



# Digital transformation of incumbent firms from the perspective of portfolios of innovation

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## ABSTRACT

Digital technology has created new elements of innovation types and given incumbent firms new portfolios of innovation. The portfolio of innovation used during a digital transformation allows it to be successfully implemented and gives a competitive advantage to incumbent firms. We present two propositions for the portfolio of innovation and its shift during the process of digital transformation. Based on an emergent innovation matrix, we conducted a multi-case study on three Chinese firms from different industries, in order to identify the novel innovation types that appear when these firms undergo digital transformation. The research suggests that incumbent firms innovate in various ways simultaneously to implement a digital transformation when faced with market and technology change, and the portfolio of innovation shifts during the digital transformation process.

## 1. Introduction

Currently, the advent of emerging digital technologies such as blockchains, artificial intelligence (AI), Internet of Things (IoT), digital infrastructure, and digital platforms as a whole has profoundly affected business practices, which has implications for both management strategy and policy [1–6]. Businesses in this way could harness the benefits of digital technology to stay competitive [7]. The term ‘digital transformation’ is substantially pervasive in contemporary business media, reflecting the drastically transformational influence of digital technology on firms. The link between digital technology and traditional industries breaks down organizational boundaries and changes the value creation process [8], and this link has also prompted novel business models, varieties of products/services, and kinds of customer preferences [9,10]. Furthermore, digital transformation challenges the specific ways incumbent firms may need to fundamentally change themselves to respond to technological and environmental changes and consequently succeed in the emerging digital era [11–13].

Recently, there has been an increase in academic articles [14,15] and practical reports on both digital transformation strategies [16] and the internal and external drivers of digital transformation [17,18]. This

upswing in publication reflects the fact that technology and the market are changing as a response to digital evolution, while imposing high-velocity contingencies upon incumbent firms. Generally, these external contingencies trigger incumbent firms to reflect on their chosen innovation type [19,20]. However, which innovation types will contribute to the digital transformation of manufacturing firms, and what changes the process of digital transformation will make in the portfolio of innovation, are still questions that need to be answered.

In this study, we define a portfolio of innovation as the combination of innovation types enacted by firms in one specific phase of a digital transformation. The success stories of some firms provide us with examples to support our starting proposition that the development of digital strategy requires focusing on the internet, cloud technology, artificial intelligence, and big data.

We seek to address the research gap on the question of to what extent innovation types could contribute to the digital transformation of incumbent firms in emerging economies. In other words, how can a firm design an innovation strategy to use during digital transformation from the perspective of innovation type?

Considering theories and practical limitations, we adopt a multi-case approach [21]. Based on the cases of Company G in the auto industry,

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Company T in the logistics industry, and Company Z in the energy equipment industry in China, we track the portfolios of innovation of firms in emerging economies during the process of digital transformation.

Our study makes three main contributions to the literature. Firstly, we enrich the extant research on innovation types during digital transformation by proposing two novel types: process-reconstruction innovation and product-renewal innovation. Secondly, we build on and extend the concept of the innovation portfolio by illustrating the sequential choices of the firms' innovation portfolio during digital transformation. Lastly, we build on the evolutionary perspective and contribute to the dynamic process of a firm's innovation portfolio strategy during digital transformation.

In the remainder of this study, we review the literature on transformation, digital transformation, artificial intelligence, innovation types, and technology and market dynamics. Accordingly, we make two propositions and put forward a basic research matrix using extant literature. We discuss the research methodologies used in the study, then illustrate the digital transformation process of specific firms, analysing the innovation types based on digital technology, and the portfolio of innovation and how it shifts. Building on prior phases, we finish by commenting on the digital transformation and discussing limitations and potential research aspects.

## 2. Literature review

### 2.1. Transformation of firms

Based on the traditional, functional organizational structure and adopting management reform [22], the transformation of a firm refers to the process by which the firm significantly improves its performance indicators (e.g. cost, quality, and service) to survive or develop better, which is the life cycle stage of a firm [23]. The success of the transformation is affected by the external environment and organizational culture [24,25], the pressure for change (which may come from performance pressure and technological change) and resources that affect the ability to change [26]. Furthermore, the transformation of a firm can be achieved through innovation and integration [27]. Resource use is important to the process of firm transformation, particularly the effectiveness with which incumbent assets are deployed. A firm undergoing transformation strives for continuous productivity growth, the creation of new competencies and new businesses, the challenging and changing of rules, and the quantum leaps past the competition [28].

### 2.2. Digital transformation of incumbent firms

Primarily, incumbent firms represent the firms that have already operated in the market with established external relationships and accumulated internal routines and capabilities [30]. Accordingly, incumbent firms could react differently to digital innovation strategies compared with new entrants [29]. Next, we will further define the digital transformation of existing firms.

With the emergence of next-generation information technologies (IT) such as cloud computing, mobile internet, big data, the IoT and AI, digital technology has demonstrated its natural advantages in optimizing resource allocation, production and service, and organizational change [31,32]. In particular, AI is an emerging technology with great potential for change. AI could reduce the perceived complexity faced by decision makers and thus provide certainty in an uncertain environment [33], supporting the firm's existing business through digital transformation projects [34]. AI has been growing into a complementary strategy and a new way of decision-making, changing business models across multiple industries [35]. AI is just one of several digital strategies. Others include employing IT, digital networks, and other technologies to provide individuals, groups, and organizations with new opportunities and challenges [36].

The remarkable development of digital technologies and the growing popularity of high-speed internet services have fundamentally changed firm operations and business models [37]. For instance, digital strategies will fuel sales and productivity improvements, helping businesses get the most out of them and reducing costs [37]. They can facilitate the integration of supply chain management-marketing functions [38], value creation innovations [39], and new forms of interaction with customers. The extant literature has examined the mechanisms that drive an organization to participate in emerging technologies [40]. These new 'big things' lead to the successful replacement of a business model [41,42], or create new business models [5], which can be called digital transformation [15,43]. Further, by implementing new business models, firms could achieve better financial performance and attain competitive advantage as well [44].

From our multidisciplinary literature review, we learned that scholars agree that there are three stages of digital transformation: digital application, digitalization, and digital transformation (Verhoef, 2019). In the first phase, the firm mainly adopts digital technology to change some processes. In the second stage, the specific functions of digitalization are affected. In the third stage of digital transformation, the firm aims to transform their value creation and occupancy through the application of digital technologies. They then aim to implement digital technology in every function of the firm and focus on building digital capabilities to grow through specific digital growth strategies [14]. Digital transformation is a high-level transformation that is based on digitization and digitalization, further touching the firm's core business to create a new business model [45]. Digital transformation can be defined as the use of new digital technologies (social media, mobile devices, analytics, or embedded devices) to achieve significant business improvements, such as enhancing customer experience, simplifying operations, or creating new business models. At the organizational level, digital transformation involves changes in corporate strategy, structure, resources, processes, capabilities, etc., and can be understood as an opportunity to innovate and transform an organizational legacy of outdated capabilities, structure, processes, and business models [46].

Research suggests several perspectives relevant to the digital transformation of incumbent firms in emerging economies. One might consider the relationship between IT and a firm's business strategies to assess its capabilities for digital transformation [47], or look at the role of leaders like CIOs in the digital transformation process [48,49]. [43] proposed four dimensions in the strategy for digital transformation: usage of technologies, changes in value creation, structural changes, and financial aspects. Some articles discuss the connection between digital transformation and innovation management from the macro, meso, and micro levels [50].

