of DIA to further the understanding of digital transformation (Fig. 2). The first component of the model is firm characteristics. What kinds of pressure drive firms to initiate digital transformation and what is the "binding force"? From the lens of transaction costs (Williamson, 1975, 1985), digitalization may increase transparency and openness, enhance work efficiency and reduce communication costs, which will eventually lower transaction costs both internally and externally. From the lens of competitive advantages, a firm in a shifting industry (e.g., smart, connected products) must gain a price premium, operate at a lower cost than its competitors or both (Porter and Heppelmann, 2014). By adopting DIA, managers could understand how, where and when a business process creates economic value to choose the processes that should be eliminated, improved or redesigned (Sonnenberg and vom Brocke, 2014). Using an event approach (Sorter, 1969; McCarthy, 1982), Sonnenberg and vom Brocke (2014) propose a process accounting model to illustrate business process-oriented accounting, which combines financial/non-financial information and produces real-time reports on which managers can act. A growing literature studies how organizational mindfulness toward digital transformation influences information processing capabilities (Li et al., 2021). If a firm is under no pressure, it will have little motivation to invest in digitalization. In our case, one of Ash Cloud's key concerns is cost pressure. In the case of state-owned enterprises (SOEs), pressures may come from the State-owned Assets Supervision and Administration Commission of the State Council (SASAC), in line with its longstanding objective of "separating government from corporate governance" (Guo and Lu,
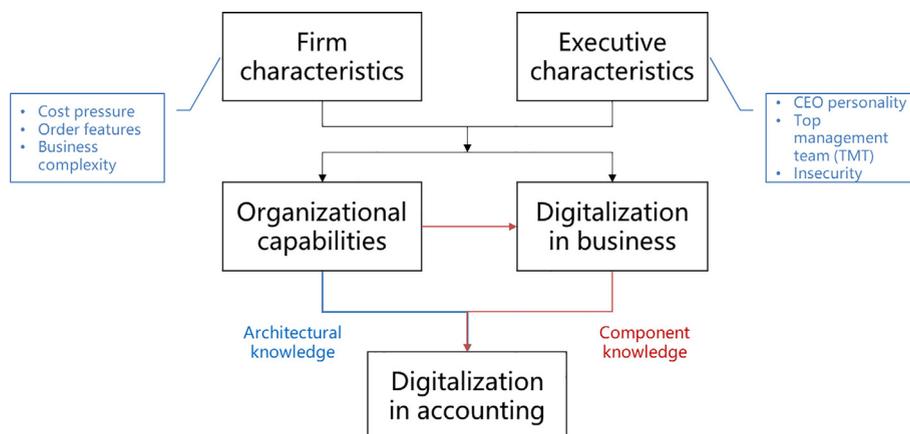

Fig. 2. A conceptual model of DIA.

2007, p.20). Moreover, order features and business complexity are other firm characteristics that affect decision-making in relation to digitalization.

Second, executive characteristics might be an impetus for strategic change. The role of managers in business strategy is critical inside the organization (Augier and Teece, 2009; Porfírio et al., 2021). In addition to allocating expenditure to R&D, managers should orchestrate the resources and dynamic capabilities needed to innovate. According to the framework developed by Winter (2000), leaders' aspiration levels may affect organizational incentives to develop innovative and digital capabilities. In particular, their aspiration level could shape strategic intent (Hamel and Prahala, 1989), and the imbalance between strategic intent and organizational capability might drive firms to accumulate knowledge and experience. From the lens of DIA, an organization's motivation for digitalization is associated with its leaders' aspiration levels and orchestration of resources. In other words, leadership characteristics can promote more advanced stages of digital transformation (Porfírio et al., 2021).

Third, firm characteristics and executive characteristics are associated with organizational capabilities. Indeed, both firm and executive characteristics influence the portfolio of organizational capabilities they would like to accumulate, such as ordinary or dynamic capabilities. The purpose of ordinary capabilities is to increase technical efficiency in business functions, while dynamic capabilities arise from the congruence of technological and business opportunities (Teece, 2014). As foundations to achieve DIA, ordinary capabilities refer to best practices for controlling costs, whereas dynamic capabilities refer to signature processes or organizational routines that have developed over time through the accumulation of tacit knowledge and organizational learning (Winter, 2003; Gratton and Ghoshal, 2005). Financial process mining, one such dynamic capability, requires a prescient assessment of the competitive environment, technological opportunities and resource orchestration (Werner, 2017). Teece (2014) considers that ordinary capabilities can be bought or built through learning, but dynamic capabilities can only be built through learning. However, the ability of a CEO or the top management team to sense a trend, seize a chance and lead a transformation is part of the firm's capabilities or even the most visible feature of its dynamic capabilities (Adner and Helfat, 2003). To some extent, dynamic capabilities and entrepreneurial management can explain heterogeneity among firms (Teece, 2016) because the knowledge of individual managers and the idiosyncratic organizational routines makes rivals difficult to imitate (Gratton and Ghoshal, 2005).

