

St. Petersburg State University
Graduate School of Management
Master in Management Program

**Digital transformation of SMEs' Business Models in the post-pandemic era
—— An Effectuation Perspective**

Master's thesis by the 2nd year student

Master in Management program

Cai Jiannan

Academic supervisor: Associate Professor

Karina A. Bogatyreva

Department of Strategic and International Management

St. Petersburg

2022.6

ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ
ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

Я, Цай Цзяньнань __, студент второго курса магистратуры направления «Менеджмент», заявляю, что в моей магистерской диссертации на тему « Цифровая трансформация бизнес-моделей МСП в постпандемическую эпоху с точки зрения теории эффектуации», представленной в службу обеспечения программ магистратуры для последующей передачи в государственную аттестационную комиссию для публичной защиты, не содержится элементов плагиата.

Все прямые заимствования из печатных и электронных источников, а также из защищенных ранее выпускных квалификационных работ, кандидатских и докторских диссертаций имеют соответствующие ссылки.

Мне известно содержание п. 9.7.1 Правил обучения по основным образовательным программам высшего и среднего профессионального образования в СПбГУ о том, что «ВКР выполняется индивидуально каждым студентом под руководством назначенного ему научного руководителя», и п. 51 Устава федерального государственного бюджетного образовательного учреждения высшего образования «Санкт-Петербургский государственный университет» о том, что «студент подлежит отчислению из Санкт-Петербургского университета за представление курсовой или выпускной квалификационной работы, выполненной другим лицом (лицами)».

Цай Цзяньнань

(Подпись студента)

01.06.2022 _____

_(Дата)

STATEMENT ABOUT THE INDEPENDENT CHARACTER OF THE MASTER THESIS

I, ____Cai Jiannan __, (second) year master student, program «Management», state that my master thesis on the topic « Digital transformation of SMEs' Business Models in the post-pandemic era — An Effectuation Perspective », which is presented to the Master Office to be submitted to the Official Defense Committee for the public defense, does not contain any elements of plagiarism. All direct borrowings from printed and electronic sources, as well as from master theses, PhD and doctorate theses which were defended earlier, have appropriate references.

I am aware that according to paragraph 9.7.1. of Guidelines for instruction in major curriculum programs of higher and secondary professional education at St. Petersburg University «A master thesis must be completed by each of the degree candidates individually under the supervision of his or her advisor», and according to paragraph 51 of Charter of the Federal State Institution of Higher Education Saint-Petersburg State University «a student can be expelled from St. Petersburg University for submitting of the course or graduation qualification work developed by other person (persons)».

Цай Цзяньнань

_(Student's signature)

_____01.06.2022_____ (Date)

ABSTRACT

Master Student's Name	Cai Jiannan
Academic Advisor's Name	Karina A. Bogatyreva
Master Thesis Title	Digital transformation of SMEs' Business Models in the post-pandemic era —— An Effectuation Perspective
Description of the goal, tasks and main results the research	<p>COVID-19 brings a huge impact to the survival and development of SMEs, while the wave of digitalization brings important opportunities to enterprises. But we have to consider that the environment is dynamic and complex. The purpose of this master's thesis is to investigate the relationship between effectuation and the performance of SME business models that have undergone digital transformation. In order to enrich entrepreneurship research, we also attempt to consider environmental uncertainty as a moderating variable, exploring the moderating effect of environmental dynamism and complexity in the relationship between effectuation and the digital performance of SMEs, and determining the decision-making logic behind the digitalization of SMEs. In this thesis, we performed principal component analysis and hierarchical linear regression analysis on the collected data based on the questionnaire data using SPSS statistical tools.</p> <p>Based on the analysis, we found that there is a significant positive relationship between effectuation and SME digital performance and environmental dynamism and complexity negatively moderate on the relationship between effectuation and SME digital performance.</p>
Keywords	Effectuation, SMEs, Digital Transformation, Business Models, Digital Performance

АННОТАЦИЯ

Автор	Цай Цзяньнань
Научный руководитель	Карина А. Богатырева
Название ВКР	Цифровая трансформация бизнес-моделей МСП в постпандемическую эпоху с точки зрения теории эффектуации
Описание цели, задач и основных результатов исследования	<p>COVID-19 оказывает огромное влияние на выживание и развитие МСП, а волна цифровизации открывает широкие возможности для предприятий. Но мы должны учитывать, что окружающая среда является динамичной и сложной.</p> <p>Цели исследования данной магистерской диссертации - выявить взаимосвязь между эффектуацией и эффективностью цифровой трансформации бизнес-моделей МСП. Мы также пытаемся рассмотреть неопределенность окружающей среды в качестве умеряющей переменной, изучить умеряющее влияние динамичности и сложности окружающей среды на взаимосвязь между эффектуализацией и цифровыми показателями МСП, а также найти логику принятия решений, лежащую в основе цифровизации МСП, с целью обогащения исследований предпринимательства.</p> <p>В данной диссертации мы провели анализ главных компонент и иерархический линейный регрессионный анализ собранных данных на основе анкетных данных с использованием статистических инструментов SPSS.</p> <p>На основе анализа мы обнаружили, что существует значительная положительная связь между теорией эффектуации и цифровыми показателями МСП, а неопределенность окружающей среды отрицательно влияет на связь между эффектуацией и цифровыми показателями МСП.</p>
Ключевые слова	Теория эффектуации, МСП, цифровая трансформация, бизнес-модели, цифровая производительность

Contents

Introduction	1
Chapter 1. Description of the research background	2
1.1. Research background	2
1.1.1. Macro-background.....	2
1.1.2. Theoretical background.....	3
1.2. Purpose and significance of the study.....	5
1.3. Research Methodology and Framework	6
1.3.1. Research methodology.....	6
1.3.2. Research roadmap.....	6
Chapter 2. Literature review	7
2.1. Definition of selected concepts.....	7
2.1.1. Definition of digitization.....	8
2.1.2. Definition of digital transformation	8
2.1.3. Business models.....	9
2.2. Small and medium-sized enterprises (SMEs)	1 1
2.2.1. Definition of SMEs	1 1
2.2.2. Digital transformation of SMEs	1 1
2.3. Effectuation Theory	1 2
2.3.1. Definition of effectuation.....	1 2
2.3.2. Digital business model transformation from an effectuation perspective	1 5
Chapter 3. Research design	1 6
3.1 Research hypothesis and model	1 6
3.1.1. Effectuation and SME's Digital Transformation Performance	1 6
3.1.2. Dynamism and complexity positively moderate on the relationship between effectuation and SME business model digital transformation performance	1 7
3.1.3. Research theoretical model	1 8
3.2 Questionnaire Design.....	1 9
3.2.1. Object of research	1 9
3.2.2. Data collection	1 9
3.2.3. Research method.....	2 0
3.3. Selection and measurement of variables	2 1
3.3.1. Variable measurements.....	2 1
3.3.2. Independent variable - Effectuation	2 1
3.3.3. Dependent variable - SME digital transformation performance	2 1
3.3.4. Moderating variable - Environmental dynamism and complexity	2 2
3.3.5. Control variables	2 2
Chapter 4. The empirical analysis	2 3
4.1. Reliability Analysis and Factor Analysis of the scale	2 3

4.2. Reliability tests and factor analysis for each scale dimension	2	9
4.3. Statistical analysis of data	3	4
Chapter 5. Discussion and conclusions	4	0
5.1. Conclusions of the study	4	0
5.1.1. Effectuation is a multidimensional concept	4	0
5.1.2. Significant positive relationship between effectuation and SME digital performance	4	0
5.1.3. Environmental uncertainty negatively moderate on the relationship between effectuation and SME digital performance	4	1
5.2. Research contributions and shortages	4	1
5.2.1. Research contributions	4	1
5.2.2. Research Shortages	4	2
References List	4	3
Appendix.....	5	1

Introduction

In the development of the world economy, SMEs play a unique and important role in increasing employment, stabilizing growth and promoting innovation. The impact of COVID-19 on various types of economic entities around the world shows an unbalanced character: SMEs is smaller in capital size and less able to cope with risks, and therefore suffer more from the impact of the epidemic. Many large enterprises have a relatively high level of digital transformation and are able to quickly adjust their production and management strategies and production plans, and are less affected by the pandemic. However, many small and medium-sized enterprises have a lower level of digitalization and have experienced lower operating income and difficulties in resuming production and work. In the post-pandemic era, it is significant to accelerate the digital transformation of SMEs. On the one hand, digitization can help SMEs manage better with the effects of uncertainty; On the other hand, it is a crucial tool for businesses to gain future sustainable competitiveness.

At the same time, we must be aware of the reality that despite the importance of digital transformation is self-evident, in reality, not all enterprises are actively involved in the transformation. In the case of China, only about 25% of SMEs have implemented the transformation so far. According to existing studies, the reasons are mostly due to the poor digital technology base, lack of capital and digital talent, etc.

Based on the above background, we would like to further understand how SMEs is surviving in the face of the huge impact of the pandemic for them. How do they participate in the current wave of digitalization? What is the decision logic of entrepreneurs in this process?

In this thesis, we will develop our research based on entrepreneurial theory-effectuation theory. Specifically, we will explore the relationship between entrepreneurs' decision logic and the digital performance of SMEs' business model transformation; Then, we will try to analyze the impact of environmental uncertainty on this relationship from a microscopic perspective. In terms of specific research methodology, we will use quantitative analysis to verify and answer the queries we have raised. The final results, on the one hand, we expect to expand and enrich the research content and context of effectuation theory; On the other hand, we also hope to provide support to SMEs in their digital transformation decision-making.

Chapter 1. Description of the research background

1.1. Research background

1.1.1. Macro-background

The outbreak of COVID-19 in 2020 has had a huge impact on society and the economy. Currently, each country in the world is trying to contain the pandemic and attempt economic recovery. In this process, the economic recovery of China, the world's second largest economy, is crucial to the recovery and development of the world economy. As a developing country, China's economic system and market players have their own peculiarities. According to the most recent 2020 estimates, the number of small and medium-sized businesses has increased by 13.2 percent year on year to 45 million. The number of SMEs in China surpasses 90% of the total number of firms, their GDP contribution exceeds 60%, and their tax contribution exceeds 50%, they provide 80% of urban jobs in China, which is of great importance to China's economic and social development.

Since the COVID-19, SMEs have been hit hard by lack of access to finance, availability of production materials and low flexibility to risk. The latest report shows that 29.6% of SMEs have seen their business income fall by more than 50% in 2020. Therefore, promoting the survival and development of SMEs is the current focus of the Chinese and global economies.

However, COVID-19 is not only a challenge for SMEs, but also an opportunity for their digitalization and business model transformation. Based on the application of digital technologies such as Big Data, Cloud Computing and Artificial Intelligence, most enterprises around the world are trying to achieve multi-dimensional and multi-level innovation in production, research and development, operation, marketing and management through digital transformation to facilitate enterprises to maintain their competitive advantage and promote the development of digital economy in the industry and society.

For most enterprises, there are several main reasons for choosing digital transformation: firstly, the change of consumers. As people have become accustomed to a digital lifestyle and individuals become digital individuals, companies must keep up with this change. At the same time, digital technology is reshaping industries and reinventing them. If companies are not able to complete their digital transformation, they will also not be able to keep up with the changes in industry development and gain access to new growth opportunities in the industry, and they may

even be eliminated as a result. In a sense, digitalization is no longer a matter of choice, but has become a mandatory course for the survival and development of enterprises. However, the digital transformation and upgrading of enterprises is a complex system project that requires continuous investment of a large amount of time and capital in various aspects, and under the impact of the pandemic, it is difficult for SMEs to bear for a short period of time compared to large enterprises. However, SMEs also have many advantages, as they are flexible, dynamic, working closely with other stakeholders, informal and less bureaucratic. SMEs can start with manufacturing technology, management philosophy and organizational structure in order to obtain an efficient digital transformation process.

1.1.2. Theoretical background

The main theory involved in this thesis topic is effectuation theory, which is an emerging theory of entrepreneurship and is a representative theory in mainstream entrepreneurship study. The evolution of effectuation theory is intertwined with the following two theories. Simon's bounded rationality and approximate decomposability and March's exploration and exploitation theory.

(1) Simon's bounded rationality and approximate decomposability

Simon argues that there are two types of things in human society, those that are purely natural, i.e. things that have not been transformed by humans, and those that have been created by human processes as new things, i.e. artefacts (Simon, 1988). For example, enterprises, markets and products have been created and evolved over time to become the main core artefacts of today's society. The core artefacts of complex systems have the general characteristic of being nearly decomposable, whether they are organisms, inorganic bodies, or social institutions, they are artefacts made up of numerous decomposable elements that work together to support the perfection and development of things (Simon, 1991). Because of this decomposable nature of things, it provides us with a good way of studying things, where we can start with one aspect or element and gradually understand the composition of the whole thing. The proposed notion of artefacts embedded in and driven by localities and contingencies in structure and movement forms the basis of the theory of near-decomposability. These ideas echo perfectly with the definition of entrepreneurial success or failure.

Simon argues that in the real world, constrained by time, experience, ability and financial resources, we are unable to identify and exploit all opportunities that arise, design all alternatives for each decision, or make accurate predictions about the future; hence, constrained by rationality, we make decisions that are as satisfactory as possible, rather than optimal (Simon, 1978). Approximate decomposability and bounded rationality are among the origins of logical thinking in effectuation theory.