The dynamic functional framework is one of the most critical topics in the field of strategic management, and dynamic capability is undoubtedly a major source of firms' competitive advantage [8]. Recent work has focused on how a firm's dynamic capabilities affect their process of evolving their business model [5,13]. The existing research on business model transformation suggests that it is a gradual process, a circular transition [51]. Research also targets digital transformation, concentrating on the information and communication industries, such as digital industries in emerging economies (e.g. Refs. [52,53], service industries like the consulting industry (e.g. Ref. [54], and the chemical industry [56]. Research is lacking on the digital transformation process in the garment industry, auto industry, and other manufacturing industries, especially in emerging economies.

Incumbent firms have acknowledged the significance of digitalization in business. The digital transformation has brought dividends to businesses, stimulating business activity and entrepreneurship [57]; however, transformation of any kind leads to huge challenges, and firms need dynamic capability, organizational learning, and IT transformation in order to overcome resistance and successfully achieve a strategic adjustment [58]. We assume that these requirements are the same in a digital transformation, and that the resources, competencies, and new

businesses are critical to the construction of new rules.

### 2.3. Innovation strategy and digital transformation

Driven by digitalization and data, the firm implements digital technology at every function and focuses on building digital capabilities, which in turn creates growth through specific strategies [14]. Digital transformation exposes incumbent firms to high-velocity external environments and affects their choice of innovation strategies. When speaking about digitalization, using the term “transformation” rather than “change” emphasizes that a firm’s digital transformation goes far beyond the scope of functional thinking. This language reflects the comprehensiveness of the actions that must be taken to seize opportunities or avoid digital technology threats [49].

Beginning with the design of the business model, the value network can be reconstructed to achieve transformation. However, many enterprises have failed during the strategic implementation phase of digital transformation, often due to putting an overemphasis on technical issues over the market [59]. Along with the changing characteristics of competitive environments in the digital era, market and technology are regarded as two core dimensions to illuminate an obscure landscape [60–62]. The nexus of market and technology, to some extent, has a far-reaching impact on adopting innovation types [60].

Regarding the innovation types, researchers commonly adopt the categories proposed by OECD [63]: product, process, organizational, and market innovation. Utterback and Abernathy [64] suggested a relationship between process innovation and product innovation in their U-A model, while Linton and Walsh [65] stressed process-based innovation and its domination of specific industries. Karabulut [66] studied the relationship between innovation types and the performance of firms. Despite the enduring endeavour during the process of digital transformation, what innovation types a firm uses and how it uses them require further research.

Despite a good volume of literature on the relationship between adopted innovation strategies and firm performance, previous research has mainly considered one sole innovation type. Firms in emerging economies, under mature technology in the mainstream market, are largely focused on product innovation. For an example of this, consider the competition between mobile phone terminal manufacturers in the 1990s in China [67,68]. However, it is detrimental to insist on choosing a specific innovation type, when diverging from an industry’s typical portfolio of innovation types would contribute to the firm’s performance instead [69]. Likewise, Satell (2017) indicated that several innovation strategies fail eventually because there is no one true path to innovation; he showed that portfolios of innovation are better for adapting to ever-changing external environments. Azar and Ciabuschi [71] empirically confirmed that the combination of different innovation types is beneficial to a venture’s export performance using evidence from 218 Swedish export firms. Thus, we infer that firms currently tend to rely upon several kinds of innovation types to alleviate uncertainty and risk from changing technological and business environments.

Firms should choose the appropriate innovation types according to their characteristics and establish a product-process matrix model according to the product structure and each major stage of the process [72]. A firm’s decision-makers should choose an appropriate proportion between product innovation and process innovation according to different situations, that is, the proportion of investment in product innovation and process innovation should be different according to different industries and firms’ conditions.

We propose that the emergence of digital technologies will extend this research stream. In more formal terms, we offer the following proposition:

**Proposition 1.** *In the process of digital transformation of incumbent firms in emerging economies, firms adopt transformation strategies based on different combinations of innovation types (portfolios of innovation), which will be conducive to the implementation of digital transformation.*

Although the mainstream and emerging markets, as well as the mature and emerging technologies, exist in different dimensions, sometimes, mature technology and emerging technology will co-exist [73]. Accordingly, incumbent firms in the mature market may also have access to the application and development of both mature technology and emerging technology, enabling them to adopt shifting innovation strategies to fit their strategic adaptation. For example, when the third-generation (3G) mobile communication technology emerged, many mobile phone manufacturers produced second-generation (2G) mobile communication technologies and 3G technologies simultaneously, whereas others focused on 2G technology products [74]. Likewise, technology is undergoing perpetual shifts in one industry, which means technology is promoted from the mainstream (mature) market to emerging markets, requiring incumbent firms to shift their portfolios of innovation responsively.

Our work builds on prior literature to suggest that long-term technology change involves a shift of innovation strategy [75], especially from the perspective of the evolution theory of economics [73]. Nowadays, a firm’s portfolio of innovation shifts when it is exposed to an intense variety of digital technology and a constantly-changing business environment [70]. As a whole, the portfolios of innovation for incumbent firms employed in emerging economies present dynamic characteristics along with the digital transformation process [76]. Thus, we posit the following:

**Proposition 2.** *In the process of the digital transformation of incumbent firms in emerging economies, firms need to shift their portfolios of innovation dynamically, facilitating a faster digital transformation.*

In the following sections, we build on the arguments above, propose a basic research matrix, and conduct a case study to examine our propositions.

## 3. Research framework (matrix) and research methods

### 3.1. Research framework

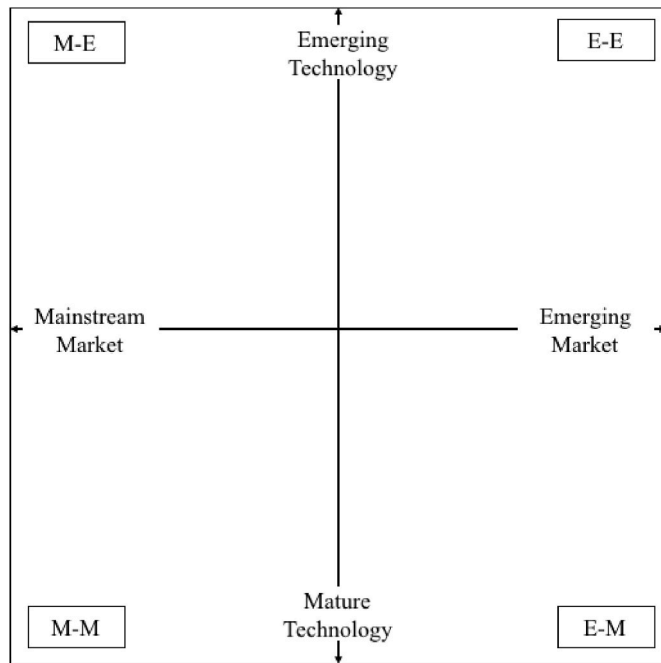
Given that this research focuses on innovation types during the process of transformation based on digital technology, the digital strategy in this research refers to the permeation of digital technology (such as big data, cloud technology, and the internet) across business activities (including marketing, new product development, services, value creation, and management), which contributes to the transformation of incumbent firms.