Fourth, organizational capabilities shape digitalization in business processes and eventually lead to DIA. There are two arrows leading to DIA in the lower part of Fig. 2, namely, architecture knowledge and component knowledge. The distinction between the product as a system and the product as a set of components underpins the notion that successful product development requires both component knowledge and architectural knowledge (Henderson and Clark, 1990). If DIA is regarded as a product development process, firms that aim to achieve digital transformation might choose different approaches according to their organizational capabilities and knowledge.

2.3. Approaches to DIA

Next, we distinguish the four approaches to DIA along two dimensions shown in Fig. 3, following Henderson and Clark (1990). The horizontal dimension describes the emphasis of digitalization on component knowledge, while the vertical emphasizes architectural knowledge. Thus, approaches to DIA include I) the incremental approach, II) the modular approach, III) the architectural approach and IV) the radical approach. To some extent, the incremental and radical approaches can be considered two extreme points on the spectrum, while many real cases fall in the middle under the modular and/or architectural approaches.

Quadrant I in Fig. 3 captures an incremental approach to DIA, which requires reinforced component knowledge but few changes in architectural knowledge. The incremental approach involves successful digitalization in business leading to DIA. Under this approach, firms may not necessarily intend to excel in DIA but effectively "drift" into it. For instance, Alibaba provides a good example of such an approach, as its e-commerce features digitalized processes and its digital maturity in To B (business to business) and To C (business to consumer) could be applied easily to its internal financial processes.

Quadrant II of Fig. 3 captures a modular approach that requires overturned component knowledge but few changes in architectural knowledge. For factories that assemble sophisticated products and for large groups

Component

	Reinforced	*Overturned*
Unchanged	I. Incremental approach	II. Modular approach
Changed	III. Architectural approach	IV. Radical approach

(Left axis label: Architecture)

Fig. 3. Approaches to DIA.

with global segments, it may be easiest to choose this approach to DIA to build a "system of systems" (Porter and Heppelmann, 2014) and connect different databases because it is likely that they already possess various systems, such as ERP, supply chain management (SCM), customer relationship management (CRM) and manufacturing execution system (MES). To illustrate the combination of architecture and component knowledge in this quadrant, Midea Group, an electrical appliance manufacturer, provides an example of this modular approach. During Midea Group's digitalization, a few components of its systems have been improved but its architecture as a whole remains unchanged, namely, it is based on Oracle's ERP system.

Quadrant III represents the architectural approach, which requires reinforced component knowledge and changes in architectural knowledge. Ash Cloud provides the best example of this approach, as it has integrated iOS-based ERP across its business processes, including procurement, production, sales and accounting. We will discuss this further in the case description and analysis, i.e., Section 4 and 5.

Compared with the other approaches, the radical approach (Quadrant IV) is more creative but also destructive. Similar to radical innovation (Tushman and O'Reilly, 1997), a radical approach is more difficult for firms to implement due to technological inertia, conflicts of interest and internal culture. In other words, in terms of our conceptual diagram in Fig. 1, it would be very difficult to "create" water and pour it into the ocean, which would exemplify the radical approach. However, a natural question is how a firm could implement DIA in a radical way. Possible solutions are to shift from either Quadrant II to Quadrant IV or from Quadrant III to Quadrant IV. From the perspective of dynamic capabilities, know-how (such as tacit knowledge) should be accumulated through learning (Teece et al., 1997; Dosi et al., 2000). A firm's achievement of DIA might turn out to be a radical innovation, like the iPhone, with news headlines announcing "Apple reinvents the Phone" in 2007.[5] However, the whole journey of digital transformation is done step by step, day by day. The radical approach to DIA is yet to occur in a real-life example, which means that Alibaba, Ash Cloud, Midea and many other firms that are on the path to DIA may have a chance to reinvent DIA.

3. Research methodology

3.1. Method and case selection

Regarding the research questions mentioned above, we use a single case study and collect data from semi-structured interviews with Ash Cloud's management teams and workers. First, as Yin (2018) notes, case studies are the preferred strategy when "how" and "why" questions are posed. Second, DIA is a new research area and undergoing change, and case studies are empirical inquiries that are suitable for new research areas or research areas for which existing theory seems inadequate (Eisenhardt, 1989; Yin, 2018). Third, there are few accounting studies offering empirical evidence on the effect of DIA (Knudsen, 2020).

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[5] Steve Jobs used this slogan to introduce the iPhone to the world on 9 January 2007. Similarly, the breakthrough Apple made cannot be accomplished with one stroke. It is a result of unique experiences from long-term R&D.

Table 1
Data collection.

