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# **MODERN MANAGEMENT BASED ON BIG DATA I**

**Proceedings of MMBD 2020**

Edited by  
Antonio J. Tallón-Ballesteros

## **MODERN MANAGEMENT BASED ON BIG DATA I**

The management of any modern organisation involves data, but the volume of information has become almost impossible for even the most up-to-date computer system to handle. Fortunately, big-data technologies are now enabling new ways of dealing with the flood of information, making an approximate solution possible in a reasonable time-frame, as an alternative to waiting for an exact result taking much longer.

This book contains the 17 papers presented at the inaugural conference of the new series: Modern Management based on Big Data (MMBD 2020). The conference was originally scheduled to be held in Beijing, China, but due to measures to prevent the spread of the COVID-19 pandemic, the conference was held online from 18-21 October 2020. As its name suggests, the conference covers the connected aspects of Big Data and Modern Management, and the 17 papers included here, accepted from a total of 68 submissions, cover topics including data capture and storage; search, sharing and analytics; data visualization; machine learning algorithms for big data; distributed file systems and databases; management strategy and decision making; manufacturing and logistics systems; total quality management; management information systems; human factor engineering; and human resources.

Providing an overview of current developments in modern management based on Big Data, the book will be of interest to all those working in the field.



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# Preface

The management of any modern organisation involves data. The volume of information is becoming almost prohibitive for even the most up-to-date computer system. But big data technologies are enabling new paths to deal with the information and get an approximate solution in a reasonable time-frame instead of an exact result taking much longer.

This year, 2020, sees the launch of the conference series: Modern Management based on Big Data (MMBD). MMBD deals with two main branches: Big Data and Modern Management. The former includes, among other things: data capture and storage; search, sharing and analytics; big data search, mining and visualization; big data technologies; data visualization; architectures for massive parallel processing; data mining tools and techniques; machine learning algorithms for big data; cloud computing platforms; distributed file systems and databases; scalable storage systems; big data for business; and government and society. The latter encompasses: modern management; management strategy; management decision making; manufacturing systems; logistic systems; facilities planning; cost analysis; engineering economy; total quality management; management information systems; human factor engineering; and human resources.

This book contains papers accepted for and presented at MMBD 2020. The conference was originally scheduled to be held from 18–21 October 2020 in Beijing, the capital city of China, to provide a high-level platform for experts and scholars from all over the world to share the latest ideas on big data and management and foster the prosperity of the discipline. However, due to the outbreak of COVID-19 around the world and for the safety of our participants, MMBD 2020 has been changed from an on-site conference in Beijing to a virtual conference with no physical participation, although with a high interaction, and the conference will be held online from 18–21 October 2020.

All papers have been conscientiously reviewed by programme committee members bearing in mind the breadth and depth of the research topics that fall within the scope of MMBD. From 68 submissions, 17 most promising and FAIA mainstream-relevant contributions have been included in this volume. These present original ideas or results of general significance supported by clear reasoning and compelling evidence and methods.

I would like to thank all the keynote and invited speakers, authors and anonymous reviewers for their efforts in making MMBD a conference of the highest standard. We are also very grateful to all those people who devoted their time to assessing the papers; especially the programme committee members and reviewers. It is an honour to be involved from the beginning with the publication of these proceedings as part of the prestigious series *Frontiers in Artificial Intelligence and Applications* (FAIA) from IOS Press. Our particular thanks also go to J. Breuker, N. Guarino, J.N. Kok, R. López de Mántaras, J. Liu, R. Mizoguchi, M. Musen, S.K. Pal and N. Zhong, the FAIA series editors, for supporting this conference.

Last but not least, any inconvenience caused by the format change from face-to-face to virtual is sincerely regretted. Hopefully we will all meet face-to-face at the

MMBD2021 conference next year, which is scheduled to be held in Xiamen, China, with the support of the Business School of Huaqiao University.

August 2020

Antonio J. Tallón-Ballesteros  
University of Huelva (Spain)  
Seville City, Spain

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# Research on Key Issues and Countermeasures of Internationalization of Chinese Enterprise Standards

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**Abstract.** This paper mainly discusses the current situation of the internationalization development, the issues and challenges faced of enterprise standards in China in recent years, and the countermeasures and suggestions to be taken in the future. The research methods of qualitative analysis and case studies are mainly adopted. Both primary and secondary information resources are collected for an analysis and recognition of the progress of internationalization of Chinese enterprise standards. The key issues in the internationalization process of Chinese enterprise standards are put forward through analysis of the lessons learned such as lack of consistency in technology standards and real needs in the process of internationalization of Chinese enterprise standards in the last two decades, especially in the practice of participating in foreign infrastructure construction. Under China's "One Belt and One Road (B&R) Initiative", the high quality Chinese enterprise standards and internationalization are the prerequisite for the realization of international cooperation in science and technology. The novelty of this paper is mainly reflected in the countermeasures and suggestions how to enhance the internationalization level of Chinese enterprise standards in accordance with the initiatives of the "B&R" construction and the countries concerned actual needs. These include to further improve the technology level and quality of enterprise standards, improve the applicability of Chinese enterprise standards, strengthen international exchanges and cooperation in the field of standardization, establish and improve standard information resource sharing in big data environment, enhance the competitiveness of enterprises, and realize mutual benefit and win-win situation in "B&R" international cooperation.