Technology and market are two key elements of a firm’s business environment, presenting a list of the major competitive ingredients [60]. The technology side of the firm includes production and operations while the term ‘market’ includes both the strength of the relationship and the composition of the customer group [60]. We adopt these definitions of technology and market as two dimensions of an innovation matrix in this study, further defining technology as meaning the dominant technology in the industry, and we further divide it into mature and emerging technologies. We divide the market into the mainstream (mature) market and the emerging market. A market is considered to be emerging if it is new in time or space, or otherwise rising and developing significantly.

Fig. 1 shows the innovation matrix we propose, with these elements arranged into quadrants: Quadrant M-M, Quadrant E-M, Quadrant M-E, and Quadrant E-E. Using this matrix, we will analyse the transformation and innovation types of firms in emerging economies from the perspective of markets and technology.

### 3.2. Research methods

This study uses a multi-case study methodology based on the principles of engagement with practice [77] to address the research question. Through this multi-case study, it is possible to illuminate and explain multi-level phenomena that are too complex for tightly



**Fig. 1.** Innovation matrix for the analyses of innovation types and digital transformation of incumbent firms.

structured designs or pre-specified data sets. The multi-case study is suitable for unravelling concepts and building theories [78]. Since this study focuses on the innovation types and digital transformation processes of incumbent firms in emerging economies, we choose China as the representative for emerging economies. Basically, Chinese firms have undergone typical digital transformations over the past few decades [6,74]. Besides, Chinese firms have been adjusting to dynamic environment through catch-up strategy to innovate and then upgrade [79,80]. The context thus provides a good background to investigate the digital transformation and development of incumbent firms in emerging economies.

We chose our research targets based on four criteria:

1. They must be incumbent firms with more than 10 years of experience in the manufacturing or traditional industries.
2. They must conduct digital strategies, such as using cloud technology and/or big data in their operations.
3. They must have made significant changes in the process of their digital strategy implementation.
4. They need to be sufficiently representative in their specific industries.

Based on our research question and case selection criteria, Company

G, Company T, and Company Z stood out. These three companies, from different industries in China, have each implemented their digital strategies and enhanced their services. Table 1 shows three core aspects of these firms: founding information, industry, and main products or services.

Company G, founded in 1986, is a Chinese automaker that is moving beyond traditional auto manufacturing. It currently does electrical vehicle manufacturing, internet concept car manufacturing, and online community-building for its customers. Founded in 2010, Company T is a private freight transportation service provider in the logistics industry that is currently entering the field of intelligent road logistics, cloud platform systems, and supply chain finance. Company Z, founded in 2011, is in the energy equipment industry and is a part of a larger firm that focuses on control technology and equipment. Although explicitly chosen from different industries, all firms have been private firms in China for decades and are well recognized for their digitalization practices. This commonality helps facilitate the development of a more generalized framework.

### 3.2.1. Data sources

We employed multi-source data for trig validation [81], establishing a case study database through data recording and collation. Our data resources consisted of interviews, field visits, and archival material. Besides conducting an informal discussion with the managers and employees of these companies, we formally interviewed Company G 10 times between 2014 and 2018. The main two interviewees were Company G's vice president, Ms. Zhang, and the central information officer, Mr. Ding. In one interview we focused on Company G's internet cars in 2017. We conducted interviews on Company T's internet platform three times in 2014 and once in 2018 with Company T's deputy general manager, Mr. Yan. Twice in 2014 we interviewed Company Z's president, Mr. Zou, on Company Z's data-driven service). All interviews were combined with field visits that lasted at least a half-day. The socio-demographic characteristics of the respondents are displayed in Table 2.

For the interviews, we chose a series of core factors including a) the way the firm was founded, b) the technology and market environment it was faced with, c) the industry the firm worked on, d) how the firm developed or changed in the direction of digital transformation, and e) the firm's plans or prospects for digital transformation in the future. The relevant information is summarized in Table 3.

Public information from company websites and publicly-available documents were also included as background information to triangulate the data. We collected the annual reports of Companies G and T, the significant public speeches of Company G, and the internal material of Company Z. We included internal materials, interview recordings, research transcripts, relevant forms and materials, and second-hand data gathered through other channels in the case study database (Table 4).

### 3.2.2. Data analysis

We developed our initial analysis by shaping the data into a synthetic

**Table 1**  
Sample firms.

Firm	Founded	Industry	Size	Products and Services
Company G	1986, China	Automobile	Large-scale The number of employees:131,426 (2020)	Traditional auto manufacturing Electrical vehicles manufacturing Internet concept cars manufacturing Customers' online community
Company T	2010, China	Logistics	Large-scale The number of employees:7600	Road and port infrastructure Intelligent road logistics cloud platform system Supply chain finance
Company Z	2011, China	Energy equipment	Small and medium firms The staff size is less than 50 people	Energy control equipment and systems Energy-saving solutions (including energy efficiency analyses) Digital energy-saving system (including an energy-saving cloud and an online energy monitoring and evaluating system) Big data processing and service



**Table 2**  
Sociodemographic characteristics of respondents.

	Position	Gender	Industry work experience	Number of investigations
Company G	vice president	Female	more than 40 years	4
	development director	Male	more than 20 years	3
	engineering vice president	Male	more than 20 years	3
Company T	Vice president	Male	more than 40 years	3
	engineering vice president	Male	more than 20 years	2
	operations chairman	Male	more than 10 years	2
Company Z	CEO/founder vice president	Male	more than 10 years	3
	product vice president	Male	more than 10 years	2

**Table 3**  
Case data source coding.

The data source	Data classification	Source code
Semi-structured interview	Company G field survey (n)	FG0n
	Company T field survey (n)	FT0n
	Company Z field survey (n)	FZ0n
Field visit	Field interviews to obtain information	CG
	Obtained through the firm official website and internal information	WZ
	Get it from electronic websites and newspapers	BD
	Obtained from literature and library	NZ

case history for the three firms. Then we conducted a detailed investigation of the market, technology, digital technology, and innovation types involved in the transformation process of each firm to acquire the encoded data. In this process, we were able to differentiate and defined the sub-categories of market and technology. When details were missing, we turned to additional archival materials or reached out to employees by phone or email. One author prepared drafts of the preliminary cases, while a second reviewed the data to obtain an independent view [78]. Whenever the two sides came up with different conclusions, we revisited the data to resolve the conflict. We also identified emergent patterns by analysing each case underlying our

primary research targets.

After conducting the intra-case analysis, we proceeded to conduct an inter-case analysis using replication logic to confirm emergent patterns among cases [21]. We created charts and tables to compare tentative theoretical constructs such as markets, technology, and innovation types across cases, a process that improved the robustness of our distinctions among market, technology, and innovation types. We then cycled between our emergent framework and data to articulate constructs, build up measures, modify abstractions, and render the underlying arguments that were connected to the constructs.

As our theoretical facts became more nuanced, we examined the previous literature to reflect on the data. Accordingly, we followed an iterative procedure of gaining insight, refining our thoughts, constructing underlying logical arguments, and connecting them with existing theory [78]. Using this process to identify matching attributes of different firms, we were able to see similarities within and differences between the groups.

#### 4. Case studies of the digital transformation process

Table 5 shows company's strategy and objectives across several phases. These studies describe the transformation process of each firm according to the key nodes.