Phases	Methods	Main tasks		Remarks
Phase 1	• Desk research On-site visit	• Collect media reports on Ash Cloud Observe the real-time management of assembly lines		• Obtain consent for case study Summarize the theoretical foundations
Phase 2	• Online interviews	• Online interviews with the CEO of Ash Cloud and other members of its management team. (15 October 2021)		• Collect first-hand information about digitalization in Ash Cloud
Phase 3	• On-site visit and interviews	• Face-to-face interviews with demand analyst and workers (23–24 November 2021)		• Double-check the conceptual DIA model

In the appendix, Table A1 lists some selected quotes from our interviews.[6] Following Yin (2018) and Kokina et al. (2021), we employ pattern matching, an analytical technique that compares a pattern found in interview data with a pattern predicted before data collection.[7]

3.2. Data collection

We combine different data collection methods, such as archives, interviews and observations, in our case study research. Table 1 illustrates our data collection processes. In Phase 1, we collect media coverage on Ash Cloud in both English and Chinese to obtain a general idea of its business model and history. In addition, we review the relevant literature to build the theoretical foundations of our research. In Phase 2, we gather first-hand data and materials through online interviews with the CEO of Ash Cloud and other members of the management team and draft the initial conceptual model of DIA. In Phase 3, we modify our conceptual model through the second-round interviews at Ash Cloud. The final phase allows us to cross-validate the information and data obtained during the first two phases (Yin, 2018).

4. Case description

4.1. Exploration stage: 2004 to 2005

Ash Cloud was established in Shenzhen, China, in June 2004 to produce mobile phone accessories for global clients. In the early stages of its operations, most leather phone case orders came from Europe. Over time, order quantities became smaller and more diverse. The gross profit margin of mobile phone accessories was quite considerable, often more than 50 %. However, Mr. Guanyi Chen, the CEO of Ash Cloud, realized that production management could be improved to increase profit margins further. The CEO deliberated whether to purchase an ERP system or build one. He found that the prices for mainstream ERP suppliers were high, exceeding Ash Cloud's 1-year operating income at that time. Moreover, the functions of an off-the-shelf ERP system would satisfy at most 80 % of Ash Cloud's requirements, and concerns about system compatibility would remain. A team led by Mr. Chen began investing in digital initiatives to reduce production costs. Specifically, from the second half of 2005, the members of the management team decided to build their own internal ERP system.

4.2. Growth stage: 2006 to 2011

The first version of Ash Cloud's ERP system, launched in 2006, integrated purchases, sales and inventory management. Subsequently, assembly line, human resources, administration and other functions were gradually added to the internal ERP system. With Apple's launch of the iPhone in 2007, Ash Cloud developed an iOS-based ERP system; before that, its ERP system was PC-based. In 2011, Ash Cloud launched its first ver-

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[6] All interviews were conducted in Chinese and we translated the quotations to English. All errors are ours.
[7] Referring to Yin (2018), if the predicted and found patterns converge, internal validity is strengthened, allowing conclusions to be drawn.

sion of the iOS application for its internal ERP system and introduced its first iPad device to facilitate process management. In addition, the project team led by Mr. Chen began to redesign the packing factory to use more automated machines than before, which had the double benefits of reducing costs and human errors, as well as helping the management team to improve efficiency by instantly and remotely monitoring production lines.

4.3. Optimization stage: 2012 to 2016

To optimize the iOS application, Ash Cloud supported its software engineers to learn PHP, a scripting language for website development, and MySQL, a database management system, in Beijing. They emphasized aesthetics, quality and durability when seeking suitable materials and machines to redesign leather case manufacturing. In 2016, Ash Cloud introduced the "ALLrounder" injection molding machine for plastics processing by Arburg, a German machine construction company, one of the world's leading manufacturers of such machines. Together with the MES developed, the new injection molding machine enabled Ash Cloud to track and collect all of the data required to produce a mobile phone case. In the smart factory of Ash Cloud, humans and robots can work together, with robotic arms serving as extensions of the human body (Het Nieuwe Instituut, 2018). In Ash Cloud, robots and automated facilities have not replaced humans, but they have become managers. For example, as illustrated in the middle of Fig. A1 in the appendix, a dashboard reports the real-time performance of work in zone E. When the daily performance of a worker is unusually slower (faster), an emoji of a tortoise (rabbit) will display on the dashboard.

4.4. Maturity stage: 2017 to the present

Step by step, Ash Cloud used iPhones, iPads and different applications to modernize its ERP system across the business, from procurement to production, from sales to support and from the factory to the finance office (see Figs. A1 and A2 in the appendix).[8] Thus, its iOS-based ERP system became an integrated information system. Specifically, Ash Cloud's iOS application is not a system of systems (Porter and Heppelmann, 2014) but an integrated system featuring the functions of ERP, SCM, CRM and MES. With the growth of labor costs and the intensity of competition, the gross profit ratios of manufacturing firms in China are decreasing. The average gross profit ratio of its peers is approximately 10 %, whereas that of Ash Cloud is above 18 % (see Fig. A3 in the appendix). Its financial performance provides evidence that digitalization in business and DIA improve the efficiency of production, operations and management, enabling Ash Cloud to outperform its peers.

In addition to producing mobile phone and tablet accessories, since 2017, Ash Cloud has expanded its business to provide other firms with consulting advice and assistance on how to implement their iOS applications and provide solutions for iOS-based ERP systems. That is, although Ash Cloud originally designed the application to fit its own operational processes, it then redesigned it to fit broader business scenarios. Close to 40 manufacturing firms have installed Ash Cloud's application and upgraded their processes and production lines.