(2) March's theory of exploration and exploitation

Exploration involves searching, experimentation, risk-taking, discovery and innovation. Exploration requires a significant investment of time and resources to explore and find better product and technology solutions from the time an opportunity is identified until a decision is made to formally commit to it. As such, exploration is characterized by future-oriented uncertainty, where incremental exploration can improve capabilities and help systems remain dynamically adaptive over time. Development is the established, controlled present and consists mainly of proposing, refining, selecting, executing and giving feedback. Actions such as conducting market research on consumer needs, assembling a management team and gaining stakeholder support provide the necessary support to exploit opportunities (March, 1978). In the short term, exploitation improves current performance more than exploration, but in the long term, the process of increasing exploration is more likely to significantly increase adaptive presence and reduce self-sabotage. Exploration and exploitation are two important concepts in organizational learning theory, both of which constitute the dynamic adaptive capacity and enduring competitive ability of organizations, and exploration and exploitation theory is one of the sources of effectuation theory.

(3) Effectuation theory

Effectuation theory reveals that entrepreneurs face an entrepreneurial environment that is often highly uncertain and severely under-resourced. In such situations, entrepreneurs cannot predict the future through experience and knowledge use, research or competitive analysis, but can only examine possible entrepreneurial opportunities through the creative use of their own conditions and the resources and means available to them, and control the future on a risk-averse basis (Sarasvathy, 2001, Perry et al., 2012).

1.2. Purpose and significance of the study

Mainstream economics and management always conduct decision analysis assuming that something already exists, rather than examining how it was created step by step. For example, in the case of Alibaba Group, the current Chinese internet giant founded in 1999, how did they grasp the opportunity before starting their business, how did they define the internet market that did not exist in China at that time, how did they develop a marketing strategy for a market that did not exist, etc. The “Eighteen Men” represented by Jack Ma, they were faced with an uncertain entrepreneurial environment: there was no historical data to use, no industry to refer to, and even the needs of customers could not be precisely determined, so clear objectives could not be set. In such a situation, using traditional causal reasoning for decision-making can be very problematic.

Building on the work of her predecessors, Professor Sarasvathy has proposed a theory that better addresses the problems faced by the actual entrepreneurial process - effectuation - in the context of the high level of uncertainty faced by entrepreneurship, breaking with some of the assumptions of mainstream management and economics.

Since Professor Sarasvathy proposed effectuation theory in 2001, it has attracted many entrepreneurship researchers who believe that effectuation theory offers a new perspective on the entrepreneurial process and promises a breakthrough in the field of entrepreneurship research. Currently, the field and content of research on effectuation theory has been enriched. From early conceptual and connotation definitions to practical studies, researchers have now extended their research objects from entrepreneurial enterprises to internationalized enterprises and SMEs, and the content has been extended to internationalization, marketing, business model innovation and other fields.

All businesses in the world are currently facing the combined impact of the digital economy wave and the pandemic. In such a complicated, volatile market environment, there is insufficient research on what causes SMEs to become digital, how the evolution of business models occurs and what the logic behind it is. Furthermore, it is surprising that there is still very little research based on this research scenario in China, as one of the fastest growing economy.

In terms of current research methods, researchers have mainly used case studies and meta-analysis, and in recent years, quantitative research methods have begun to be introduced into effectuation research. Although, many scholars advocated the introduction of environmental uncertainty into effectuation research, and there is much discussion in this regard, there is still a

gap in empirical research in this area.

Based on the above background, the object of this study is Chinese SMEs established within eight years. The research purpose of this master's thesis are to reveal the connection between effectuation and the performance of digital transformation of SME business models by means of questionnaire survey, based on the current situation of innovation and entrepreneurship development of Chinese SMEs.

Using effectuation theory as the theoretical basis, we also attempt to propose the use of environmental uncertainty as a moderating variable, investigating the moderating role of environmental dynamism and complexity in the link between effectuation and the digital performance of SMEs, and to find the decision-making logic behind the digitalization of SMEs, with a view to enriching entrepreneurship research.

1.3. Research Methodology and Framework

1.3.1. Research methodology

(1) Literature research

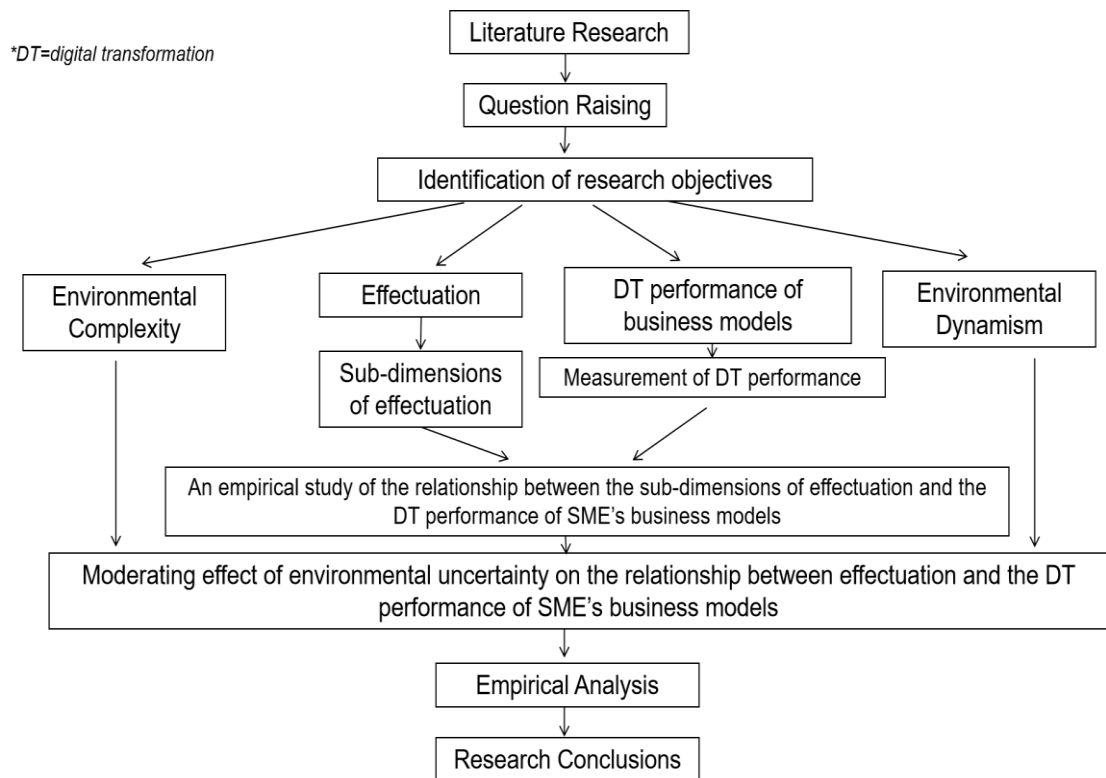
By reading top management and entrepreneurship journals, we combed and summarised research papers on environmental uncertainty, corporate performance and effectuation, extracted common keywords in these literatures, and then re-searched the literature based on these common keywords, focusing on papers on the relationship between effectuation and corporate performance in uncertain environments.

(2) Quantitative research

According to the established theoretical model, based on the company samples collected by the Enterprise Survey for Innovation and Entrepreneurship in China (ESIEC) from Open Data Platform of Peking University, after preliminary filtering and cleaning of the data, we attempt to analyze the relationship between effectuation and enterprise digital transformation performance using principal component analysis and hierarchical liner regression, to verify whether environmental uncertainty plays a moderating role in the relationship between effectuation and digital transformation performance SME's business model.

1.3.2. Research roadmap

Figure 1.1



Chapter 2. Literature review

Digitalization, for example, is undoubtedly a leading topic in industry and academia at the moment. When talking about sustainable economies, Industry 4.0 or business model innovation, digitalization cannot be avoided. However, when trying to understand more about digitalization or digital transformation, there is a lot of confusion about some conceptual relationships and terms such as digital, digitalization, digital business models, digital transformation. Without a common understanding and interrelationship of these terms, their roots, applications, impacts and ultimately sustainable measures are difficult to establish, develop and discuss (Bican & Brem, 2020). Without these interrelationships, academic discourse lacks a foundation on which it can be built. Therefore, it is necessary to define some of the terms covered in this thesis before the discussion.

2.1. Definition of selected concepts

2.1.1. Definition of digitization

First, we need to clarify the difference between digitization and digitalization, although in most cases the terms digitization and digitalization are often used interchangeably (Bloching et al., 2015).

Digitization refers to the technological process of implementing digital technologies into daily activities (Fors, 2013). Viewed through the lens of information technology in terms of coding and programming, digitization describes the conversion of analogue information into a digital format (Yoo et al., 2010) and refers to the capacity to collect relevant information, evaluate it, and transfer it into action, which is related to the big data and analytics topics. Correspondingly, digitalization is described as a socio-technological process of applying digitization techniques to broader social and institutional contexts that render digital technologies' infrastructures (Sussan & Acs, 2017).

2.1.2. Definition of digital transformation

After years of development and practice, digital transformation (DT) has gradually been recognized and familiar, and digitalization has gradually developed from a concept and a tool to a transformation. The deep integration of digital technology and industry has become a new driving force for high-quality economic development.

Digital transformation uses technology to radically improve a firm's performance or reach of enterprises (Westerman et al., 2014) and is a transition that is facilitated by developing information technology and incorporates goods, business processes, operational procedures, and organizational skills (Lucas et al., 2013 & Tan et al., 2015). At the same time, it is not ephemeral, but an intentional and continuous digital evolution of a company, business model, idea process or approach, both strategically and tactically (Mazzone, 2014). From this definition, digital transformation can also involve different dimensions. In digitalization, changes of digital technologies can bring to a company's business model that lead to changes in product or organizational structures or the automation of processes (Hess et al., 2016). Specifically, such as enhanced customer experience, streamlined operations or value creation (Horlacher et al., 2016; Singh & Hess, 2017). Within the enterprise, digital transformation is defined as an organizational shift towards big data, analytics, cloud, mobile and social media platforms (Nwankpa & Roumani., 2016). It is a profound change that accelerates business activities, processes, capabilities and

models to make the most of the changes and opportunities of digital technologies (Demirkan et al., 2016).

2.1.3. Business models

Business models, which are different descriptions of how firms create, capture and deliver value, have been receiving academic attention for decades. When examined closely, we found that the existing literature describes the concept of a business model in a variety of ways. Generally speaking, a business model can be seen as a description of a story that explains how a business works (Magretta, 2002). The business model undoubtedly solves the question of how the firm's benefits flow back to the company in the form of revenue. The value provided may be used to distinguish competitors, establish consumer connections, and gain a competitive edge.

Wheelen and Hunger (2016) define that business model is a company's method for making money in the current business environment. A business model typically reveals that what it provides, how to create money, how to distinguish and sustain competitive advantage, and how to provide products or services, describing how the company and its partners create and deliver value to gain and maintain revenue. As a structural template, the business model identifies the company's value proposition, associated networks, costs and revenue streams, and other key distinctions.

Currently, researchers are increasingly concerned with the changes and evolution of business models due to the rapid development of digital technology and the drastic changes in the surrounding environment. Likewise, businesses must effectively adapt their business models to changing technology and circumstances. Thus, a firm's performance is determined by its ability to distribute resources. (Amit & Han, 2017).

As business model is a broad concept, in order to understand the changes and evolution of business models, and based on the existing research literature, Baber et al. (2019) considers five important business elements. These are product or service, value network, which refers to the key actors in a company's operations (Autio et al., 2018), value delivery, which covers how value is exchanged to various partners and customers in the ecosystem (Ojala & Lyytinen, 2018), revenue models and information flows, an element that acts as a link between all business model elements and enables firms to exchange information about the value of the network.

2.1.4. Digital transformation of business models

Digitization in digital business models can be seen as enhancing resource optimization

through digital technologies, such as mobile sharing schemes like Uber's or Software as a Service (SaaS), interacting between entities and systems (Planing, 2017).

If technological improvements cause fundamental changes in the way business is done and money is earned, business models are digital (Veit et al., 2014). These changes are reflected in the distinction between place (i.e. pre-Internet business models) and space (i.e. post-Internet business models) (Weill & Woerner, 2015). Today, many industries are shifting to a digital world. All are shifting to a digital world of space-more intangible, more service-based, and geared towards the customer experience (Weill & Woerner, 2015).

Weill and Woerner (2015) propose three components that lie at the heart of the digital business value proposition: platform, content and experience. In addition, other characteristics of digital business models identified by previous literature include their intangibility, meaning that data collected under multiple functional conditions have the potential to be reused indefinitely (Yoo, 2012); And software-based capabilities that refine existing functionality (Adomavicius et al., 2008). However, efficiency gains may come at the cost of increased complexity that is difficult to understand (Parida et al., 2019). Herein we quote a critical statement from the work of Schallmo and Williams (2018), where the definition of business models digital transformation is presented as follows:

“The digital transformation of business models involves the networking of individual business model elements, the entire business model, the value-added chain, and the different players in the value-added network.

The degree of digital transformation is related to incremental (marginal) and radical (fundamental) changes in the business model. The unit of reference for the degree of novelty is primarily the customer. But it may also affect one's own business, partners, industry and competitors.