**Table 4**  
Overview of data sources.

Firm	Interview		Field observation	Archival
	Number	Informants		
G	Ten times from 2014 to 2018	Vice president, business development director, engineering vice president, sales	Visit the headquarters in Hangzhou and its Swedish subsidiary	The research results of other researchers on firms, annual and quarterly reports, corporate news, industry development reports and related news, other internal information
T	Three times in 2014 with TMT and once in 2018	Vice president, engineering vice president, operations chairman, marketing	Visit the headquarters, firm show hall, and road port in Hangzhou	Corporate news, other internal information
Z	Twice in 2014 with president and others Informal discussion with employees and the managers of father firm in 2014, 2015, and 2019 for the updated information	CEO/founder vice president, product vice president, engineering	Visit the headquarters and firm development show hall	Corporate news, other internal information, industry development reports, and related news

**Table 5**  
The strategy and goal of the company before and after the transformation.

Company	The first stage strategy<	The second stage strategy	The third stage strategy	The fourth stage strategy
G	1996–2006:Automobile manufacturing	2007–2017:Strategic transformation - technology leadership	2018:-Smart network connection construction	
T	1997–2001:Transport Service supply	2002–2015: Intelligent logistics platform construction	2016:-Open Internet Logistics ecological chain Basic Data Supporting service platform Project	–
Z	2011–2012:Hardware equipment manufacturing	2012–2018:Energy information service	2019:-big data services	–

Data source: According to the case company research, public data collation

**Table 6**

Typical quotation examples and coding results of company G's digital transformation.

The core construct	The second-order coding	The third-order coding	Examples of typical quotations
Digital application	Adopt digital technology to change the process	–	Firms mainly use digital technology to change some processes: ... Not only in line with international technical standards, but also can greatly shorten the new car research and development cycle, from the traditional platform of 40 months to develop a new product, reduced to 18–24 months, and can realize the synchronous development and synchronous launch of traditional power and new energy power models .... (WZ)
Digitalization	The specific functions of digitization are affected	Function affected	Digital specific functions are affected: It has applied for more than 100 intellectual property rights in intelligent network connection, mainly covering automatic driving and AI voice recognition. (CG,FG02,FG04) It will promote the realization of “car-sharing 4.0” through the high integration of vehicle technology and Internet technology, the interconnection and intelligent integration of internal networks, inter-vehicle networks, and on-board mobile Internet, the storage of user information and consumer behavior information in the cloud, and the application of big data, wireless charging, and automatic driving technologies. (BD)
		Digital capability building	With the addition of the new Boyue PRO, it is going to the next level in intelligent network construction. Based on a deep understanding of the needs of 800,000 Bo Yue users, using the Internet, cloud computing, big data, artificial intelligence, and other technologies, from the four aspects of vehicle chip, intelligent interaction, cloud manufacturing, intelligent safety, it is possible to refresh the new standard of Intelligent vehicles in China. (FG04,BD)
Digital transformation	Change in value creation and occupancy (create new business models/replacement of a business model)	Major business improvements	Through the application of digital technology to change its value creation and occupation: Based on big data and cloud computing service providers, Gelicondi, Alibaba, Uber, ZTE and Minsheng Bank signed a cooperation declaration in Hangzhou, and will work together to build the “car-sharing 4.0” model. (BD, WZ) Time-sharing leasing can not only meet consumers' fragmented needs at a lower cost but also improve vehicle utilization rate. Time-sharing leasing has become one of the most effective commercial promotion models in the industry (FG03) “Car sharing 1.0 was the traditional rental sharing, which was upgraded to 2.0 with the addition of the Internet, while new access was 3.0, which added more forward-looking technologies such as wireless charging and autonomous driving.” (BD)
		Create new business models	... it also put 200 global Eagle K17 pure electric vehicles for Hangzhou's “microbus” project ... (FG04, CG) ... plan to establish a joint venture in China dedicated to bringing the world's leading urban air mobility solutions to China ... (BD) it began to involve the fields of trucks, flying cars, and public transportation services, vaguely beginning to transition to the era of 4.0, from an automobile manufacturer to a future mobile transportation service provider ... (BD)

Note: FG01, FG02, FG03, CG, WZ, BD, and NZ in parentheses of typical quotation examples in the table correspond to the data sources in [Table 3](#).

#### 4.1. The digital transformation of company G

Founded in 1986, the Company G group is principally engaged in the research, development, and manufacturing of automobiles as one of the local Chinese automakers. [Table 6](#) lists quotations that typified the responses we heard from several people and shows the coded results of Company G's digital transformation.

The initial stage of Company G's transformation took place from 1996 to 2006. Like other automakers, Company G sets up its online customer community in order to answer customer requests, introduce new models of cars, offer opportunities to test drive of new cars, and provide insurance and other services. In 2007, Company G started its strategic transformation from a price-winning strategy to a technology-leading strategy. In 2010, it opened its e-store at Alibaba to sell its cars online. Launching an online customer community improved the way Company G connected with and managed its customers and provided automotive services. At this stage, Company G hoped to integrate customer information into all the processes of developing new products through its cloud platform so it could design and provide more customized vehicles, auto finance, and automotive after-sales services, among other things. Company G began to produce electrical vehicles at this stage. It not only sold electrical vehicles in its physical stores but also set up a firm to provide a chauffeur-driven car service using its electric vehicles, accessible online. Additionally, Company G set up a joint firm to facilitate electric vehicle sharing and renting.

In 2018, the automotive internet era ushered in changes, and Company G built an open and shared intelligent ecological platform.

Company G designed and produced an internet concept car, the result of the global collaboration of experts in design, engineering, software, and connectivity from industry leaders like Volvo, Microsoft, Ericsson, and Alibaba. An element of the internet concept is as follows: your friend can open your car using a code in their smartphone instead of a key that you lend them when they borrow your car. The internet concept car is connected to the cloud system. The customer can check on their car from an app on their smartphone, anywhere and anytime. The car was introduced into the market in 2018.

Company G established a digital process following the value chain of automobiles. During the process of learning about the demand, comparison, purchase, driving, and replacement of a customer's vehicles and components, thorough digitalization, Company G enables to innovate its marketing strategies through the collection and analyses of digital assets, its digital marketing strategies by integrating online and offline marketing and financial loans, and its digital business model and business model innovation. Company G is not limited to the R&D and production of new energy vehicles and internet concept vehicles; it also invests in flying vehicles. It acquired an American firm in 2017 that deals with flying technology.

#### 4.2. The digital transformation of company T

Company T was founded in 1986. When it was founded, the company was mainly engaged in chemical products. Until 1997, Company T carried out diversified development and began to explore the logistics industry. The following table ([Table 7](#)) is specifically listed typical

**Table 7**  
Typical quotation examples and coding results of company T's digital transformation.

The core construct	The second-order coding	The third-order coding	Examples of typical quotations
Digital application	Adopt digital technology to change the process	–	Firms mainly use digital technology to change some processes ... integrated stakeholders into the logistics chain to communicate information in this highway port, thus changing the upstream and downstream relationship in the transportation industry chain and reducing the information asymmetry (FT01)
Digitalization	The specific functions of digitization are affected	Function affected	Digital specific functions are affected: The problem of information asymmetry and lack of trust in logistics is solved, and the whole business path is run. In the process of rapid development in recent years, digital integration of online and offline has become the biggest change. (BD) Benefited from the overall digital process change. "We produce, sell and ship according to the needs of our customers, end to end, and do things right once and for all. (BD)
		Digital capability building	Company T used smart mobile technology to provide different app services to upstream and downstream stakeholders in the logistics chain and used Internet technologies and cloud technologies to build an inter-regional online network system, that is, an intelligent road logistics cloud platform system (FT02, FT03) Through the application of digital technology to change its value creation and occupation: "We used to sell products. Now we sell solutions." (BD) Highway Port is in the right place at the right time, (WZ)
Digital transformation	Change in value creation and occupancy (create new business models/replacement of a business model)	Major business improvements	As the pioneer of online and offline road port modes .... In terms of online business, company T logistics "Open Internet Logistics ecological chain Basic Data Supporting service platform Project" was listed in the 2016 "Internet +" national major project. (WZ)
		Create new business models	... current supply chain financial services are also generated around ecology and business. "We have integrated the payment system with the logistics and transportation system and the customer management system, which can very well depict the user's portrait and create a good credit system." (BD)

Note: FT01, FT02, FT03, CG, WZ, BD, and NZ in parentheses of typical quotation examples in the table correspond to the data sources in Table 3.

quotation examples and coding results of Company T's digital transformation.