When we asked the CEO what were the advantages of Ash Cloud compared with financial software suppliers (such as Yonyou and SAP), the CEO responded as follows:

> It is our front-end business that is real-time reporting. Mr. Hang Chen, the former CEO and founder of Ding (钉钉), visited many industrial Internet platforms around China. From his experience, only Ash Cloud has achieved online business processes (or rather, the real-time reporting of business processes). Ding is famous for its online human resources and online organizations. Mr. Hang Chen spoke highly of Ash Cloud's digitalization, as he said that we are the only one in the market that realizes real-time reporting of business processes.

Ash Cloud's iOS-based ERP system can automatically generate balance sheets and income statements, which was sufficient to satisfy its initial needs; later, it added the cash flow statement in response to demand from its clients. According to our interview with the CEO of Ash Cloud, no one in the company is in charge of

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[8] A video clip on "Ash Cloud Open day" is available at https://v.youku.com/v_show/id_XMjg3MjU5NzMzNg==.html?spm=a2h0c.8166622.PhoneSokuUgc_9.dtitle (accessed 5 June 2022).
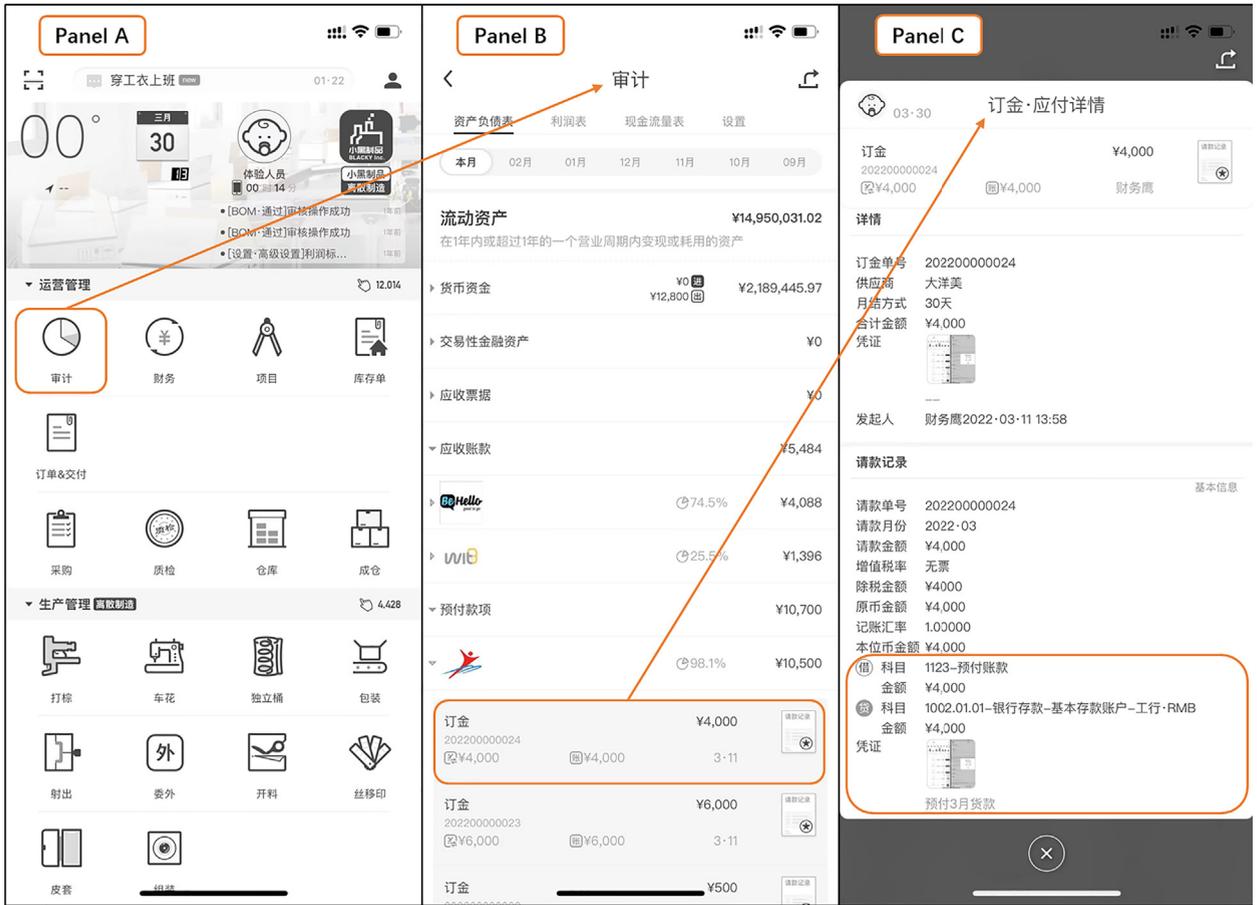
Fig. 4. The financial statements in Ash Cloud's ERP system.