In the digital transformation of business models, enablers or technologies (e.g. big data) are used to generate new applications or services. (e.g. on-demand forecasting). These enablers require skills that make data, data collection and exchange, and analysis possible.

The digital transformation of a business model is based on an approach. It consists of a sequence of tasks and decisions that are logically and temporally interconnected. It affects four target dimensions: time, finance, space and quality.”

In summary, what researchers could agree on is that business models are about the creation

and delivery of value, which ultimately needs to reach the consumer. In addition to this, there is a necessary connection with stakeholders in the process to ensure that value is delivered successfully. Considering the concepts involved in the design process of this thesis questionnaire, regarding the digital transformation of business models, the Veit's definition as we quoted previously is the most accepted example (Veit et al., 2014).

2.2. Small and Medium-sized Enterprises (SMEs)

2.2.1. Definition of SMEs

Small and medium-sized businesses power the global economy. They help to create jobs and boost economic growth, and ensure social stability. In addition, SMEs stimulate entrepreneurship and innovation. As such, it is essential for promoting the competitiveness and sustainable development of enterprises.

For a precise definition of an SME, according to EU standards, an enterprise with less than 10 employees and an annual turnover of up to €2 million is a micro-enterprise; An enterprise with up to 50 employees and an annual turnover of up to €10 million is a small enterprise; An enterprise with less than 250 employees and an annual turnover of less than €50 million is a medium-sized enterprise.

China also classifies enterprises as small, medium and micro, but the specific criteria are based on indicators such as the number of employees, business revenue and total assets of the enterprise, coupled with industry characteristics and with varying values. In the retail sector, for example, small and micro enterprises with less than 300 employees or operating income of less than RMB 200 million. Among them, those with 50 or more employees and business revenue of over RMB 5 million are medium-sized enterprises; Those with 10 or more employees and business revenue of over RMB 1 million are small enterprises; Those with less than 10 employees or business revenue of less than RMB 1 million are micro enterprises.

2.2.2. Digital transformation of SMEs

While SME digital transformation has received some research over the past decades, the majority of it has been on the efficiency of certain technology skills and tools given by SMEs via third-party online platforms, such as online interaction and transactional processing systems, to assist SMEs in better understanding their consumers and transacting orders. Secondly, existing

research has found that managers and employees of SMEs lack general awareness and understanding of the importance of digital transformation compared to large enterprises.

In addition to perceptions, SME managers and employees lack the capacity to undertake digital transformation. Previous research has indicated that top management capabilities are vital in digital transformation, and that senior managers' awareness of and conviction in the potential benefits, in particular, are critical to effective digital transformation adoption and implementation. Scholars also point out that this is more of a management issue than a technology issue (Besson & Rowe, 2012). Successful digital transformation requires not only the acquisition and deployment of technical resources, but perhaps more importantly, the ability to act and manage teams in the business. Bai et al. (2021) find that digital payments, especially mobile money, should be a critical digital transformation priority for MSEs. Also, institutions must support MSE resources and capabilities to adopt digital transformation for business continuity, and sustainable production and consumption.

Regarding digital transformation strategies, Berman (2012) proposes the following three strategies. Firstly, reinventing the customer value proposition; Secondly, using digital technology to transform the operating model and gain access to more customer interactions; Thirdly, combining the two claiming strategies by simultaneously reinventing the customer value proposition and transforming the operating model with digital technology. Thomas and Alexander (2015) categorize digital transformation strategies into four basic dimensions: Digital Technology Utilization Strategy, Value Creation Transformation Strategy, Structural Transformation Strategy and Financial Transformation Strategy. In reality, the choice of specific strategies depends on the company's strategic objectives, industry context, competitive pressures and customer expectations. Furthermore, when one's own technological limitations cannot be ignored, Ulas (2019) arranges the technological software and processes that SMEs can use in the process of digital transformation.

2.3. Effectuation Theory

2.3.1. Definition of effectuation

Effectuation refers to means-driven and emphasizes the use of flexible and experimental strategies in planning new risk paths, where unexpected events provide new opportunities and uncertainty is dealt with by adapting to new circumstances (Sarasvathy, 2001). Effectuation is a type of decision logic as opposed to causation, where causation identifies outcomes first and then

method based on the desired outcome, whereas effectuation looks for feasible methods first and then chooses between the possible outcomes of these methods. Causation starts with a defined goal or outcome and considers a range of methods to achieve that goal, then considers the limitations or risks to which those methods may be subject, and in the choice of approach is more focused on maximizing the desired goal, which is a goal-oriented decision-making process. Effectuation, on the other hand, starts with the resources and methods available to it, considers the possible outcomes of these methods, and then considers the possible outcomes of these methods. The choice is based on the resources and methods available to the company, the likely outcomes of these methods, the potential external influences on these methods, and the risk of loss and risk to the company. The choice of decision is based on the losses and risks that the company can bear (Perry et al., 2012; Sarasvathy, 2009; Sarasvathy & Dew, 2005).

Regarding the specific components of effectuation, Sarasvathy (2001) suggests four principles of effectuation as opposed to causation: Considering affordable losses rather than calculating expected returns; Conducting strategic alliances rather than competitive analysis; Focusing on exploiting contingencies rather than using existing knowledge; and Emphasizing control of the unforeseen future rather than forecasting the uncertain future.

Effectuation theory has gone through three stages. In the early stages, researchers focus on the core definitions of effectuation, such as what are effectuation? how entrepreneurs act under uncertainty (Wiltbank et al., 2006), how entrepreneurs behave before establishing a firm, and how entrepreneurs succeed in creating a firm.

As the theory of effectuation continues to gain attention among researchers, scholars have begun to explore the connection between effectuation theory and data using research methods such as questionnaire-based statistical analysis, case study analysis and meta-analysis. For example, a common research strategy for researchers is to add mediating and moderating variables. Empirical research in the category of effectuation deepening is based on quantitative analysis and focuses on the antecedents and consequences of effectuation.

The turning point was the introduction and testing by Chandler et al. (2011) of the first measurement scale on effectuation and causation, where they created four sub-concepts corresponding to the four principles of effectuation, namely experimentation, affordable loss, organizational flexibility and pre-commitment, which were measured by 13 question items. In addition, causation is also measured with seven question items. The measurement approach

featured separate measures of the four sub-constructs of causation and effectuation, which allowed for the examination of whether entrepreneurs use a mixture of the two reasoning logics in different contexts, and also allowed for the exploration of the relationship between the sub-dimensions of the different dimensions of effectuation and the front-end and outcome variables separately.

The theory has been further developed by its proponents, such as Fisher (2012), who argue that it is one of the few viable alternative theoretical perspectives for describing entrepreneurial action. In contrast to Chandler et al (2011) measurement, (Brettel et al., 2012b) measure effectuation and causation as opposing aspects, with the measurement unfolding through 23 entries.

At the same time, scholars have extended the theory of effectuation, which originated in the field of entrepreneurship, to other fields and contexts, examining whether and how decision-makers in other fields use the logic of effectuation in the face of uncertainty. This type of research has made an important contribution to the extension of effectuation theory to other domains.

For example, Mainela et al. (2013) have examined how international cooperation projects are carried out through opportunity exploration and effectuation behavior in turbulent environments. Andersson (2011) explore the characteristics of early internationalization processes and decisions of born-global firms based on effectuation theory and found that these firms were able to enter multiple markets in a short time by working with local network partners. Accordingly, the author argue that effectuation is an important tool for understanding the development of born-global firms. Evald and Senderovitz (2013) find that SMEs mainly adopt an improvisational approach to international corporate venture capital, and that opportunities are mainly created through trial and error, in which the logic is effectuation mainly. Kalinic et al (2014) suggest that unplanned internationalization is not necessarily an illogical decision, and that entrepreneurs follow effectuation logic rather than causation logic in this process. Galkina and Chetty (2015) not only extend effectuation to the field of internationalization, but also integrate it with the classic Uppsala model in internationalization research to show how SMEs build relationships with like-minded partners in the internationalization process, rather than carefully selecting internationalization partners based on pre-determined network goals.

In addition, some studies have extended the effectuation to the fields of marketing and social entrepreneurship. For example, Lam et al (2015) analyze marketing activities in entrepreneurship based on effectuation theory; Yusuf and Sloan (2015) use it to analyze how social entrepreneurs make decisions when creating non-profit social organizations; Wu et al (2015) study

the biomedical technology industry based on effectuation theory.

Of course, there have been disagreements in the development of the theory. Overall, however, there were four dominant areas of research during the period 2012-2016. Innovation and product development (Brettel et al., 2012b), international (Kalinic et al., 2014; Fuerst & Zettinig, 2015), effects and causal logic can work together in the same organization (Lingelbach et al., 2015; Reymen et al., 2015) and performance and growth (Brettel et al., 2012; Xia, 2020).

Since 2016, Matalamäki (2017) has argued that experienced entrepreneurs seem to follow certain patterns, encouraging scholars to further investigate how practitioners fit into these patterns and under what conditions or mechanisms. Like (Shirokova et al., 2021) argue that the validity of causation and effectuation is influenced by the level of development of regulatory, normative and cultural cognitive systems.

Of course, as mentioned earlier, effectuation has faced controversy throughout its development. Opinions from Arend et al (2015) are perhaps one of the most vocal critics of effectuation, claiming that it has not been fully developed as a new theory of entrepreneurship. They insisted that effectuation emphasizes description rather than explanation, failed to build on previous research, and lacks a clear account of context. (Kitching & Rouse, 2020) argued that effectuation theory does not adequately take into account the substantial, pervasive and enduring effects of social structure and cultural context on entrepreneurship. Professor Zhao (2020) argued that effectuation theory is a beautiful theory but may be wrong as it can suggest how to find business opportunities for simple products or services, but is not suitable for large complex products such as the COVID-19 vaccine.

2.3.2. Digital business model transformation from an effectuation perspective

Based on the previous analysis, in the post-pandemic era, faced with uncertainty in the external environment, unpredictability of risks and high resource constraints, enterprises need to seek opportunities to develop new businesses, new products and new markets through digital transformation. The process of digital transformation of enterprises is inevitably accompanied by adjustments and changes in operational or business models. Effectuation theory can be used to better understand how entrepreneurial opportunities for new digital business models emerge, and how and under what conditions they lead to changes in business models (Ojala & Lyytinen, 2018). From a dynamic process perspective, researchers have also studied business model evolution

through resource restructuring (Demil & Lecocq, 2010) and entrepreneurial initiatives by entrepreneurs to create and discover new opportunities (Ojala & Lyytinen, 2018). While existing articles extend the content of effectuation theory, the decision logic behind the change and evolution of business models remains unclear for SMEs in the process of digital transformation.

Chapter 3. Research design

3.1 Research hypothesis and model

3.1.1. Effectuation and SME's Digital Transformation Performance

When Professor Sarasvathy introduced the theory of effectuation, she suggested that it did not predict business performance, but scholars are still keen to explore the relationship between effectuation and performance.

In situations where risk and uncertainty coexist, decision makers find it difficult to make optimal decisions based on careful design due to limited information and resources and the constraints of an unpredictable environment. Effectuation is the heuristic logic that guides enterprises in carrying out management actions in an uncertain environment. As in the case of start-up development, SMEs still face problems such as shortage of capital, lack of talent and struggle to develop business in an uncertain environment compared to large enterprises. From a business development perspective, SMEs are the surviving start-ups and therefore the growth shortcomings and advantages of start-ups can still be present in SMEs.

On the one hand, uncertainty brings opportunities. Firms cannot assess in advance the possible risks and benefits of business model innovation, product innovation, and technological innovation in the process of digital transformation, so decision makers still need to identify, explore and evaluate opportunities through the process of trial and error by thinking about established means. Compared to large established enterprises, SMEs are adept at being flexible and constantly creating possibilities, showing unique advantages in terms of patchwork and creative access to resources.

On the other hand, uncertainty can be costly. In order to compensate for the lack of basic aspects such as access to established means and information, SMEs are also forced to consider

exploring innovations in products and services in order to survive, and to be willing to take the risks that are assumed as a result of innovation. In the start-up phase, entrepreneurs take risks based on what they can afford to maximize their losses (Sarasvathy, 2001). In contrast, it is unclear whether the attitude of SME entrepreneurs towards risk-taking in the digitalization process is based on the maximum loss they can afford or the expected return. Whether the formation of strategic alliances through pre-commitments in the entrepreneurial phase is still valid in the digitalization decision process is also a question that needs to be re-confirmed.

Based on the above analysis, the following hypotheses are proposed in this paper.

H1: Effectuation has a positive impact on the performance of digital transformation of SME's business models.

H1a: Experimentation has a positive impact on the performance of digital transformation of SME's business models;

H1b: Affordable losses have a positive impact on the performance of digital transformation of SME's business models;

H1c: Organizational flexibility has a positive impact on the performance of digital transformation of SME's business models;

H1d: Pre-commitment has a positive impact on the performance of digital transformation of SME's business models;

3.1.2. Environmental uncertainty positively moderate on the relationship between effectuation and SME business model digital transformation performance

Management research has more often defined uncertainty as the difficulty of expressing it in probability, the lack of causal relationships and the inability to predict consequences. Environmental uncertainty arises from the external environment and is also closely related to the capabilities and knowledge of decision makers. Uncertainty is not a one-dimensional concept, but should be seen as a multidimensional concept, or a conceptual framework (Nygaard et al., 1997). Environmental uncertainty is a function of dynamism and complexity as it addresses the variability and complexity of information in a firm's business environment.