Company T has provided transport services to its group since the 1980s, just like other logistics companies. Based on its experience in the manufacturing and logistics industries, Company T felt itself to be low, small, and scattered in the logistics industry. The phenomenon of no-load trucks, caused by information asymmetry, not only reduced the transportation efficiency but also increased the cost. Because of this pain point, Company T launched the construction of the first highway port urban logistics centre platform, Hangzhou highway port in 2002. The highway port urban logistics centre integrates stakeholders into the logistics chain and communicates information in the highway port, which changes the upstream and downstream relationship of the transportation industry chain and reduces information asymmetry. Since 2010, Company T has further used digital technology to build an intelligent logistics platform at the service industry end. Through digital technology, every highway port is connected to a national network. The intelligent logistics platform helps Company T to provide different application services for upstream and downstream stakeholders of the logistics chain.

In 2016, following the pace of the times, Company T gradually built a national highway port city logistics centre network, a "universal socket" intelligent system, and a financial service system with a digital payments as the core. Company T provided payment financial services and built an industrial end credit system. Using the internet, big data, artificial intelligence, and other technologies, they are gradually building a nationwide and interconnected basic data support service platform for the open internet logistics ecological chain. Company T has entered the emerging market of Intelligent City construction based on digital finance and logistics.

#### 4.3. The digital transformation of company Z

Company Z<sup>1</sup> was first a department of Group ZK that provided energy

control equipment and systems to organizations. It was separated from the ZK group in 2011 as an independent firm to operate its cloud service. Because customers had to buy the central service processor of the energy control equipment and system, which was a high percentage of costs, it was not easy to widely market their products.

Around 2012, to attract more customers to purchase their energy-saving system, Company Z set up a cloud platform as the central service processor of the energy control system for their customers. Based on the IoT (Internet of Things) and cloud data, Company Z transitioned from a firm selling energy control equipment and systems to a company providing energy-saving solutions with a new system that included a cloud-based system to monitor and evaluate energy and analyse energy efficiency, as shown in Table 8. Company Z sells energy-monitoring sensors for various kinds of energy-using equipment as well as mobile monitoring terminals that can monitor energy usage anytime. This system contributes to the Company Z's market access because of the price slumps of energy-saving systems but also provides Company Z with new business opportunities based on the data they collect. For instance, their customers can monitor their energy-saving systems through an app on their smartphones or smart tablet.

Company Z collects a wide range of data generated by the 100+ control sensors per user via their intelligent terminals. Based on these data and statistical and other data from agencies, Company Z has the ability to launch new big data services and become a big data processing and service company.

In 2018, Company Z completed the acquisition of Rongshang Tonglian and entered the industrial internet market. Company Z has realized the application of big data in the energy field and is providing data support for the development and diffusion of energy-saving products, which is a different market from traditional control equipment. In the future, new IoT and cloud technology like this energy-saving sensor system will be used to develop the energy and big data services of Company Z.

#### 5. Case analysis and discussion

Using the research framework in Fig. 1, we drew some conclusions

<sup>1</sup> Company Z's energy service division was sold in 2016.

**Table 8**  
Typical quotation examples and coding results of company Z digital transformation.

The core construct	The second-order coding	The third-order coding	Examples of typical quotations
Digital application	Adopt digital technology to change the process	–	Firms mainly use digital technology to change some processes Company Z set up a cloud platform as the central service processor of the energy control system for their customers. Based on the IoT (Internet of things) and cloud data, Company Z transitioned from a firm selling energy control equipment and systems to a company providing energy-saving solutions with a new energy-saving system (FZ01, FZ02)
Digitalization	The specific functions of digitization are affected	Function affected	Digital specific functions are affected: Company Z provides more services to customers based on the data on the cloud platform. For instance, their customers can monitor their energy-saving systems through an app on their smartphones or smart tablet. (BD, NZ) “We have a complete business structure, and we continue to develop new features, and we upgrade them every two months, and we provide our customers with online solutions, Internet applications.” (FZ01)
		Digital capability building	In 2014, the company Z. and Zhejiang University jointly built China’s first education energy big data crowdfunding platform – Education Energy Network, which accessed the data of more than 90 universities at home and abroad, laying the company’s leading position in the construction of big data platform in the field of building energy conservation. (WZ) It continues to research and develop heating terminal products and operation management information systems, open the heating market in northern China with the “Urumqi city-level energy supervision platform”, and quickly become the only one-stop heating overall solution provider in China. (FZ02) For a large number of small and medium-sized firms, the company actively innovates, leading the industry to launch an online industrial energy management service platform – “Younengli” (FZ01) ... building the country’s first “urban energy centre” ... “The first “provincial smart energy monitoring centre” in China” ... (WZ, BD) “We did mass database research and development before, efficient accumulation; Now do mining and analysis, emphasizing the use of data.” (FZ01)
Digital transformation	Change in value creation and occupancy (create new business models/replacement of a business model)	Major business improvements	... The core solution is to serve the government, public institutions, firms, commercial, and civil energy saving cloud solutions (WZ) Relying on the three business directions of building energy conservation, industrial energy conservation, and heating energy conservation, the company has introduced the Internet model into the energy conservation industry, established two business models of traditional business and cloud business, and become the leading domestic intelligent energy management overall solution, provider. (BD, NZ)
		Create new business models	Through the application of digital technology to change its value creation and occupation : In the future, the company will focus on improving and consolidating traditional business while making bold innovations, realizing the strategic goal of developing energy-saving and energy big data services by using the Internet of things and cloud computing technology, and building the company into an international leading online energy saving service provider. (FZ03,BD)

Note: FZ01, FZ02, FZ03, CG, WZ, BD, and NZ in parentheses of typical quotation examples in the table correspond to the data sources in Table 3.

related to the question of how firms in emerging economies adopt innovation strategies in digital transformation. We have also analysed the reasons behind these practices.