preparing financial statements. Instead, every Ash Cloud employee participates in data gathering and data entry. Fig. 4 illustrates the details incorporated into the balance sheet. After clicking the "audit" icon, shown in Panel A of Fig. 4, it is possible to check the financial statements in real time. Selecting orders in the pull-down menus of each balance sheet item (e.g., "prepayments" in Panel B) presents detailed information, such as order numbers, debit and credit accounts and original documents (Panel C). Thus, all of Ash Cloud's accounting data are automatically collected based on its iOS-based ERP system.[9]

5. Case analysis: What drives a firm's achievement of DIA?

5.1. Firm characteristics

The first firm characteristic that drives manufacturing firms such as Ash Cloud to achieve DIA is cost pressure, in that the profit ratio of this industry is relatively low compared with other industries. In such cases, as the old saying goes, a penny saved is a penny earned. Without DIA, a small and medium-sized enterprise would struggle to survive. Our interview with the CEO of Ash Cloud made his strong intention to control costs evident. In other words, cost minimization was Ash Cloud's top priority. For example, as Mr. Chen commented:

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[9] Four video clips on how Ash Cloud realizes DIA via its iOS-based ERP are attached with QR codes in the appendix (Fig. A4): for example, (1) real-time income statements showing details of each order, (2) the user guide for the cash flow statement and (3) a demonstration of direct ICBC (Industrial and Commercial Bank of China) payment.

Since our establishment in 2004, I would have liked to accept orders featuring a smaller quantity but more diversity. Why? Because large order quantities are associated with price negotiations, while small orders give me pricing power. However, with the number of orders becoming smaller and more diverse, all management is about cost control, including controlling waste, inventory and delivery.

In contrast, cost inefficiency appears to be common for traditional (non-digitalized) firms. For instance, internal transaction costs or frictions will increase if interdepartmental handover delays become frequent. These delays might result from the bureaucratic structure, conflicts of interest or information asymmetry. Accordingly, for traditional non-digitalized firms, it may be harder to achieve digital transformation than for digitalized firms.

Nevertheless, some small and medium-sized enterprises such as Ash Cloud have the motivation and are under pressure to reduce costs. Digital transformation provides them with opportunities to use new technological tools to improve internal transparency, which helps to decrease internal fraud and frictions. Ash Cloud attempts to understand every business and every process. In doing so, it has been made aware of many avoidable costs. For example, consider a situation where we would like to find a vendor to purchase something. Traditionally, we might call the potential vendor without documenting the process and we would have little knowledge of whether the price is fair or, later on, whether there is something wrong with the order. However, in a digitalization scenario, firms use systems (e.g., Oracle and SAP) and applications (e.g., Ash Cloud) to help record and manage the procurement process, which enables them to compare prices from different vendors over time, check the qualifications of suppliers and review the order history of a certain product. In the case of Ash Cloud, the firm kills two birds with one stone, as digitalization not only helps the firm cut costs but also cultivate an organizational culture of transparency and openness.

5.2. Executive characteristics

The trait of Ash Cloud's CEO that drives his firm's achievement of DIA is insecurity. To cope with the insecurity and uncertainty of his business and industry, Mr. Chen endeavors to keep every operational routine under control. As he commented, "In my small business, I would be unable to fall asleep if many processes were out of control."

Specifically, the CEO feels quite insecure when information within the organization is hidden and when there are leadership blind spots in his management. This was what drove him and his team to develop Ash Cloud's internal ERP system. Using their iOS-based ERP application, the CEO of Ash Cloud could reduce uncertainty and insecurity by being able to watch over every corner of his factory.

Another executive characteristic of Mr. Chen is his leadership style. According to Ms. Baimei Yu, a system analyst at Ash Cloud, "Many firms are not willing to use our App in that the finance and accounting function is too transparent and open."

However, the CEO's pursuit of information transparency makes the performance and qualifications of each supplier clear. As Mr. Chen said, "Information disclosure per se is the best defense for our firm, as exposure to the sun seems to be an anti-corrosion treatment. When everyone has a different notebook for accounting, it is easier to generate asymmetric information that may lead to misconduct." In particular, Mr. Chen insists that the iOS-based ERP system should be easy to use, in contrast to the PC-based ERP system, and as simple as possible.

As a detail-oriented person, Mr. Chen believes that one should "buy the furniture items and office stationery that will last however long you want to operate the business." Many trolleys, chairs and tables have been in use since the establishment of Ash Cloud and may have cost more than similar items purchased by peers, but high-quality items cost less in the long run as they do not need to be replaced.

5.3. Organizational capability

An important issue is whether firms that aim to achieve digital transformation are actually capable of digitalization? We argue that they would not accomplish such aims without organizational capability. The distinct capability of Ash Cloud is to redesign or redefine. Over 5,000 people from Foxconn, a famous supplier of Apple, visited Ash Cloud. As Mr. Chen recounted, Mr. Taiming Guo (known as Terry Gou),

the founder of Foxconn, asked Mr. Guanyi Chen,[10] "Don't you worry that I would copy your system and application?"