Numerous scholars have found that simply studying the linear and linear relationship

between effectuation reasoning and the performance of start-up and high-tech enterprises is hardly a true reflection of the environmental uncertainties faced in the entrepreneurial process, and the conclusions drawn are not as explanatory and generalizable. In order to improve the generalizability of effectuation, researchers have started to introduce environmental factors into the research models.

From the perspective of contingency theory, the relationship between effectuation and SME's performance is influenced by several factors such as organizational and environmental factors, and it is necessary to introduce contingency factors into the research model of corporate decision logic and corporate performance to conduct a more detailed analysis of the digital transformation process. Previous scholars have analyzed environmental uncertainty in four aspects: dynamism, complexity, competitiveness and undirectedness. This paper draws on the views of most existing scholars to analyze environmental uncertainty in terms of both dynamism and complexity of the environment.

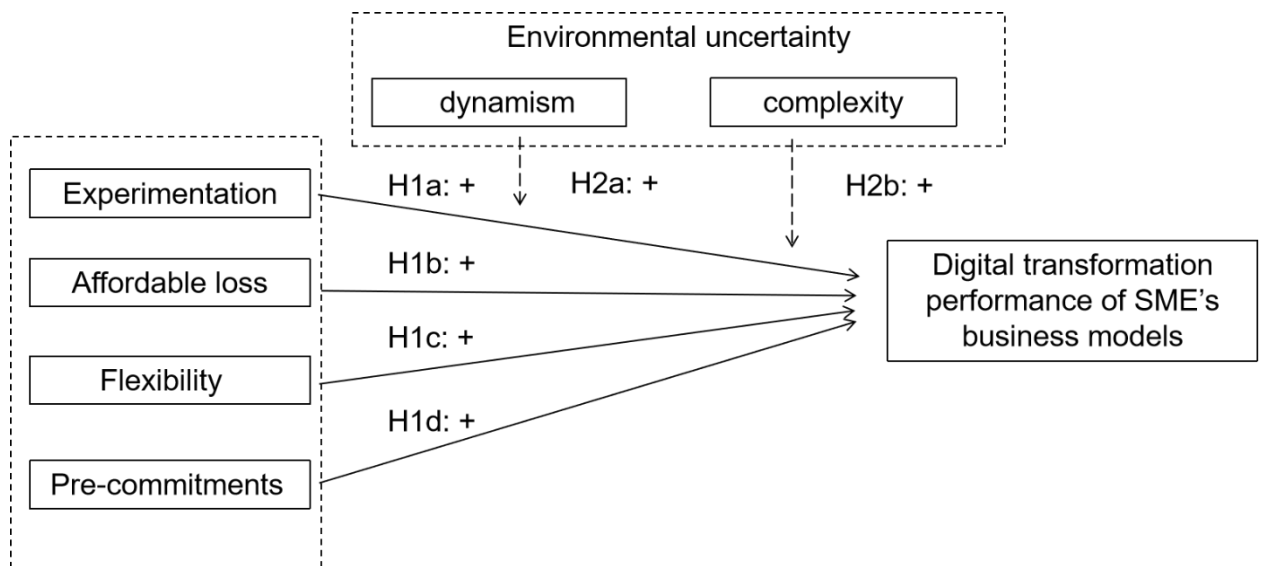
Based on the above discussion, we make the following assumptions:

H2a: Environmental dynamism has positive moderating effect on the relationship between effectuation and the performance of digital transformation of SME business models.

H2b: Environmental complexity has positive moderating effect on the relationship between effectuation and the performance of digital transformation of SME business models.

3.1.3. Research theoretical model

Figure 3.1



3.2 Questionnaire Design

3.2.1. Object of research

Small and medium-sized companies (SMEs) drive the global economy. They help to create jobs and promote economic growth, and ensure social stability. In addition, SMEs stimulate entrepreneurship and innovation. This is therefore essential for promoting enterprise competitiveness and sustainable development. In this paper, SMEs with less than 300 employees are used as the sample for this paper, based on the characteristics of the research objectives and the target population, and combining the EU and Chinese classification criteria for SMEs.

3.2.2. Data collection

The research data for this paper comes from the China Enterprise Innovation and Entrepreneurship Survey Project conducted by the Enterprise Big Data Research Centre at Peking University.

The Enterprise Survey for Innovation and Entrepreneurship in China (ESIEC) is a field survey of private enterprises in China conducted by Peking University's Enterprise Data Research Centre over the past years. The data cited in this paper are provided by ESIEC from their sample pool used during two rounds of online surveys in February 2020 and May 2020, conducted after the COVID-19 outbreak.

We created the questionnaire ourselves and distributed it to their current sample pool of businesses to collect data. The surveys were issued on February 10, 2022, and as of February 23,

2022, the online survey had received a total of 464 responses. After excluding responses with errors and those that did not meet the requirements of the study, 345 valid responses remained. The valid sample rate is 74.4%. The basic information of the sample is as follows:

Table 3.1 Basic information of the sample

Item	Classification	Sample	%	Item	Classification	Sample	%
Gender	Man	248	53.45	Education	High school	42	9.05
	Woman	216	46.55		Junior college	139	29.96
Age	≤25	95	20.47		Undergraduate	229	49.35
	26-30	141	30.39		Master	48	10.34
	31-35	98	21.12		Phd&MBA	6	1.29
	36-45	84	18.1		Industry	Manufacturing	123
	≥46	46	9.91	Retailing		142	30.60
Position	Board member	38	8.19	Catering Services		75	16.16
	Senior manager	60	12.93	Internet and IT		100	21.55
	Department head	1	0.22	Others		24	5.17
	Project manager	241	51.94	Nature	State owned	101	21.77
	Other positions	124	26.72		Private	142	30.60
					Joint venture	135	29.09
					Foreign owned	86	18.53
					Others	0	0

3.2.3. Research method

According to our research objectives, this thesis first conducts a reliability test, including the reliability test of each dimension of the scale and the total scale, to test the stability and consistency of the results obtained from the scale. Then, we conduct factor analysis by using principal component analysis for all the indicators to reduce the dimensionality of the indicators and find the common components. Finally, we use hierarchical multiple regression analysis to investigate the moderating effects of environmental uncertainty factors in the relationship between effectuation and SME digital performance.

Specifically, to test the six hypotheses proposed above, we gradually add control variables(number of staff ,time of establishment), independent variables (experiment, affordable loss, organizational flexibility, and pre-commitment), moderating variables (environmental dynamism, environmental complexity), and eight interaction terms for the independent and

moderating variables to the hierarchical multiple regression model (experiment*complexity, affordable loss*complexity, organizational flexibility*complexity, pre-commitment*complexity, experiment*dynamism, affordable loss*dynamism, flexibility*dynamism, pre-commitment*dynamism), to verify the linear relationship between effectuation and SMEs digital performance, and the moderating effect of environmental uncertainty between them.

3.3. Selection and measurement of variables

3.3.1. Variable measurements

This paper focuses on the relationship between effectuation and the digital transformation performance of SME's business models and the moderating effect of environmental uncertainty, therefore the variables measured are mainly effectuation, SME's digital performance and environmental uncertainty. This is measured using a Likert5 five-point scale, where higher scores indicate greater agreement, as follows: 1=completely disagree; 2=disagree; 3=uncertain; 4=agree; 5=completely agree.

3.3.2. Independent variable - Effectuation

There are two types of effectuation measurements. The first is a scale established by Chandler et al., (2011) that precisely evaluates the aspects of effectuation, with 14 items on four dimensions: experimentation, affordable loss, organizational flexibility and pre-commitment, and the other is a scale developed by Brettel et al., (2012a) based on Sarasvathy's (2001) theoretical comparison of effectuation and causation. As this paper only measures effectuation and does not compare it with causation, the scale by (Chandler et al., 2011) was chosen for reference. The scale was drawn upon in this paper, but given the data source and the subject of this paper, some of the measures of the scale were adapted and modified as appropriate, resulting in 13 question items. These include 4 items on experimentation, 3 items on affordable loss, 4 items on organisational flexibility and 2 items on pre-commitment.

3.3.3. Dependent variable - SME digital transformation performance

As there is a wealth of research on the measurement of business performance, the mainstream scales are well established. Taking into account the difficulty of obtaining financial indicators and the life cycle of SMEs, combined with the definition of digital transformation of

business models, we used the subjective evaluation index of Mao-Mao Chi (2020) to select performance indicators such as whether a company uses digital technologies for business operations, improving business processes, achieving value creation and reducing costs. The same point Likert scale approach was used to describe the digital transformation performance of SMEs, with higher scores indicating better performance.

3.3.4. Moderating variable - Environmental dynamism and complexity

Environmental uncertainty is the most important contingency factor faced by entrepreneurs and researchers have used different approaches to scale environmental uncertainty. Lumpkin and Dess (2001) divided the dimensions of environmental uncertainty into stability and dynamism. While Duncan used two dimensions of complexity and dynamism to describe environmental uncertainty. Some other scholars describe environmental uncertainty in terms of dynamism, competition and complexity (Hu & Zhang, 2012). Through the review of scholars' research on the division of environmental uncertainty, it is found that although scholars understand environmental uncertainty from different perspectives and put forward their own divisional dimensions, they have reached a consensus on the two dimensions of dynamism and complexity. Based on this, this paper also uses environmental uncertainty in terms of both dynamism and complexity.

Drawing on previous research, seven measures of environmental uncertainty were selected, including four measures of environmental dynamics and three measures of environmental complexity. Environmental uncertainty is also measured using the Likert5 five-point scale, where higher scores indicate greater agreement, as follows: 1 = totally disagree; 2 = disagree; 3 = uncertain; 4 = agree; 5 = totally agree.

3.3.5. Control variables

Previous studies have shown that firm background variables, such as age, industry and size, affect firm performance, so this study chose to treat firm establishment time and number of employees as control variables.

Chapter 4. The empirical analysis

4.1. Reliability Analysis and Factor Analysis of the scale

Reliability analysis in statistics is mainly used to check the reliability and validity of data on variables and is a common and valid method of analysis. Cronbach's α coefficient is commonly used in empirical studies to determine the reliability of data. When the Cronbach's α coefficient is greater than 0.7, it is generally considered that the questionnaire data has a certain degree of reliability, while a larger value of the alpha coefficient means a higher degree of reliability. In this study, the measurements include mainly effectuation, SME digital transformation performance and environmental uncertainty.

Principal component analysis (PCA) is a statistical method that identifies variables by extracting common factors between measurement questions. Generally, the suitability of factor analysis is determined by judging the KMO value. A KMO value greater than 0.7 is considered suitable for factor analysis, while a larger KMO value indicates a higher suitability for factor analysis.

We conduct descriptive analyses, reliability tests, principal component analysis and hierarchical linear regression on the data obtained from 345 valid responses. We use the statistical software SPSS 26.0 to conduct reliability tests and principal component analysis on the scales. The descriptive statistics of the sample are shown in Table 4-1 below.

Table 4-1 Descriptive statistics of the sample

Numb	Questionnaire item	N	Mean	Std. Deviation
X1	To achieve information sharing, all business departments of the company can realize remote office	345	3.64	1.315
X2	The company's internal software applications can realize the use of various analysis platforms	345	3.66	1.333
X3	Employees can access all platforms through the company's user interface	345	3.72	1.291
X4	The company tried to adopt novel trading methods to obtain revenues	345	3.69	1.307
X5	The company has tried to build a variety of distribution channels	345	3.76	1.325

X6	The company has reduced inventory, marketing, sales and other costs through new technologies	345	3.66	1.311
X7	In the process of digital transformation, the company will try other different product designs and services	345	3.81	1.186
X8	In the process of digital transformation, the products and services created are the same as before the transformation	345	3.86	1.145
X9	The company's existing products and services are fundamentally different from those before the transformation	345	3.81	1.241
X10	The company is still in the exploratory stage until a viable business model is found	345	3.74	1.26
X11	In the process of digital transformation of the company, relevant commitments will be made cautiously to ensure that it is not more than the company can afford	345	3.7	1.278
X12	In the process of digital transformation of the company, it will prudently invest resources to avoid more losses than the company can afford	345	3.82	1.243
X13	In the process of digital transformation of the company, the use of funds will be strictly controlled to avoid unaffordable risks	345	3.75	1.251
X14	The company use existing resources to transform digital business	345	3.78	1.301
X15	In the process of digital transformation, the company will try to take advantage of new opportunities, and will not deliberately avoid	345	3.83	1.283
X16	In the process of digital transformation, the company will adaptively adjust the resource investment according to the changes in the environment	345	3.7	1.293
X17	In the process of digital transformation, company can maintain sufficient organizational flexibility to identify and utilize new opportunities timely	345	3.68	1.302
X18	In the process of digital transformation, company will establish cooperative relationships with customers, suppliers and other organizations to reduce the risks of environmental uncertainty	345	3.64	1.271
X19	In the process of digital transformation, the previous commitments of customers and suppliers will be used to drive business development	345	3.68	1.326
X20	When the company undergoes digital transformation, it has a complete understanding of the industry it belongs to	345	3.62	1.346

X21	When the company undergoes digital transformation, the competition in its industry is complicated	345	3.69	1.351
X22	When the company undergoes digital transformation, the markets of the products and services they create vary widely	345	3.7	1.273
X23	When the company undergoes digital transformation, competitors often take some unpredictable actions	345	3.62	1.302
X24	When the company undergoes digital transformation, new products have a long-life cycle	345	3.64	1.309
X25	When the company undergoes digital transformation, product technology changes rapidly	345	3.78	1.276
X26	When the company undergoes digital transformation, unpredictable changes in consumer demand within the industry	345	3.71	1.27
X27	The company's sales growth rate is relatively satisfactory	345	3.64	1.323
X28	The company's market share growth rate is relatively satisfactory	345	3.69	1.33
X29	The company's new employee growth rate is relatively satisfactory	345	3.72	1.286
X30	The company's operating profit is relatively satisfactory	345	3.72	1.312

4.1.1. Scale Reliability Test

Table 4-2 Scale Reliability Test

Reliability Statistics	
Cronbach's Alpha	N of Items
.959	30

As shown in Table 4-2, the Cronbach's alpha value is 0.959, suggesting that the total scale's internal consistency is strong and the reliability test is extremely excellent.