### 5.1. Innovation types in digital transformation

Company G, Company T, and Company Z created new business models, implement digital technology in every function of the firm, and focus on digital capacity building to transform the company’s core business, so successfully implemented digital transformations. These

**Table 9**  
Innovation types and detailed information during the digital transformation of case firms.

Quadrant	Firm	Typical Evidence	Technology Infrastructure	Innovation Types
Quadrant E-M	G	The company enters electric car sharing and leasing services into the new car market and provides a new service	Based on smartphones, Internet applications	Product innovation based on digital technology
	Z	Relying on IoT and cloud computing, the company provides customers with customizable energy-saving solutions and enters the new market of energy-saving services. However, the core production technology has not changed	Based on the strategic consideration of using big data and Internet thinking to seek new competitive advantages, the company uses a commercial cloud to provide users with real-time monitoring systems of energy use	
Quadrant M-E	G	Reconstructs the process of automobile equipment and production, pays more attention to process innovation to realize the reconstruction, and provides automobile products to meet the personalized needs of customers in the mainstream automobile market	Global collaboration of design, engineering, software, and connectivity experts based on the IoT and cloud systems	Process innovation based on digital technology
	T	To build an online network system between highways and ports in different regions, namely the intelligent highway logistics system, to form the whole network scheduling of transport vehicles, but still serve the logistics market	With the proliferation of smartphones and the popularity of the Internet, Company T uses smart mobile technology to provide different mobile service terminals for the upstream and downstream stakeholders in the logistics chain	



three cases are examples of how to build a data platform [37], where data can be leveraged to generate new products and services. Company G collects customer information through its cloud platform to provide customers with customized automotive after-sales service. Company T uses its data platform to provide application services to upstream and downstream stakeholders in the supply chain. Company Z provides customers with big data services based on data collected by its cloud platform. As a whole, the three cases confirm the conclusion of Correani et al. [37] that data platforms are foundational for implementing digital transformation strategies.

At present, Company G is turning to the emerging market of intelligent driving. They have built an open and shared Intelligent Eco-Platform and developed an internet concept car. Company T has turned to the new market of digital finance and Intelligent City construction based on logistics and uses emerging technologies such as intelligent systems, payment systems, and consumer finance platforms. Company Z will use the Internet of Things and cloud technology to develop big data services and enter emerging markets in the future. It can be seen that Company T, Company Z, and Company G are all located in the Quadrant E-E (i.e. emerging markets and emerging technologies quadrant). Quadrant E-E involves competition for technology in emerging markets, resulting in new products or processes.

Firms in emerging economies with mature technology and mainstream markets (Quadrant M-M) pay more attention to product innovation [67] & 1999). Just as Company G engages in product competition in the automobile manufacturing market, Company T engages in product competition in the logistics industry.

Through intra-case analysis, we found that Company Z and Company G have entered new markets: energy-saving services and electric vehicles, respectively. They achieved transformation mainly by providing new services. As Company G's vice president, Ms. Zhang, noted in a 2014 interview, "In addition to satisfying our own needs, we also supply other car companies with several accessories in new markets." Meanwhile, Company T achieved transformation mainly through process reconstruction, as did Company G. "After that, with the proliferation of smartphones and the popularization of the internet, we used smart mobile technology to provide different APP services to upstream and downstream stakeholders in the logistics chain and used internet

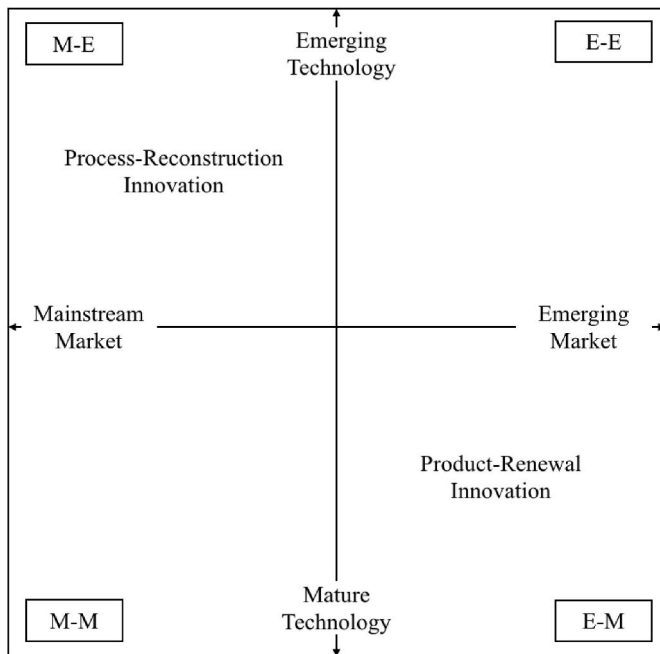
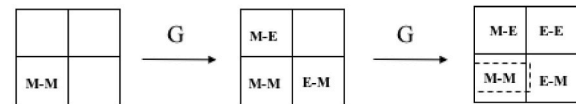


Fig. 2. Emergent innovation matrix through the analyses of innovation types and digital transformation of incumbent firms.



G's Original Phase → Digital Transformation

Fig. 3. The shifting portfolio of innovation of company g.

technologies and cloud technologies to build inter-regional online network system, that is, intelligent road logistics cloud platform system"; this quotation from the 2018 annual report describes the digital technologies leveraged by Company T.

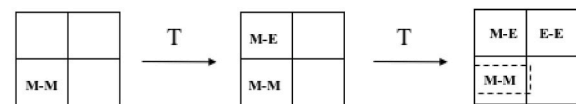
All these transformations flow from the foundation of big data, the internet, and other digital technologies. Digital technologies contribute to products and services that are more efficient and responsive to customer needs, thus help firms attain significant competitive advantage [37].

After analysing the case data, we conducted a comparison and created a summary through inter-case analysis, shown in Table 9.

Table 9 shows that Company G and Company Z underwent their main transformations in Quadrant E-M, emerging market and mainstream technology, whereas Company G and Company T faced competition in Quadrant M-E, mainstream market and emerging technology. Further, we can see from Table 9 that the innovations of Company G, Company T, and Company Z in Quadrant E-M and Quadrant M-E are all based on digital technology, particularly internet technology, and big data; Therefore, we define the innovation types in these two quadrants as innovation based on digital technology.

In Quadrant E-M, Company Z provides value-added services to their energy control equipment and systems, value-added services are considered to be new services. Company G adds electric car-sharing and leasing services into the new car market and provides a new service. It is a product innovation if we think of service as one kind of product, just as we mentioned "Our strategy is to adapt to the current business environment, considering the changes brought about by the internet: the traditional service model or the high cost and low efficiency may not be feasible in the future." It is the same with Company G. In Quadrant E-M, "These technologies can also be used to transform the sales model, service model and product use model, such as the community business model, the sharing economy model, and other industries and consumer sectors of the internet, to gradually realize success in the automotive industry," Company G's CIO Mr. Ding stated in a 2017 official report. The value-added service provided for energy control equipment and systems is also a new product as well as a new service. Hence, we define the innovation type in Quadrant E-M as *Product (service)-renewal Innovation*. A product or service innovation based on digital technologies such as ICT (Information and Communications Technology), is a strategic consideration based on the use of big data and internet thinking to seek new competitive advantages. It can help firms to increase the value of products, considering Company Z's case.

Discussing Company T's highway port, deputy general manager, Mr.



T's Original Phase → Digital Transformation

Fig. 4. The shifting portfolio of innovation of company T.

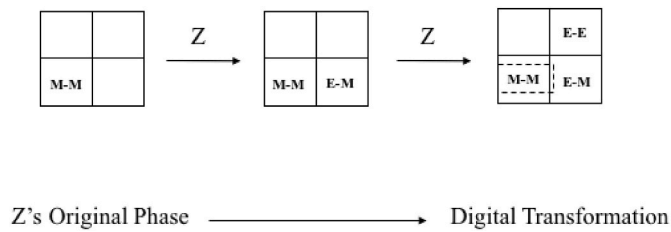


Fig. 5. The shifting portfolio of innovation of company Z.

Yan said, “It reconstructs the value chain of the logistics industry while the online chauffeur-driven car service using our products changes the value chain loop of the vehicle industry.” This can be recognized as process innovations. Just as Hutz (2020) put it that IoT as an emerging digital technology, has greatly changed the Company T’s value chain and the internal processes. Hence, we define the innovation type in Quadrant *M-E* as *Process-reconstruction Service Innovation*, a kind of service innovation that uses emerging technology to reconstruct an industrial process flow and find a niche market and disruptive market entry point from industrial process flow.