Mr. Chen answered as follows:

> I don't think you could copy it. For instance, if you employ the world's top maintenance engineers at BMW's 4S (Sale, Spare part, Service, Survey) stores, no matter how many thousands, it would be hardly possible for them to design new automobiles for BMW. As design is disruptive, being a maintenance engineer is not equal to being innovative. Innovation means redefinition. How many soft engineers at Foxconn are capable of redesigning? I think the answer is zero.

Ash Cloud has not applied for any copyright or patent protection for its internal ERP system. Mr. Chen said that he would like to see peers' copies because their imitations mean that Ash Cloud is doing the right thing.

5.4. Toward DIA: Ash Cloud's industrial version of LEGO building

When explaining Ash Cloud's company philosophy, Ms. Baimei Yu (a system analyst at Ash Cloud) said, "Our boss's philosophy is to build an industrial version of LEGO[11]: whatever I want, I will build it myself. For example, those small molds on the shelf are made by us."

As mentioned, Ash Cloud has introduced some advanced machines (e.g., the "ALLrounder" by Arburg) to achieve assembly automation. Hence, to fit its business processes and iOS-based system, the CEO of Ash Cloud always leads his team to redesign the tools, just as one builds one's own creative toy with LEGO's bricks and pieces. According to the management team of Ash Cloud, "We do not achieve a lot of innovation but always try to find the best tool or solution."

No matter how humble they are in recognizing their creative ability, Ash Cloud makes significant progress toward an architectural approach to DIA. Specifically, when describing why Ash Cloud selected iPhones and iPads as terminals, Mr. Chen remarked:

> When we arrived at the offices 10 or 15 years ago, we first started our personal computers or laptops and logged on to the Sina or Yahoo website to read the latest news. Now we read information through notifications from Toutiao (i.e., Tiktok). Likewise, the concept of ERP originated in the 1980s, the system of which is PC-based. Nowadays, terminals like iPhones and iPads are more flexible. Compared with a PC-based ERP system, our iOS-based application is lighter, suggesting that the customer experience of To B apps can be as good as that of To C apps or even better.

As Alex Chen, Operations and Project Manager at Ash Cloud, put it, "Apple has given us the tools we need to build an ideal management system, which has helped us achieve our vision."

5.5. The core competence of Ash Cloud

From the experience of Ash Cloud, its core competence is its systems integration capability (Brusoni et al., 2001; Pavitt, 2003), which includes its knowledge of redesign, reconfiguration and redefinition.

In effect, this systems integration capability has its foundations in daily routines and tacit knowledge. In addition to addressing explicit knowledge, acquiring tacit knowledge is critical for organizational capability. As mentioned, organizational capability is a continuous and accumulated process. Learning by doing helps obtain tacit know-how, which may enhance a firm's core competence (Prahalad and Hamel, 1990). The core competence of systems integration makes Ash Cloud successful in DIA. Because the division of labor can be different from the division of knowledge (Williamson, 1999; Brusoni et al., 2001; Pavitt, 2003), Ash Cloud stands out by possessing knowledge beyond the firm's boundaries (product manufacturing). Specifically, the division of labor may refer to product manufacturing, whereas the division of knowledge may underscore

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[10] During our online interview, we asked whether Ash Cloud was afraid of potential competitors for ERP service suppliers, especially from firms with abundant capital resources. Mr. Guanyi Chen quoted the conversations with Mr. Taiming Guo quoted above.

[11] LEGO is a Danish toy production firm based in Billund, Denmark. It manufactures Lego-brand toys, mainly consisting of interlocking plastic bricks (Source: Bing.com).

design and development. Similar to the value chain of Apple's iPhone, there is no one-to-one mapping between the division of knowledge and that of labor.

Overall, the core competence of Ash Cloud, systems integration, is acquired through organizational learning and accumulated through tacit knowledge. As such, the knowledge boundaries of Ash Cloud extend beyond its production boundaries, which helps us to understand its approach to DIA.

5.6. Alternative explanation

As suggested by Yin (2018), an alternative explanation should not be neglected. Admittedly, some may argue that the products of Ash Cloud are not that complex or that its organizational structure is not that large. Thus, in our conceptual model of DIA (Fig. 2), we hypothesize that firm characteristics (such as business complexity) impact digital strategies. To alleviate this concern regarding business complexity and its impact on DIA, we asked whether Ash Cloud's achievement of DIA is partly driven by its relatively simple production process. The management team replied:

> No matter how large the business scale, the key point is to check whether it changes or not. What has changed and what remains unchanged? In my opinion, what remains unchanged is the business processes, whereas the changed parts include production machines and specific procedures. Concerning these changed and unchanged parts, Ash Cloud is quite flexible to fit each production process of manufacturing firms, especially those in intermittent manufacturing. ... For example, a subsidiary corporation of Foxconn Group is a user of our iOS-based ERP system, and its product (computer server) consists of more than 4,000 pieces. It is undoubtedly feasible.

Such evidence shows that the core competence of Ash Cloud arises from its knowledge and experience in systems integration, which further enhances its organizational capabilities to sustain a competitive advantage.