4.1.2. Factor Analysis

Table 4-3 Scale KMO test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.946
Bartlett's Test of Sphericity	Approx. Chi-Square	8178.629
	df	435
	Sig.	.000

The KMO value here is 0.946, as shown in Table 4-3, with the indicator value greater than 0.7, indicating the presence of common factors between the variables and that the variables are well suited for factor analysis. In addition, the approximate chi-square value of Bartlett's Test of Sphericity is 8178.629 with a degree of freedom of 435 and P-value of $0.000 < 0.05$, which is statistically significant and suitable for factor analysis.

4.1.3. Factor extraction

In this thesis we use principal component analysis (PCA) method for factor extraction. These factors are extracted by setting the criteria with an eigenvalue greater than 1 and loading of each item greater than 0.5 are grouped into one component. Also, if the overall explained variance is 60% or more, it indicates that the extracted principal components have good explanatory power.

According to the output of SPSS 26.0, the cumulative variance contribution of the eight principal components extracted in this paper reaches 79.56%, which is more than 60%. Also, the factor analysis scree plot in Figure 4-1 shows that the slope line is relatively flat starting from the 8th factor, indicating that there is no specific factor worth extracting. Therefore, it is more suitable to retain these 8 common factors. Each loading value for the entire measurement scale in Table 4-4 is greater than 0.5.

Figure 4-1

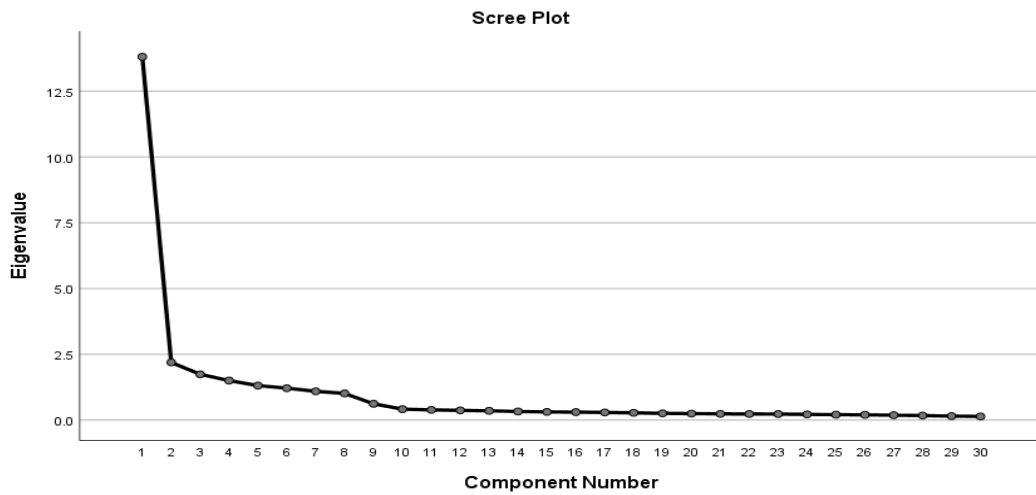


Table 4-4 Rotated Component Matrix^a

Rotated Component Matrix^a								
	Component							
	1	2	3	4	5	6	7	8
In order to achieve information sharing, all business departments of the company can realize remote office	.814							
The company's internal software applications can realize the use of various analysis platforms	.813							
The company tried to build a variety of distribution channels	.807							
The company has reduced inventory, marketing, sales and other costs through new technologies	.805							
The company tried to adopt novel trading methods to obtain revenues	.783							
Employees can access all platforms through the company's user interface	.760							
When the company undergoes digital transformation, new products have a long life cycle	.825							
When the company undergoes digital transformation, competitors often take some unpredictable actions	.815							
When the company undergoes digital transformation, unpredictable changes in consumer demand within the industry	.802							
When the company undergoes digital transformation, product technology changes rapidly	.744							
The company's market share growth rate is relatively satisfactory			.821					

The company's sales growth rate is relatively satisfactory	.800
The company's operating profit is relatively satisfactory	.797
The company's new employee growth rate is relatively satisfactory	.770
<hr/>	
In the process of digital transformation, the company will adaptively adjust the resource investment according to the changes in the environment	.818
In the process of digital transformation, the company can maintain sufficient organizational flexibility to identify and utilize new opportunities timely	.791
The company use existing resources to transform digital business	.790
In the process of digital transformation, the company will try to take advantage of new opportunities, and will not deliberately avoid	.747
<hr/>	
In the process of digital transformation, the company will establish a large number of cooperative relationships with customers, suppliers and other organizations to reduce the risks of environmental uncertainty	.783
In the process of digital transformation, the previous commitments of customers and suppliers will be used to drive business development	.757
<hr/>	
In the process of digital transformation, the company will try other different product designs and services	.797
The company's existing products and services are fundamentally different from those before the transformation	.755
In the process of digital transformation, the products and services created are the same as before the transformation	.741
The company is still in the exploratory stage until a viable business model is found	.762
<hr/>	
When the company undergoes digital transformation, the competition in its industry is complicated	.810
When the company undergoes digital transformation, it has a complete understanding of the industry	.788

When the company undergoes digital transformation, the markets of the products and services they create vary widely	.767
In the process of digital transformation of the company, the use of funds will be strictly controlled to avoid unaffordable risks	.774
In the process of digital transformation of the company, relevant commitments will be made cautiously to ensure that it is not more than the company can afford	.781
In the process of digital transformation of the company, it will prudently invest resources to avoid more losses than the company can afford	.741
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.	
a. Rotation converged in 6 iterations.	

4.2. Reliability tests and factor analysis for each scale dimension

4.2.1. Reliability analysis and factor analysis of effectuation

Table 4-5 Reliability analysis of effectuation sub-dimensions

Reliability Statistics	
Cronbach's Alpha	N of Items
.920	13

In social research, each scale contains sub-dimensions, so researchers often provide a reliability coefficient for each dimension in addition to the reliability coefficient for the total scale. In the case of subscales, the reliability coefficient should be above 0.7. The reliability coefficient for the effectuation scale dimension is 0.920, as shown in the table, with a reliability coefficient greater than 0.7, indicating good internal consistency of this dimension.

Table 4-6 KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.903
Bartlett's Test of Sphericity	Approx. Chi-Square	2880.788
	df	78

	Sig.	.000
--	------	------

As can be seen from the above table, the KMO value of effectuation is 0.903, which is significantly greater than 0.7. The chi-square value of Bartlett's spherical test is 2880.788 (df=78, p=0.000), indicating that the effectuation dimension is suitable for factor analysis.

Based on the eigenvalue greater than 1, the principal component extraction method, after six iteration convergence, the cumulative explained variance of the four extracted components: experimentation, affordable loss, organizational flexibility and pre-commitment is 78.034%, as shown in Table 4-7.

Table 4-7 Factor analysis of the effectuation sub-dimension

	Rotated Component Matrix^a			
	1	2	3	4
In the process of digital transformation, the company will adaptively adjust the resource investment according to the changes in the environment	.841			
In the process of digital transformation, the company can maintain sufficient flexibility to identify and utilize new opportunities timely	.817			
The company use existing resources to transform digital business	.825			
In the process of digital transformation, the company will try to take advantage of new opportunities, and will not deliberately avoid them	.790			
The company is still in the exploratory stage until a viable business model is found		.812		
In the process of digital transformation, the company will try other different product designs and services		.841		
The company's existing products and services are fundamentally different from those before the transformation		.811		
In the process of digital transformation, the products and services created are the same as before the transformation		.796		
In the process of digital transformation of the company, relevant commitments will be made cautiously to ensure that it is not more than the company can afford			.847	
In the process of digital transformation of the company, it will prudently invest resources to avoid more losses than the company can afford			.805	
In the process of digital transformation of the company, the use of funds will be strictly controlled to avoid unaffordable risks			.832	

In the process of digital transformation, the company will establish a large number of cooperative relationships with customers, suppliers and other organizations to reduce the risks of environmental uncertainty					.816
In the process of digital transformation, the pre-commitments of customers and suppliers will be used to drive business development					.753
Eigenvalue	6.64	1.403	1.081	1.021	
Explanation of variance %	20.44	19.93	18.89	18.76	
Cumulative explained variance %	20.44	40.38	59.27	78.03	
Extraction Method: Principal Component Analysis.					
Rotation Method: Varimax with Kaiser Normalization.					
a. Rotation converged in 6 iterations.					

4.2.2. Environmental uncertainty reliability analysis and factor analysis

Table 4-8 Environmental uncertainty reliability analysis

Reliability Statistics	
Cronbach's Alpha	N of Items
.895	7

Table 4-9 KMO and Bartlett's Test for environmental uncertainty

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.867
Bartlett's Test of Sphericity	Approx. Chi-Square	1749.760
	df	21
	Sig.	.000

Table 4-10 Factor analysis of environmental uncertainty

Rotated Component Matrix^a		
	Component	
	1	2
When the company undergoes digital transformation, new products have a long life cycle	.887	
When the company undergoes digital transformation, competitors often take some predictive actions	.882	
When the company undergoes digital transformation, unpredictable changes in consumer demand within the industry	.863	

When the company undergoes digital transformation, product technology changes rapidly	.842	
When the company undergoes digital transformation, the competition in its industry is complicated		.908
When the company undergoes digital transformation, the markets of the products and services they create vary widely		.874
When the company undergoes digital transformation, it has a complete understanding of the industry		.874
Eigenvalue	4.307	1.438
Explanation of variance %	45.454	36.618
Cumulative explained variance %	45.454	82.073
Extraction Method: Principal Component Analysis.		
Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

The reliability analysis and factor analysis on environmental uncertainty are shown in Tables 4-8, 4-9 and 4-10. From the tables, it can be found that the alpha value of the environmental uncertainty reliability analysis is 0.895, which has a high internal consistency and a very good reliability test. In contrast, the KMO value of it is 0.867, which is greater than 0.7 and suitable for factor analysis. In addition, the approximate chi-square value of Bartlett's test is 1749.760 (df=21, p=0.000). Each of the items measuring environmental uncertainty has a loading value greater than 0.5 and the cumulative explained variance of 82.073%, with 7 question items attributed to 2 components, namely environmental complexity and environmental dynamics.

4.2.3. Reliability analysis and factor analysis of SMEs' digital performance

Table 4-11 Reliability analysis of DT performance

Reliability Statistics	
Cronbach's Alpha	N of Items
.926	10

Table 4-12 KMO and Bartlett's Test for DT Performance

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.932
Bartlett's Test of Sphericity	Approx. Chi-Square	2802.025
	df	45
	Sig.	.000

Table 4-13 Factor analysis of digital transformation performance

Rotated Component Matrix^a		
	Component	
	1	2
The company's internal software applications can realize the use of various analysis platforms	.866	
In order to achieve information sharing, all business departments of the company can realize remote office	.856	
The company tried to build a variety of distribution channels	.853	
The company has reduced the cost of inventory, marketing and sales through new technology	.848	
The company tried to adopt novel trading methods to obtain revenues	.844	
Employees can access all platforms through the company's user interface	.811	
The company's market share growth rate is relatively satisfactory		.885
The company's operating profit is relatively satisfactory		.864
The company's sales growth rate is relatively satisfactory		.861
The company's new employee growth rate is relatively satisfactory		.850
Eigenvalue	6.036	1.829
Explanation of variance %	45.319	33.324
Cumulative explained variance %	45.319	78.642
Extraction Method: Principal Component Analysis.		
Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

The reliability analysis and factor analysis on the digital transformation performance of SMEs are shown in Tables 4-11, 4-12 and 4-13. From the tables, it can be found that the alpha value of the digital transformation performance reliability analysis is 0.926, which means it has a high internal consistency and is a very good reliability test. Again, we use principal component analysis

for factor analysis. The results shows that KMO value is 0.932, indicating suitability for further factor analysis. In addition, the approximate chi-square value of Bartlett's test is 2802.025 (df=45, p=0.000). Each problem item has a loading value greater than 0.7 and a cumulative explained variance of 78.642%, and we attributed these 10 problem items to two components, namely, digital performance and financial performance.

Yet in the following analysis, given the research objectives of this thesis, we will focus on analyzing digital performance without including the component of financial performance as a dependent variable in the next model.