Firms can adopt this type of innovation when they use emerging technologies to subvert mainstream markets, as we can see Company T doing. With their new internet concept car, Company G restructured the process of designing and producing automotive equipment to invite the collaboration of global design, engineering, software, and connection experts, based on the IoT, cloud systems, and artificial intelligence. It provides products that met the individual needs of customers; this is referred to as process-reconstruction innovation. Company G’s process-reconstruction innovation also further validates the view of Brem et al. [33] that AI enables firms innovation by restructuring innovation processes within established organizational structures.

In this section, we identify two main types of innovation in the matrix from the perspectives of technologies and markets (Fig. 2), based on the analysis and summary of the above literature, which enriches the typology in Fig. 1. The two emergent innovation types are the process-reconstruction innovation in the quadrant for mainstream market-emerging technology (*M-E*) and product (service)-renewal innovation in the quadrant for emerging market-mainstream technology (*E-M*).

## 5.2. Portfolios of innovation and their shift in the process of digital transformation

Having defined some innovation types in the previous section, we can now build on this basic foundation to further explore what innovation types firms adopt and how they alter their choices of innovation types over time.

Table 9 shows the innovation types in Quadrant *M-E* and *E-M* identified in the case of Company G. When Company G moved to produce electrical vehicles as a mainstream automaker, the combination of the production and improvement of electrical vehicles and the addition of a chauffeur-driven car service based on a digital platform can be seen as a portfolio of innovation in Quadrants *M-E*, *E-M*, and *M-M*. In his 2017 New Year’s speech, Company G’s president, Mr. Li, said “In 2017, the TX5, a new generation of London taxi, will officially be rolling on the U. K.’s roads. It will achieve zero emissions through world-leading power solutions, providing the most environmentally friendly mode of travel for modern cities.”

Accordingly, we believe Company G has made innovations in Quadrant *E-E* as well (G company enters the field of intelligent driving). Thus, the portfolio of innovations for Company G is changing, as shown in Fig. 3, which is also the process of transformation of Company G. Because it is for a different product, the role of innovation in Quadrants *M-E* and *E-M* is shifting. This shows that the development of a firm is a process of iteration and multi-stage learning and innovation [82]. And in

the dynamic development, digital technologies could, to a large extent, enable firms to remain innovative [50].

When Company T initiated its highway port strategy (the innovation in Quadrant *M-E* in Table 9), it was still in the logistics services market. Company T mainly carries out product innovation, which is in Quadrant *M-M*. Its portfolio of innovations lies in both Quadrants *M-M* and *M-E*. When integrating the online and offline networks of the highway ports in different regions, Company T formulated its intelligent logistics cloud platform system based on internet technology and cloud technology.

“Based on this cloud platform, we provide financial services to customers on our platforms, including a payment system,” said Mr. Yan in a 2018 interview. This implies that Company T has moved to a new market with digital finance, digital-logistics-based Intelligent City construction, and so on, which could be seen as an innovation in Quadrant *E-E*. At the same time, Company T remains in the digital logistics business and shows innovation in Quadrant *M-E*. The portfolio of innovation is changing to Quadrants *M-E* and *E-E* from the combination of Quadrants *M-M* and *M-E*, as shown in Fig. 4. Therefore, Company T’s construction and development of a highway port and the logistics cloud demonstrates a dynamic evolution from a mainstream market with mainstream technology to emerging technology in an emerging market. The development of Company T fully demonstrates the close relationship between IT and the firm’s strategy [47] in a digital transformation. Company T’s 2018 Annual Report states, “We provide intelligent highway port solutions that connect offline physical platforms with online platforms, use information-based command platforms, and utilize technologies such as cloud computing.”

Company T’s move to a new market with digital finance and digital logistics-based Intelligent City construction shows changes in value creation, structural changes, and financial aspects due to the use of digital technology. As Matt et al. (2015) have mentioned, the changes that digital technology has brought to firms.

As indicated in the section on Company Z’s digital transformation in Table 8, Company Z has begun to innovate in Quadrant *E-M*, providing services based on IoT technology and other digital technologies. Of course, Company Z provides hardware for energy control, the innovation in Quadrant *M-M*, but their portfolio of innovations includes entries in both Quadrants *M-M* and *E-M*. When the big data service for energy saving became their key business, Company Z became a big data firm in Quadrant *E-E*. Company Z’s president, Mr. Zou, stresses the importance of data, saying, “Our data comes from our customers, and we attach importance to the value of networks, to build the firm energy crowd-funding platform.” Lichtenthaler [59] has similarly acknowledged that data contains valuable information towards firms and data needs to be properly managed. “We remain in the business and make innovations in energy-saving services,” Mr. Zou added. Thus, we can see that Company Z at this time has its portfolio of innovation in Quadrants *E-M* and *E-E*. In short, the portfolio of innovation of Company Z is changing, as shown in Fig. 5. Company Z’s big-data-driven commercial systems and information networks are creating new profit sources and an innovative business model, confirming the finding of Sorescu [83] that a firm can create new competencies and new businesses by combining digital technology with effective usage of incumbent assets to realize firm transformation, as Bartlett and Ghosal Bartlett and Ghosal (1995) proposed.

Overall, the results confirm Proposition 1 asserting that firms are inclined to adopt innovative portfolios at some stage of digital transformation. According to our case analyses (see Table 3), the innovation types in Quadrants *M-E* and *E-M*, which firms create in the process of digital transformation, are the leading innovation types in the portfolios of innovation. The three cases indicate that incumbent firms have different portfolios of innovation in the process of digital transformation.

In the process of digital transformation, the portfolio of innovation changed for the three firms in our case study (Fig. 6), a finding that favours Proposition 2. That is, a high-velocity situation induces firms to employ different innovation types in order to adapt. As a result, the

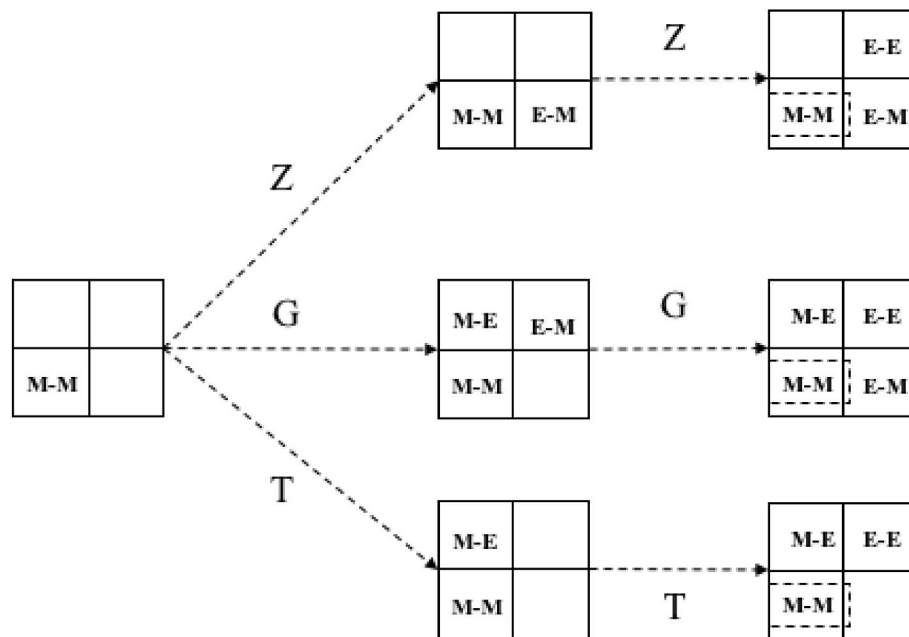


Fig. 6. Digital transformation process with the shifting portfolio of innovation.