6. Implications and conclusions

Our case study shows that the learning and accumulation of organizational capabilities is the foundation of digitalization. At the same time, both firm and executive characteristics can influence a firm's digital strategy or decision to initiate digitalization. In the face of intense competition and technological change, firms are highly unlikely to gain sustainable advantages or achieve digital transformation simply by imitating their peers. However, the development of organizational capabilities makes firms more resilient to market turbulence and more mature in DIA.

6.1. Implications

The organizational implication for firms is that knowledge and capabilities need time and must be accumulated. A product does not appear all of a sudden but as the result of learning and knowledge. That is, product development is a vital way to "learn by doing." Firms aiming for digitalization should emphasize the importance of the "D" (development) part of R&D. Many forms of know-how can only be learned from the experience of product development.

Another implication for policymakers is that leaders of SOEs should take an active part in digital transformation and have more patience to accumulate organizational capabilities. As stated previously, digital transformation is more about strategy than technology (Tabrizi et al., 2019). According to the literature, leadership characteristics shape strategic intent, organizational learning and digital transformation. The digital agenda should be led from the top (Kane et al., 2015). In China, digitalization has become a national plan (the 14th Five-Year Plan), increasing the responsibilities of SOEs to engage in digital initiatives. Digitalization in large firms will have more significant spillover effects than is the case for smaller firms, although their businesses may be much more complicated than those of small and medium-sized enterprises. Digitalization is not the ultimate goal but the way to improve operational efficiency and optimize organizational structure. Digital transformation per se will help SOEs sustain competitive advantages with technological changes such as 5G,

the Internet of Things and blockchains, the knowledge spillovers of which might solve technological pain points beyond the industrial boundaries.

6.2. Future directions

Our case study highlights three potential future directions. First, business intelligence or business analytics could be added to further DIA. Many algorithms, such as machine learning, may deepen our understanding of big data and social media. Real-time reporting would help us accomplish nowcasting instead of forecasting.

Second, although DIA is an inevitable trend, there are few studies on relevant topics. A financial decision support system may be the updated version of the accounting information system, as DIA is expected to support financial decision-making.

Third, digitalization blurs not only the boundaries of the firm but also the boundaries of professions such as accounting (Kokina et al., 2021). Digitalization may drive profound changes in how accountants think about acquiring, providing and using information for decision-making (Knudsen, 2020). It may even be possible that the role of the chief financial officer under DIA will be replaced with that of a chief information officer, chief technology officer, chief data officer or chief marketing officer, as more and more data from social media impact firm performance.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
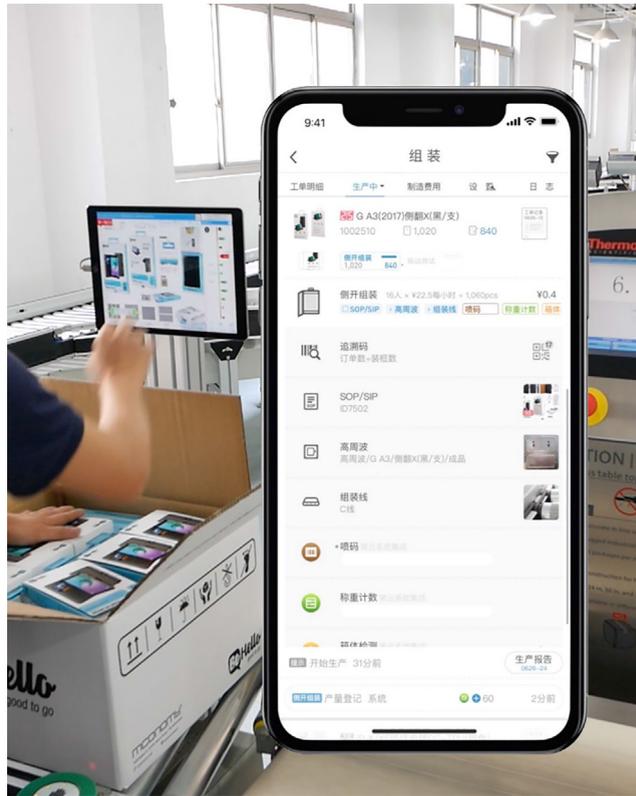

Fig. A1. The smart factory.

Fig. A2. The Ash Cloud app interface.