4.3. Statistical analysis of data

4.3.1. Model testing

Table 4-14

Model Summary^e										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			Sig. F Change	Durbin-Watson
						F Change	df1	df2		
1	.314 ^a	.099	.094	.952	.099	18.757	2	342	.000	
2	.526 ^b	.277	.264	.858	.178	20.769	4	338	.000	
3	.557 ^c	.310	.294	.840	.034	8.187	2	336	.000	
4	.590 ^d	.348	.317	.826	.038	2.404	8	328	.016	2.024

a. Dependent Variable: FAC7_Digital_Performance

b. Predictors: (Constant), 8. The current number of staff ?, 7. The establishment time?

c. Predictors: (Constant), 8. The current number of staff ?, 7. The establishment time? , FAC2_Experiment, FAC4_Pre-commitment, FAC3_Affordable loss, FAC1_Organizational Flexibility

d. Predictors: (Constant), 8. The current number of staff ?, 7. The establishment time? , FAC2_Experiment, FAC4_Pre-commitment, FAC3_Affordable loss, FAC1_Flexibility, FAC5_dynamism, FAC6_complexity

e. Predictors: (Constant), 8. The current number of staff ?, 7. The establishment time? , FAC2_Experiment, FAC4_Pre-commitment, FAC3_Affordable loss, FAC1_Flexibility, Int1, Int4, Int3, Int5, Int8, Int7, Int6, Int2

From the above table, the explained variances of the four models are 0.099, 0.277, 0.310 and 0.348, respectively, and the R-squared changes of the four models are 0.099, 0.178, 0.034 and 0.038, indicates that the predictive power of each model for the dependent variable is gradually strengthened. The F change statistics are 18.757, 20.769, 8.187 and 2.404, p-values are 0.000 and 0.016 < 0.05, all reaching significance levels. In Model 1, the variance explained by the two control variables (Establishment time and Number of employees) is approximately 10%, which reaches a statistically significant level ($\Delta F=18.757$, $p=0.00 < 0.05$); When we add another four independent

variables (experiment, pre-commitment, affordable loss, organizational flexibility) to Model 2, the percentage of variance in the dependent variable jointly explained by the independent variables reaches 26.4%, which is statistically significant ($\Delta F=20.757$, $p=0.00<0.05$).

By adding two more moderating variables (Environmental dynamism and environmental complexity) to Model 3, the variance explained by these two moderating variables on SMEs' digital performance is 29.4%. If we exclude the effect of the variables in model 2 on the dependent variable, the variance explained by environmental dynamics and complexity on SMEs' digital performance is 3%, meeting the significance level ($\Delta F=8.187$, $p=0.00<0.05$).

The Model 4 is a full-variance model. We analyze two-by-two interactions between the four variables of the effectuation dimension and the two moderating variables. The percentage of variance in SME digital performance explained by the model's independent variables is 31.7% ($\Delta F=2.404$, $p=0.01<0.05$).

Table 4-15

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34.004	2	17.002	18.757	.000 ^b
	Residual	309.996	342	.906		
	Total	344.000	344			
2	Regression	95.164	6	15.861	21.544	.000 ^c
	Residual	248.836	338	.736		
	Total	344.000	344			
3	Regression	106.727	8	13.341	18.892	.000 ^d
	Residual	237.273	336	.706		
	Total	344.000	344			
4	Regression	119.871	16	7.492	10.964	.000 ^e
	Residual	224.129	328	.683		
	Total	344.000	344			

a. Dependent Variable: FAC7_Digital_Performance

b. Predictors: (Constant), 8. The current number of staff ?, 7. The establishment time?

c. Predictors: (Constant),8. The current number of staff ?,7. The establishment time? , FAC2_Experiment, FAC4_Pre-commitment, FAC3_Affordable loss, FAC1_Organizational Flexibility

d. Predictors: (Constant), 8. The current number of staff ?,7. The establishment time? , FAC2_Experiment, FAC4_Pre-commitment, FAC3_Affordable loss, FAC1_Flexibility, FAC5_dynamism, FAC6_complexity

e. Predictors: (Constant),8. The current number of staff ?,7. The establishment time? , FAC2_Experiment, FAC4_Pre-commitment, FAC3_Affordable loss, FAC1_Flexibility, Int1, Int4, Int3, Int5, Int8, Int7, Int6, Int2

The F-values for the significance tests for the four models overall explained variance are 18.757, 21.544, 18.89 and 10.964 respectively. The P-values for model significance tests are all $0.00 < 0.05$, indicating that all four different models overall explained variance at a significant level.

Table 4-16

Coefficients ^a								
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics		
	B	Std. Error	Beta			Tolerance	VIF	
1	Establishing time	.299	.049	.314	6.123	.000	1.000	1.000
	Number of staff	-.006	.048	-.007	-.135	.893	1.000	1.000
	(Constant)	-.174	.171		-1.018	.310		
2	Establishing time	.081	.052	.085	1.558	.120	.725	1.380
	Number of staff	-.011	.044	-.011	-.241	.809	.988	1.013
	Flexibility	.151	.050	.151	3.016	.003	.859	1.164
	Experiment	.295	.048	.295	6.172	.000	.938	1.066
	Affordable loss	.295	.048	.295	6.111	.000	.921	1.086
	Pre-commitment	.185	.048	.185	3.853	.000	.929	1.076
	(Constant)	-.089	.170		-.525	.600		
	Establishing time	.032	.052	.034	.611	.542	.681	1.469
3	Number of staff	.005	.043	.005	.106	.916	.974	1.026
	Flexibility	.070	.053	.070	1.316	.189	.734	1.362
	Experiment	.200	.052	.200	3.825	.000	.750	1.333
	Affordable loss	.200	.053	.200	3.789	.000	.739	1.354
	Pre-commitment	.095	.052	.095	1.827	.039	.755	1.325
	Enviro-complexity	.214	.059	.214	3.638	.000	.594	1.683
	Enviro-dynamism	.180	.059	.180	3.066	.002	.594	1.685
	(Constant)	.096	.180		.532	.595		
4	Establishing time	.029	.033	.027	.890	.374	.478	2.091
	Number of staff	-.004	.022	-.004	-.177	.859	.994	1.006
	Flexibility	.186	.058	.179	3.226	.001	.140	7.164
	Experiment	.174	.061	.168	2.832	.005	.123	8.117
	Affordable loss	.145	.054	.144	2.657	.008	.148	6.762
	Pre-commitment	.161	.045	.162	3.581	.000	.211	4.730
	Enviro-complexity	.191	.064	.187	2.985	.003	.110	9.122
	Enviro-dynamism	.115	.057	.116	2.039	.042	.134	7.444
	Int1	-.278	.038	-.406	-7.336	.000	.151	6.642
	Int2	-.301	.034	-.449	-8.977	.000	.186	5.529
	Int3	-.276	.036	-.402	-7.637	.000	.165	6.060
	Int4	-.206	.032	-.310	-6.499	.000	.221	4.520
	Int5	-.230	.038	-.332	-6.021	.000	.153	6.599
	Int6	-.231	.036	-.340	-6.448	.000	.165	6.068
	Int7	-.225	.037	-.323	-6.154	.000	.168	5.950
	Int8	-.195	.032	-.288	-6.133	.000	.218	4.597

Table 4-16 shows the estimated regression coefficients for the four regression equations, including the variables names entered into the model, the unstandardized and standardized regression coefficients, the significance values and the collinearity statistics. Meanwhile, we briefly summarize the results obtained from the above hierarchical linear regression, as shown in Table 4-17 below.

Table 4-17 Results of regression analysis of variables

Variables	Model 1		Model 2		Model 3		Model 4	
	β	t	β	t	β	t	β	t
Establishing time	.314	6.123	.085	1.558	.034	.611	.027	.890
Number of staff	-.007	-.135	-.011	-.241	.005	.106	-.004	-.177
Flexibility			.151	3.016	.070	1.316	.179	3.226
Experiment			.295	6.172	.200	3.825	.168	2.832
Affordable loss			.295	6.111	.200	3.789	.144	2.657
Pre-commitment			.185	3.853	.095	1.827	.162	3.581
Envir-complexity					.214	3.638	.187	2.985
Envir-dynamism					.180	3.066	.116	2.039
Int1							-.406	-7.336
Int2							-.449	-8.977
Int3							-.402	-7.637
Int4							-.310	-6.499
Int5							-.332	-6.021
Int6							-.340	-6.448
Int7							-.323	-6.154
Int8							-.288	-6.133
R²	.099		.277		.310		.348	
F-value	18.757		21.544		18.892		10.964	
ΔF	18.757		20.769		8.187		2.404	
ΔR^2	0.099		0.178		0.034		0.038	

4.3.2. Test results

Using hierarchical linear regression, this thesis investigates the link between the independent and moderating variables of SMEs and the dependent variable—digital performance. Table 4-17 displays the results. Model 1 is a regression model of the control variables and SMEs' digital performance. Model 2 is a main effects model that extends model 1 by including four independent factors in order to assess the link between the independent variables and the digital performance of SMEs. Model 3 adds the moderating variable-environmental uncertainty to Model 2, and Model

4 is a full-variance model. Based on the first three models, Model 4 adds eight interaction terms between the independent and moderating variables to test whether there is a moderating effect of environmental uncertainty in the relationship between effectuation and SME digital performance.

As can be seen from Tables 4-17, the F-tests of Model 1, Model 2, Model 3, and Model 4 are all significant, and the model fits are all relatively good. In addition, in terms of covariance diagnosis, the VIF are found to be all below the critical value of 10, indicating that there is no multicollinearity among the variables.

As can be seen from the table, the control variables in model 1, time of company establishment ($\beta=0.314$, $P=0.00$), are significantly and positively related to SME digital performance, but the coefficient of the number of staff and SME digital performance are not significant ($P=0.893>0.05$). From model 2, it can be seen that the four dimensions of effectuation, organizational flexibility ($\beta=0.151$, $P=0.003$) experimentation ($\beta=0.295$, $P=0.00$), affordable loss ($\beta=0.295$, $P=0.00$) and pre-commitment ($\beta=0.185$, $P=0.00$) have a significant positive relationship with SME digital performance. It means that Hypothesis 1 and Hypothesis 1a, Hypothesis 1b, Hypothesis 1c and Hypothesis 1d are confirmed.

In model 3 it can be seen that the complexity and dynamism of the environment have a positive effect on the digital performance of SMEs. In Model 4, the interaction analysis shows that the environmental complexity negatively moderates the relationship between four sub-dimensions of effectuation — experimentation ($\beta=-0.406$, $p=0.00$), affordable loss ($\beta=-0.449$, $p=0.00$), organizational flexibility ($\beta=-0.402$, $p=0.00$) and pre-commitment ($\beta=0.310$, $p=0.00$) with SMEs' digital performance. Similarly, the dynamism of the environment also negatively moderates the relationship between the four sub-dimensions of effectuation — experimentation ($\beta=-0.332$, $p=0.00$), affordable loss ($\beta=-0.340$, $p=0.00$), organizational flexibility ($\beta=-0.323$, $p=0.00$) and pre-commitment ($\beta=0.288$, $p=0.00$) with SMEs digital performance. These are not fully inconsistent with Hypotheses 2a and 2b—it negatively moderate.

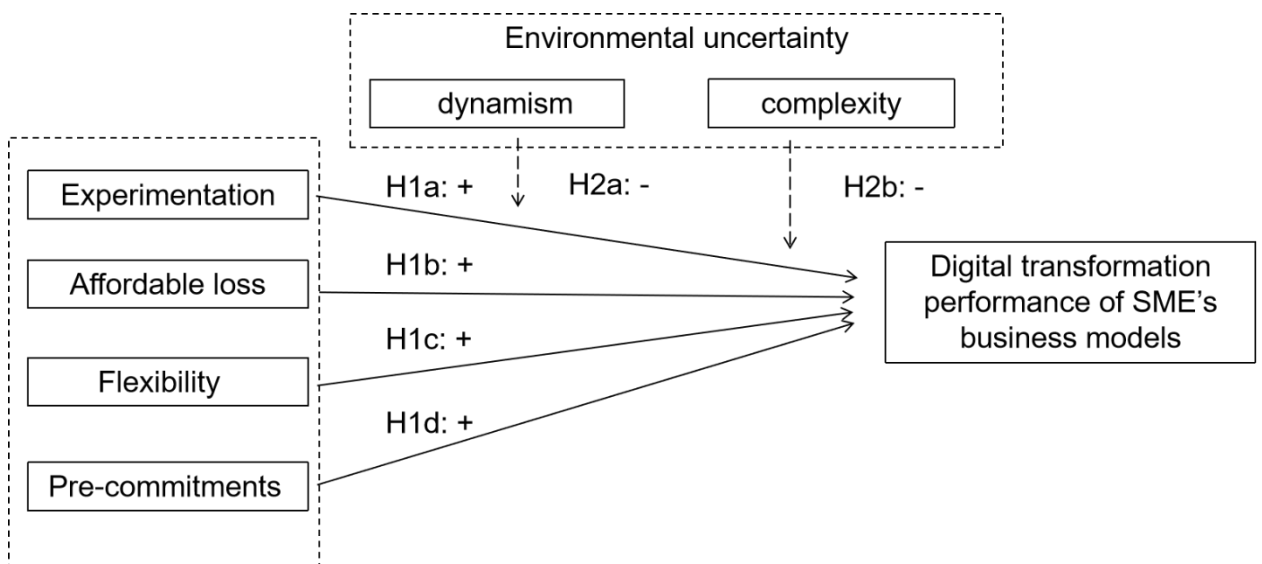
In summary, the results of the hypothesis tests are summarized in this thesis as Table 4-18 below.