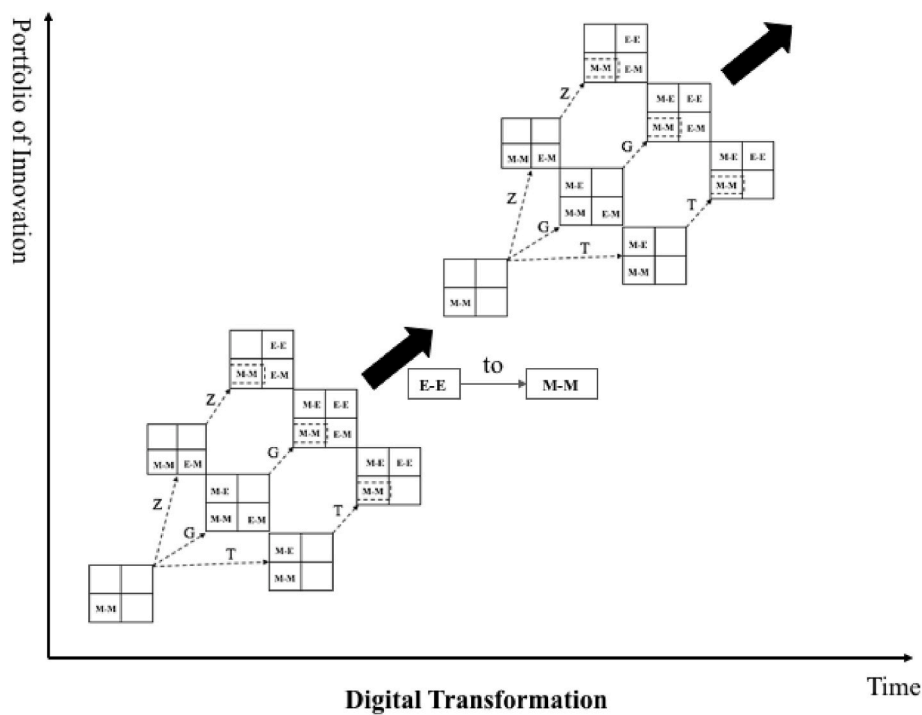


Fig. 7. The evolution of the portfolio of innovation of incumbent firms.

firms' digital transformation processes include shifting their portfolios of innovation. The emerging market will develop into a mainstream market, and emerging technology will be a mature technology in the future [73,75]. The innovation types in Quadrant E-E at that time will be considered innovations in Quadrant M-M. The transformation process will happen again, as shown in Fig. 7, indicating that the process of digital transformation is also a dynamic process.

## 6. Conclusions and suggestions

By identifying the novel innovation types chosen by incumbent firms

in their process of digital transformation, our study proposes an emergent innovation matrix from the perspective of market and technology. Specifically, we identify two innovation types that are conducive to the digital transformation of incumbent firms: process-reconstruction innovation and product-renewal innovation, based on digital technology such as Internet technology, cloud technology, artificial intelligence, and other digital technology. Additionally, we illustrate the dynamic nature of portfolios of innovation by assuming that process innovation or product innovation based on digital technology is the first step of the digital strategy, and implying different transformation processes in firms. Of course, our study also reveals that firms may as well

directly start with innovation in Quadrant E-E or start from process innovation based on digital technology in Quadrant E-M (such as nano and biological firms).

Basically, the findings agree with and extend the research on innovation types done by Abernathy and Clark [60] and the OECD [63]. Prior research has demonstrated the importance of product and process innovation for firms in emerging economies. Our study, however, not only highlights the significance of existing innovation types but also identifies that incumbent firms employ two emergent types of innovations, drawing upon digital technology characteristics. Our study suggests that incumbent firms in emerging economies seemingly include one of two leading innovation types within their dynamic transformation strategy: product-renewal innovation and process-reconstruction innovation, the two varieties of innovation described for Company G, Company T, and Company Z. Overall, our study provides a new perspective on innovation types in digital transformation for incumbent firms.

Most critically, the findings contribute to innovation management by capturing the portfolio of innovation that incumbent firms use to successfully implement their digital transformation strategies. That is, incumbent firms synthesize different innovation types based on digital technology simultaneously, leading to diverse digital transformation processes. Unlike previous research that implied that firms mainly focus on one innovation type [67,68,71], we found that incumbent firms enact several innovation types simultaneously during one specific digital transforming phase. Thus, this research blends theories and practices in digital transformation with a fresh framework perspective on innovation types to elaborate on the digital transformation process of incumbent firms in emerging economies in the digital era.

By analysing the shifting of portfolios of innovations during the process of digital transformation, we saw that a digital transformation is seemingly a dynamic, evolutionary process, emphasizing evolutionary adjustment [84–87]. Incumbent firms can select the portfolio of innovation that is consistent with their strategy and capabilities, given the trends in technology and markets. In a word, the strategic management of innovation for firms in emerging economies is a long-term process, requiring dynamic adjustment.

Lastly, our research verifies that emerging digital technology has changed the value chain and the internal processes of firms as proposed by Hutz et al. [40]. It can be seen that digital transformation has brought huge long-term benefits to the firm, reshaping the relationship between firms and stakeholders [46], as Company T did by using intelligent logistics platforms to change the upstream and downstream relationships of the transportation industry chain, and provide more logistics services for upstream and downstream stakeholders.

Considering the practical implications, digital transformation has dramatically changed established business models in many industries. As a result, new opportunities arise and a thorough analysis of the right business model is essential to facilitate this evolution [59]. Firstly, managers are expected to move along an implementation process with a dynamic learning perspective. Secondly, managers need to regularly revisit, realign, and transform their digital solutions. Thirdly, in the late stage of a firm's development, it must have a knowledge base derived from product innovation/process combination to implement technology development, and thus adapt to its external environment. To guarantee the aforementioned adaptation, firms need to match their innovation portfolio with the market environment. Lastly, managers need to balance the development of overall long-term solutions with short-to medium-term solutions in order to realize the full potential of digital transformation now and in the future [88].

Despite the potential contributions of this research, there are some limitations and avenues for further research. First, we believe that the applications of distributed ledger and other new technology will bring new challenges to the organizations and industrial ecosystems as well as opportunities for the digital transformation process. This remains to be researched later. Second, our findings recognize that firms should

consider strategic innovation and open innovation (cooperative strategy) when they are facing pressure from competition and transformation. This is a topic requiring in-depth research in the future. Third, this research is based on three cases that are typical of selected industries in China, which limits its generalisability. Therefore, further research is needed on more companies from other regions, and other research methods (such as quantitative research) will be needed to further explore the findings of the current study.

## Author statement

Zhengyi Zhang: Investigation, Conceptualization, Methodology, Writing – original draft Jun Jin(corresponding author): Investigation, Conceptualization, Funding acquisition, Supervision Shijing Li(corresponding author): Conceptualization, Writing – original draft, Formal analysis Yuanmin Zhang: Writing – review & editing

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## 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.

## Data availability

The authors are unable or have chosen not to specify which data has been used.

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