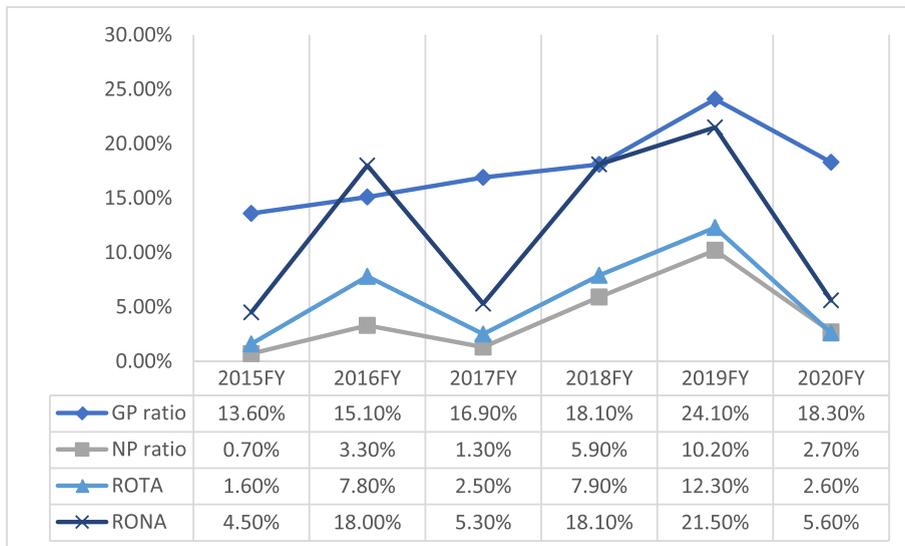|	2015FY	2016FY	2017FY	2018FY	2019FY	2020FY
GP ratio	13.60%	15.10%	16.90%	18.10%	24.10%	18.30%
NP ratio	0.70%	3.30%	1.30%	5.90%	10.20%	2.70%
ROTA	1.60%	7.80%	2.50%	7.90%	12.30%	2.60%
RONA	4.50%	18.00%	5.30%	18.10%	21.50%	5.60%

Fig. A3. Financial performance Notes: FY = fiscal year, GP = gross profit, NP = net profit, ROTA = return on total assets, RONA = return on net assets.

Fig. A4. QR code Notes: This QR code links to videos illustrating how Ash Cloud realizes DIA via its iOS-based ERP.

Table A1
Data analysis and sample quotes.

Example quote	Open code	Axial code
Since our establishment in 2004, I would have liked to accept orders featuring a smaller quantity but more diversity. Why? Because large order quantities are associated with price negotiations, while small orders give me pricing power. However, with the number of orders becoming smaller and more diverse, all management is about cost control, including controlling wastes, inventory and delivery.	• Order features • Cost pressure	Firm characteristics
No matter how large the business scale, the key point is to check whether it changes or not. What has changed and what remains unchanged? In my opinion, what remains unchanged is the business processes, whereas the changed parts include production machines and specific procedures. Concerning these changed and unchanged parts, Ash Cloud is quite flexible to fit each production process of manufacturing firms, especially those in intermittent manufacturing. . . . For example, a subsidiary corporation of Foxconn Group is a user of our iOS-based ERP system, and its product (computer server) consists of more than 4,000 pieces. It is undoubtedly feasible.	• Business complexity • Architectural knowledge • Component knowledge	Firm characteristics, Organizational capabilities
In my small business, I would be unable to fall asleep if many processes were out of control.	• CEO personality • Insecurity	Executive characteristics
Many firms are not willing to use our App in that the finance and accounting function is too transparent and open.	• Top management team	Executive characteristics
Our boss's philosophy is to build an industrial version of LEGO: whatever I want, I will build it myself. For example, those small molds on the shelf are made by us.	• Architectural knowledge • Component knowledge	Organizational capabilities
We do not achieve a lot of innovation but always try to find the best tool or solution.	• Component knowledge	Organizational capabilities
When we arrived at the offices 10 or 15 years ago, we first started our personal computers or laptops and logged on to the Sina or Yahoo website to read the latest news. Now we read information through notifications from Toutiao (i.e., Tiktok). Likewise, the concept of ERP originated in the 1980s, the system of which is PC-based. Nowadays, terminals like iPhones and iPads are more flexible. Compared with a PC-based ERP system, our iOS-based application is lighter, suggesting that the customer experience of To B apps can be as good as that of To C apps or even better.	• Digitalization in business • Architectural knowledge • Component knowledge	Approaches to DIA
I don't think you could copy it. For instance, if you employ the world's top maintenance engineers at BMW's 4S (Sale, Spare part, Service, Survey) stores, no matter how many thousands, it would be hardly possible for them to design new automobiles for BMW. As design is disruptive, being a maintenance engineer is not equal to being innovative. Innovation means redefinition. How many soft engineers at Foxconn are capable of redesigning? I think the answer is zero.	• Architectural knowledge • Component knowledge	Organizational capabilities, Core competence

Apple has given us the tools we need to build an ideal management system, which has helped us achieve our vision.	• Component knowledge	Approaches to DIA
It is our front-end business that is real-time reporting. Mr. Hang Chen, the former CEO and founder of Ding (钉钉), visited many industrial Internet platforms around China. From his experience, only Ash Cloud has achieved online business processes (or rather, the real-time reporting of business processes). Ding is famous for its online human resources and online organizations. Mr. Hang Chen spoke highly of Ash Cloud's digitalization, as he said that we are the only one in the market that realizes real-time reporting of business processes.	• Digitalization in business • Digitalization in accounting	Approaches to DIA

Acknowledgements

Appendix A. See Figs. A1–A4 and Table A1.

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