Table 4-18 Hypothesis testing results

Research Hypothesis	Outcome	Conclusion
H1:Effectuation has a positive impact on the performance of DT of SME business models	√	significant and support the original hypothesis
H1a: Experimentation has a positive impact on the performance of DT of SME business models	+	significant and support the original hypothesis
H1b: Affordable losses has a positive impact on the performance of DT of SME business models	+	significant and support the original hypothesis
H1c: Flexibility has a positive impact on the performance of DT of SME business models	+	significant and support the original hypothesis
H1d: Pre-commitment has a positive impact on the performance of digital transformation of SME business models	+	significant and support the original hypothesis
H2a: Environmental dynamism positively moderate the relationship between effectuation and the performance of DT of SME business models	—	significant and does not fully support the original hypothesis (Negative Moderating)
H2b: Environmental complexity positively moderates the relationship between effectuation and the performance of DT of SME business models	—	significant and does not fully support the original hypothesis (Negative Moderating)

The adjusted theoretical model is as follows:

Figure 4.2



Chapter 5. Discussion and conclusions

5.1. Conclusions of the study

Based on existing research, this thesis has explored the relationship between the sub-dimensions of effectuation theory and digital transformation performance of SMEs' business models, rather than with traditional financial performance. We have used principal component analysis and hierarchical linear regression to conduct our research. Given that SMEs are currently struggling with the dual effects of the digital wave and the pandemic, we also examined the moderating effect of environmental uncertainty on the relationship between effectuation and SMEs' digital transformation performance. The specific findings obtained through quantitative analysis of this paper are as follows.

5.1.1. Effectuation is a multidimensional concept

SMEs are surviving start-ups, and therefore in many ways SMEs have similar characteristics to start-ups. Faced with the wave of digital transformation and the impact of the pandemic, the entrepreneurial decisions of SME entrepreneurs remain a complex process that encompasses the interaction of various factors, and studying the entrepreneurial process from one aspect alone cannot reveal the essence of entrepreneurship. A general view that has emerged from the research of many scholars is that entrepreneurial behavior is a multidimensional concept. The factor and validation analyses of our data obtained from the questionnaire in this paper also suggest that effectuation is a multidimensional theoretical concept consisting mainly of affordable loss, experimentation, organizational flexibility and pre-commitment.

5.1.2. Significant positive relationship between effectuation and SME digital performance

In this thesis, the results of the questionnaire for SME entrepreneurs show that although entrepreneurs may not be aware of the implications of their behavioral logic, in the current context of digital transformation, they are actively seeking established resources, such as their social connections, professional experience, and knowledge, in the face of shrinking market demand, supply chain disruptions, and logistical obstacles. The focus of companies is also shifting from the expected growth of financial returns to the basic survivability and sustainability of the company.

In the process of digital transformation, on the one hand, due to technical and financial constraints, SMEs will be less concerned about competitor threats and prioritize their own development compared to established companies. On the other hand, they will seek contractual commitments with stakeholders, eventually forming strategic alliances, even if they may be temporary. In the current risk-filled and uncertain environment, cooperation is often more likely to improve their survival rate than competition.

In addition, SMEs are relatively free of strict organizational structures and complex administrative hierarchies, so they are able to adapt themselves quickly and promptly in the face of change. Within the limits of tolerable losses, firms will be allowed to make partial, gradual business model adjustments to adapt to the new environment. This explains why our analytic result supports a positive relationship between organizational flexibility, experimentation, affordable and pre-commitment, and SME digital performance.

5.1.3. Environmental dynamism and complexity negatively moderate on the relationship between effectuation and SME digital performance

According to our findings, there is a significant but negative moderating effect on the relationship between effectuation and SME digital performance for the two dimensions of environmental uncertainty—environmental dynamism and environmental complexity, as previously hypothesized. Since the independent variable—effectuation is positively related to the dependent variable—digital performance, we argue that environmental uncertainty somewhat weaken the positive relationship between SME digital performance and effectuation. We believe that the reason may be that, since the context of the study is in a situation, where the unprecedented pandemic is still not completely over and the industry has not fully recovered; Meanwhile, the new round of technological change has still not made a significant breakthrough, so in such an environmental context, it affects the willingness of the entrepreneurs; Also, even if entrepreneurs try to implement digital change, for SMEs, the digital performance presented for a short time cannot indicate the complete success of the company in the transformation.

5.2. Research contributions and shortages

5.2.1. Research contributions

Based on existing research, this paper systematically reviews the relevant literature and collects up-to-date sample data around keywords such as effectuation, SME's digital performance and environmental uncertainty. Rich and detailed data are cited to validate the ideas in this paper, contributing to a certain extent in terms of research content, research methodology and research perspective.

In terms of the content of the study, the object of the study shifts from start-ups, high-tech enterprises and multinational enterprises, which are often the focus of researchers, to SMEs, which are easily overlooked. At the same time, considering that digital transformation performance is different from general start-up financial performance assessment, this paper uses subjective indicators to measure the digital enterprise performance of SMEs during their transformation process, extends the effectuation theory to the enterprise digital transformation context and enriches the relevant research in the field of enterprise digital transformation.

From the perspective of research, the understanding of corporate digital transformation and corporate performance has been mainly explored from the perspective of technological or organizational change. It is seen as the application of digital technology to certain business aspects of the enterprise and the optimization of business management processes. However, most of these studies are limited to the description of digital phenomena or the analysis of business model transformation processes, and fail to further reveal the impact of entrepreneurs' decision-making cognitive factors on the relationship between corporate digital transformation and performance. Based on existing research findings, this paper empirically confirms the relationship between effectuation and SMEs' performance in digital transformation.

5.2.2. Research Shortages

Firstly, in the principal component analysis of our empirical analysis, the principal components were extracted for numerical performance and financial performance. In the later model construction, given the purpose of the study, the model does not consider financial performance analysis on current.

Secondly, the selection of indicators for the digital transformation performance of enterprises is a subjective evaluation indicator. There are different dimensions and more objective indicators for evaluating the digital transformation of enterprises, which need to be further improved and considered.

References List

- Adomavicius, G., Bockstedt, J. C., Gupta, A., & Kauffman, R. J. (2008). Making Sense of Technology Trends in the Information Technology Landscape: A Design Science Approach. *MIS Quarterly*, 32(4), 779–809. <https://doi.org/10.2307/25148872>
- Amit, R., & Han, X. (2017). Value Creation through Novel Resource Configurations in a Digitally Enabled World. *Strategic Entrepreneurship Journal*, 11(3), 228–242. <https://doi.org/10.1002/sej.1256>
- Andersson, S. (2011). International entrepreneurship, born globals and the theory of effectuation. *Journal of Small Business and Enterprise Development*, 18(3), 627–643. <https://doi.org/10.1108/14626001111155745>
- Arend, R. J., Sarooghi, H., & Burkemper, A. (2015). Effectuation As Ineffectual? Applying the 3E Theory-Assessment Framework to a Proposed New Theory of Entrepreneurship. *Academy of Management Review*, 40(4), 630–651. <https://doi.org/10.5465/amr.2014.0455>
- Autio, E., Nambisan, S., Thomas, L. D. W., & Wright, M. (2018). Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems. *Strategic Entrepreneurship Journal*, 12(1), 72–95. <https://doi.org/10.1002/sej.1266>
- Baber, W. W., Ojala, A., & Martinez, R. (2019). Effectuation logic in digital business model transformation: Insights from Japanese high-tech innovators. *Journal of Small Business and Enterprise Development*, 26(6/7), 811–830. <https://doi.org/10.1108/JSBED-04-2019-0139>
- Bai, C., Quayson, M., & Sarkis, J. (2021). COVID-19 pandemic digitization lessons for sustainable development of micro-and small- enterprises. *Sustainable Production and Consumption*, 27, 1989–2001. <https://doi.org/10.1016/j.spc.2021.04.035>

- Berman, S. J. (2012). Digital transformation: Opportunities to create new business models. *Strategy & Leadership*, 40(2), 16–24. <https://doi.org/10.1108/10878571211209314>
- Besson, P., & Rowe, F. (2012). Strategizing information systems-enabled organizational transformation: A transdisciplinary review and new directions. *The Journal of Strategic Information Systems*, 21(2), 103–124. <https://doi.org/10.1016/j.jsis.2012.05.001>
- Bican, P. M., & Brem, A. (2020). Digital Business Model, Digital Transformation, Digital Entrepreneurship: Is There A Sustainable “Digital”? *Sustainability*, 12(13), 5239. <https://doi.org/10.3390/su12135239>
- Bloching, B., Leutiger, P., Oltmanns, T., Rossbach, C., Schlick, T., Remane, G., Quick, P., & Shafranyuk, O. (n.d.). *The digital transformation of industry*. 52.
- Brettel, M., Mauer, R., Engelen, A., & Küpper, D. (2012a). Corporate effectuation: Entrepreneurial action and its impact on R&D project performance. *Journal of Business Venturing*, 27(2), 167–184. <https://doi.org/10.1016/j.jbusvent.2011.01.001>
- Brettel, M., Mauer, R., Engelen, A., & Küpper, D. (2012b). Corporate Effectuation: Entrepreneurial Action and Its Impact on R&D Project Performance. *Journal of Business Venturing*, 27, 167–184. <https://doi.org/10.1016/j.jbusvent.2011.01.001>
- Chandler, G. N., DeTienne, D. R., McKelvie, A., & Mumford, T. V. (2011). Causation and effectuation processes: A validation study. *Journal of Business Venturing*, 26(3), 375–390. <https://doi.org/10.1016/j.jbusvent.2009.10.006>
- Demil, B., & Lecocq, X. (2010). Lecocq, X.: Business Model Evolution: In Search of Dynamic Consistency. *Long Range Planning* 43, 227-246. *Long Range Planning*. <https://doi.org/10.1016/j.lrp.2010.02.004>
- Demirkan, H., Spohrer, J. C., & Welser, J. J. (2016). Digital Innovation and Strategic

- Transformation. *IT Professional*, 18(6), 14–18. <https://doi.org/10.1109/MITP.2016.115>
- Evald, M. R., & Senderovitz, M. (2013). EXPLORING INTERNAL CORPORATE VENTURING IN SMEs: EFFECTUATION AT WORK IN A NEW CONTEXT. *Journal of Enterprising Culture*, 21(3), 275–299. <https://doi.org/10.1142/S021849581350012X>
- Fisher, G. (2012). Effectuation, Causation, and Bricolage: A Behavioral Comparison of Emerging Theories in Entrepreneurship Research. *ENTREPRENEURSHIP THEORY and PRACTICE*, 33.
- Fors, A. C. (2013). *The Ontology of the Subject in Digitalization* [Chapter]. Handbook of Research on Technoself: Identity in a Technological Society; IGI Global. <https://doi.org/10.4018/978-1-4666-2211-1.ch003>
- Fuerst, S., & Zettinig, P. (2015). Knowledge creation dynamics within the international new venture. *European Business Review*, 27(2), 182–213. <https://doi.org/10.1108/EBR-03-2013-0036>
- Galkina, T., & Chetty, S. (2015). Effectuation and Networking of Internationalizing SMEs. *MIR: Management International Review*, 55(5), 647–676.
- Hess, T., Matt, C., Benlian, A., & Wiesböck, F. (2016). Options for Formulating a Digital Transformation Strategy. *MIS Quarterly Executive*, 15(2), 123–139.
- Horlacher, A., Klarner, P., & Hess, T. (2016). *Crossing boundaries: Organization design parameters surrounding CDOs and their digital transformation activities*. <https://repub.eur.nl/pub/96652/>
- Hu, W., & Zhang, Y. (2012). New venture capability of the transformation from entrepreneurial orientation to new venture's performance: Theory model and empirical study in China. *Nankai Business Review International*, 3(3), 302–325.

<https://doi.org/10.1108/20408741211264594>

Hunger, D. (n.d.). *Essentials of Strategic Management*. 23.

Kalinic, I., Sarasvathy, S. D., & Forza, C. (2014). 'Expect the unexpected': Implications of effectual logic on the internationalization process. *International Business Review*, 23(3), 635–647. <https://doi.org/10.1016/j.ibusrev.2013.11.004>

Kitching, J., & Rouse, J. (2020). Contesting effectuation theory: Why it does not explain new venture creation. *International Small Business Journal*, 38(6), 515–535. <https://doi.org/10.1177/0266242620904638>

Lam, W. (1), & Harker, M. j. (2). (2015). Marketing and entrepreneurship: An integrated view from the entrepreneur's perspective. *International Small Business Journal: Researching Entrepreneurship*, 33(3), 321–348. <https://doi.org/10.1177/0266242613496443>

Lingelbach, D. (1), Sriram, V. (1), Mersha, T. (1), & Saffu, K. (2). (2015). The innovation process in emerging economies: An effectuation perspective. *International Journal of Entrepreneurship and Innovation*, 16(1), 5–17. <https://doi.org/10.5367/ije.2015.0172>

Lucas, H., Agarwal, R., Clemons, E. K., El Sawy, O. A., & Weber, B. (2013). Impactful Research on Transformational Information Technology: An Opportunity to Inform New Audiences. *MIS Quarterly*, 37(2), 371–382.

Lumpkin, G. T. (n.d.). *LINKING TWO DIMENSIONS OF ENTREPRENEURIAL ORIENTATION TO FIRM PERFORMANCE: THE MODERATING ROLE OF ENVIRONMENT AND INDUSTRY LIFE CYCLE*. 23.

Magretta, J. (2002). Why Business Models Matter. *Harvard Business Review*, 80, 86–92, 133.

Mainela, T., & Puhakka, V. (2013). *Organising New Business in a Turbulent Context: Opportunity Discovery and Effectuation for IJV Development in Transition Markets* (SSRN Scholarly

<https://papers.ssrn.com/abstract=2240985>

- March, J. G. (1978). Bounded Rationality, Ambiguity, and the Engineering of Choice. *The Bell Journal of Economics*, 9(2), 587–608. <https://doi.org/10.2307/3003600>
- Matalamäki, M. J. (2017). Effectuation, an emerging theory of entrepreneurship – towards a mature stage of the development. *Journal of Small Business and Enterprise Development*, 24(4), 928–949. <https://doi.org/10.1108/JSBED-02-2017-0030>
- Mazzone, D. M. (2014). *Digital or Death: Digital Transformation: The Only Choice for Business to Survive Smash and Conquer*. Smashbox Consulting Inc.
- Nwankpa, J. K., & Roumani, Y. (n.d.). *IT Capability and Digital Transformation: A Firm Performance Perspective*. 16.
- Nygaard, A., Manolis, C., & Stillerud, B. (1997). Uncertainty and vertical control: An international investigation. *International Business Review*, 6, 501–518. [https://doi.org/10.1016/S0969-5931\(97\)00018-8](https://doi.org/10.1016/S0969-5931(97)00018-8)
- Ojala, A., & Lyytinen, K. (2018). *Competition Logics during Digital Platform Evolution*. <https://doi.org/10.24251/HICSS.2018.130>
- Parida, V., Sjödin, D., & Reim, W. (2019). Reviewing Literature on Digitalization, Business Model Innovation, and Sustainable Industry: Past Achievements and Future Promises. *Sustainability*, 11(2), 391. <https://doi.org/10.3390/su11020391>
- Perry, J. T., Chandler, G. N., & Markova, G. (2012). Entrepreneurial Effectuation: A Review and Suggestions for Future Research: *Entrepreneurship Theory and Practice*. <https://proxy.library.spbu.ru:2254/doi/full/10.1111/j.1540-6520.2010.00435.x>
- Planing, P. (2017). Will digital boost circular? Evaluating the impact of the digital transformation

- on the shift towards a circular economy. *International Journal of Management Cases*, 19, 22–31.
- Reymen, I. M., Andries, P., Berends, H., Mauer, R., Stephan, U., & Van Burg, E. (2015). Understanding dynamics of strategic decision making in venture creation: A process study of effectuation and causation. *Strategic Entrepreneurship Journal*, 9(4), 351–379.
- Sarasvathy, S. D. (2001). Causation and Effectuation: Toward a Theoretical Shift from Economic Inevitability to Entrepreneurial Contingency. *The Academy of Management Review*, 26(2), 243–263. <https://doi.org/10.2307/259121>
- Sarasvathy, S. D. (2009). *Effectuation: Elements of entrepreneurial expertise*. Edward Elgar Publishing.
- Sarasvathy, S. D., & Dew, N. (2005). Entrepreneurial logics for a technology of foolishness. *Scandinavian Journal of Management*, 21(4), 385–406. <https://doi.org/10.1016/j.scaman.2005.09.009>
- Schallmo, D. R. A., & Williams, C. A. (2018). Roadmap for the Digital Transformation of Business Models. In D. R. A. Schallmo & C. A. Williams (Eds.), *Digital Transformation Now!: Guiding the Successful Digitalization of Your Business Model* (pp. 41–68). Springer International Publishing. https://doi.org/10.1007/978-3-319-72844-5_6
- Shirokova, G., Morris, M. H., Laskovaia, A., & Micelotta, E. (2021). Effectuation and causation, firm performance, and the impact of institutions: A multi-country moderation analysis. *Journal of Business Research*, 129, 169–182. <https://doi.org/10.1016/j.jbusres.2021.02.045>
- Simon, H. A. (1978). Rationality as Process and as Product of Thought. *The American Economic Review*, 68(2), 1–16.

- Simon, H. A. (1988). The Science of Design: Creating the Artificial. *Design Issues*, 4(1/2), 67–82.
<https://doi.org/10.2307/1511391>
- Simon, H. A. (1991). The Architecture of Complexity. In G. J. Klir (Ed.), *Facets of Systems Science* (pp. 457–476). Springer US. https://doi.org/10.1007/978-1-4899-0718-9_31
- Singh, A., & Hess, T. (2017). How Chief Digital Officers Promote the Digital Transformation of their Companies. *MIS Quarterly Executive*, 16(1), 1–17.
- Sussan, F., & Acs, Z. J. (2017). The digital entrepreneurial ecosystem. *Small Business Economics*, 49(1), 55–73.
- Tan, B., Pan, S. L., Xianghua Lu, & Lihua Huang. (2015). The Role of IS Capabilities in the Development of Multi-Sided Platforms: The Digital Ecosystem Strategy of Alibaba.com. *Journal of the Association for Information Systems*, 16(4), 248–280.
- Ulas, D. (2019). Digital Transformation Process and SMEs. *Procedia Computer Science*, 158, 662–671. <https://doi.org/10.1016/j.procs.2019.09.101>
- Veit, D., Clemons, E., Benlian, A., Buxmann, P., Hess, T., Kundisch, D., Leimeister, J. M., Loos, P., & Spann, M. (2014). Business Models. *Business & Information Systems Engineering*, 6(1), 45–53. <https://doi.org/10.1007/s12599-013-0308-y>
- Weill, P., & Woerner, S. L. (2015). Optimizing your digital business model. *IEEE Engineering Management Review*, 43(1), 123–131. <https://doi.org/10.1109/EMR.2015.7059380>
- Westerman, G., Bonnet, D., & McAfee, A. (2014). The Nine Elements of Digital Transformation. *MIT Sloan Management Review*. <https://sloanreview.mit.edu/article/the-nine-elements-of-digital-transformation/>
- Wiltbank, R., Dew, N., Read, S., & Sarasvathy, S. D. (2006). What to do next? The case for non-predictive strategy. *Strategic Management Journal*, 27(10), 981–998.

<https://doi.org/10.1002/smj.555>

Wu, W., Couch, R., Suharto, Y., & Ahn, M. (2015). Reverse Stock Splits in the Biotechnology Industry: An Effectuation Approach. *Journal of Commercial Biotechnology*, 21, 3–18.

<https://doi.org/10.5912/jcb677>

Yoo, Y. (2012). The Tables Have Turned: How Can the Information Systems Field Contribute to Technology and Innovation Management Research? *Journal of the Association for Information Systems*, 14(5). <https://doi.org/10.17705/1jais.00334>

Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). Research Commentary: The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research. *Information Systems Research*, 21(4), 724–735.

Yusuf, J.-E. (1), & Sloan, M. f. (2). (2015). Effectual Processes in Nonprofit Start-Ups and Social Entrepreneurship: An Illustrated Discussion of a Novel Decision-Making Approach.

American Review of Public Administration, 45(4), 417–435.

<https://doi.org/10.1177/0275074013509685>

Appendix

Survey on the digital transformation of business models of SMEs

Part I: Basic Information

1. What is your gender?

- Male Female Prefer not to say

2. What is your age?

- ≤25 years old 26-30 years old 31-35 years old 36-45 years old ≥46 years old

3. What is your educational background?

- High school and below Junior college Undergraduate Master Doctor

4. What is your position in the company?

- CEO Board members Senior Manager Department Manager Project manager
- Other management positions

5. What industry is the company in?

- Manufacturing Wholesale and retail trade Catering and service industry Internet and Information Technology Industry Other

6. What is the ownership nature of the company?

- State-owned enterprises Private enterprise Joint venture Wholly Foreign Owned Enterprise Other

7. What is the establishment period of the company?

- <1 year 1-5 years 6-8 years >8 years

Appendix1-2

8. What is the current number of people in the company?

- 1-50 people 51-150 people 151-250 people 251-500 people >500 people

Part II: Impact of the pandemic

S1: The COVID-19 pandemic has impacted the company:

1. Overall, adverse impacts and more severe challenges have been caused

- Strongly disagree Disagree Undecided Agree Strongly agree

2. Increased the concerns of enterprises about own development in the future

- Strongly disagree Disagree Undecided Agree Strongly agree

3. Inspired enterprises to take the initiative to develop business

- Strongly disagree Disagree Undecided Agree Strongly agree

4. Makes businesses work longer

- Strongly disagree Disagree Undecided Agree Strongly agree

5. Makes the business of the enterprise more difficult

- Strongly disagree Disagree Undecided Agree Strongly agree

Part III: Digital Transformation and Business Model

S2: In the past three years, the company's digitalization performance:

1. In order to achieve information sharing, all business departments of the company can realize remote office

- Strongly disagree Disagree Undecided Agree Strongly agree

Appendix1-3

2. The company's internal software applications can realize the use of various analysis platforms

- Strongly disagree Disagree Undecided Agree Strongly agree

3. Employees can access all platforms through the company's user interface

- Strongly disagree Disagree Undecided Agree Strongly agree

4. The company tried to adopt novel trading methods to obtain revenues

- Strongly disagree Disagree Undecided Agree Strongly agree

5. The company tried to build a variety of distribution channels

- Strongly disagree Disagree Undecided Agree Strongly agree

6. The company has reduced inventory, marketing, sales and other costs through new technologies

- Strongly disagree Disagree Undecided Agree Strongly agree

S3: In terms of business model, the company are going to make the following attempts:

1. In the process of digital transformation, the company will try other different product designs and services

- Strongly disagree Disagree Undecided Agree Strongly agree

2. In the process of digital transformation, the products and services created are the same as before the transformation

- Strongly disagree Disagree Undecided Agree Strongly agree

3. The company's existing products and services are fundamentally different from those before the transformation

- Strongly disagree Disagree Undecided Agree Strongly agree

4. The company is still in the exploratory stage until a viable business model is found

Strongly disagree Disagree Undecided Agree Strongly agree

Appendix1-4

5. In the process of digital transformation of the company, relevant commitments will be made cautiously to ensure that it is not more than the company can afford

Strongly disagree Disagree Undecided Agree Strongly agree

6. In the process of digital transformation of the company, it will prudently invest resources to avoid more losses than the company can afford

Strongly disagree Disagree Undecided Agree Strongly agree

7. In the process of digital transformation of the company, the use of funds will be strictly controlled to avoid unaffordable risks

Strongly disagree Disagree Undecided Agree Strongly agree

8. The company use existing resources to transform digital business

Strongly disagree Disagree Undecided Agree Strongly agree

9. In the process of digital transformation, the company will try to take advantage of new opportunities, and will not deliberately avoid

Strongly disagree Disagree Undecided Agree Strongly agree

10. In the process of digital transformation, the company will adaptively adjust the resource investment according to the changes in the environment

Strongly disagree Disagree Undecided Agree Strongly agree

11. In the process of digital transformation, the company can maintain sufficient organizational flexibility to identify and utilize new opportunities timely

Appendix1-5

Strongly disagree Disagree Undecided Agree Strongly agree

12. In the process of digital transformation, the company will establish a large number of cooperative relationships with customers, suppliers and other organizations to reduce the risks of environmental uncertainty

Strongly disagree Disagree Undecided Agree Strongly agree

13. In the process of digital transformation, the previous commitments of customers and suppliers will be used to drive business development

Strongly disagree Disagree Undecided Agree Strongly agree

Part IV: Uncertainty of the Environment

S4: Complexity of the environment

1. When the company undergoes digital transformation, it has a complete understanding of the industry it belongs to

Strongly disagree Disagree Undecided Agree Strongly agree

2. When the company undergoes digital transformation, the competition in its industry is complicated

Strongly disagree Disagree Undecided Agree Strongly agree

3. When the company undergoes digital transformation, the markets of the products and services they create vary widely

Strongly disagree Disagree Undecided Agree Strongly agree

S5: Dynamics of the environment

1. When the company undergoes DT, competitors often take some predictive actions

Appendix1-6

Strongly disagree Disagree Undecided Agree Strongly agree

2. When the company undergoes digital transformation, new products have a long-life cycle

Strongly disagree Disagree Undecided Agree Strongly agree

3. When the company undergoes digital transformation, product technology changes rapidly

Strongly disagree Disagree Undecided Agree Strongly agree

4. When the company undergoes digital transformation, unpredictable changes in consumer demand within the industry

Strongly disagree Disagree Undecided Agree Strongly agree

S6: After digital transformation, the performance level of the company at this stage is:

1. The company's sales growth rate is relatively satisfactory

Strongly disagree Disagree Undecided Agree Strongly agree

2. The company's market share growth rate is relatively satisfactory

Strongly disagree Disagree Undecided Agree Strongly agree

3. The company's new employee growth rate is relatively satisfactory

Strongly disagree Disagree Undecided Agree Strongly agree

4. The company's operating profit is relatively satisfactory

Strongly disagree Disagree Undecided Agree Strongly agree