**Keywords.** Enterprise Standards, Internationalization, Standardization

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## 1. Introduction

Standards are the main basis for production of enterprises, and for measuring the quality of products, services and development, and an important guarantee for health, safety and the ecological environment. With the rapid development of the knowledge economy and network economy, the role of technical standards is not only reflected in reducing transaction costs, expanding the scope of market transactions and ensuring product quality, but also a source of high profits for enterprises and a tool to expand the market. In 2014, Chinese President XI Jinping put forward the theory that “standards determine quality, only high standards can lead high quality” [1]. In 2015, Chinese General Office of the State Council issued “*China National Standardization System Construction and Development Plan (2016-2020)*”, which clearly stated that the role of strong enterprise standards should be fully exerted. According to both Chinese and foreign document research, most of the current related research results mainly focus on the standard issues involved in the process of enterprise internationalization. Only a few scholars have carried out research on standards internationalization issues. Most of these studies are based on specific regional standards or sector standards internationalization path research or strategic discussion. For example: “*Internationalization of Bank Card Enterprise Standards*” [2], “*Discussion on the Implementation of Standard Internationalization Strategy for Road and Bridge Construction Enterprises*” [3], or “*Boosting Competitive Advantages of Small and Medium Manufactures in South Africa by Applying Continuous Improvement and Operational Strategies*” which indicates that the importance of standards are recognized both nationally and internationally [4]. This paper conducts research on the internationalization of enterprise standards according to T. R. B. Sanders’ standardization theory [5]. The internationalization of enterprise standards is of great significance related to the global development of enterprise products and economy, in particular, to the participating effects of the countries in “One Belt and One Road (B&R)” infrastructure construction, as well as other cooperation. As Chinese enterprise standards have not been really introduced and implemented abroad for long, its internationalization level does not meet the current needs of B&R construction. In nowadays a globalized information society, how to give full play to the overall role of standards in “B&R” construction will greatly promote the international coordinated development and cooperation. This is the main problem and challenge we are facing today.

The research content of this paper intends to make up for the blank of the research on the internationalization of enterprise standards, which takes whole enterprises level as the main body. It has been strived to analyze the main impacts and key issues of enterprise standards in the process of internationalization, to promote the process of internationalization of enterprise standards, and to accelerate the level of internationalization of enterprises.

An integrated methodology of document research, expert interviews and case study was used for conducting this research. Both primary and secondary document resources are collected and analyzed for better investigation. Most of the information and cases in the paper were obtained from the secondary sources, such as: government websites, official news, and journals. In the key issues and suggestions parts of Chinese enterprise standards, some primary resources were collected through face to face interviews or email contacts in some enterprises’ experts for gathering their experiences and opinions. Case studies are conducted to reveal the current status and issues in the development of the Chinese enterprise standards internationalization. The qualitative and quantitative research methods are also used in this research.

## 2. The progress of internationalization of Chinese enterprise standards

Chinese enterprises have been participating in international projects for decades. Generally, the Chinese enterprises going abroad to join cooperative projects might be traced back to 1980's in twenties century. However, the issue of the Chinese enterprise standards internationalization was particularly obvious in recent years. The historic development period can be divided into three stages according to each decade.

### 2.1. *The first stage: simple labor export on contract 1980-1989*

In the 1980s, the characteristics showed that Chinese enterprises possessed low competitiveness and low influence with low cost. Chinese enterprises' participation in international projects was mainly based on labor export, supplemented by contracted projects. In the face of competition among international companies, it was difficult for Chinese enterprises to stand firm in the market. A huge consumption had been staged even in some project bidding and construction, and they could earn very low profit in those construction for a long time [6].

### 2.2. *The second stage: labor-intensive construction general contracting projects 1990-1999*

In the 1990s, the characteristics in this stage showed that Chinese enterprises had certain competitiveness, high efficiency, and low cost. But they were still lack of advanced technology and standards which affected their competitiveness. Chinese enterprises participating in international projects started to transform to labor-intensive general contracting, mainly participating in international competition with cost advantages, but with low economic added value. In those competitions, the internationalization of Chinese standards had also experienced many difficulties. For example: China Road and Bridge Corporate Limited was one of the first four foreign economic enterprises to go abroad. The chief engineer of the company introduced that due to the implementation of European and American standards, their projects undertaken often needed to invite European and American enterprises to participate, or commissioned European and American consulting companies to translate their designs into European and American standard schemes which made problems such as: engineering process increased and engineering cycles lengthened [6].

### 2.3. *The third stage: engineering procurement construction projects 2000-2019*

After entering the 21st century, the technical advantages of Chinese enterprises had begun to appear. The characteristics in this stage showed technical advantages in some sectors, and more initiative projects and higher efficiency in undertaking the cooperative projects. However, there were lack of high quality technical standards and international recognition which brought a lot of difficulties and issues in the implementing of the projects. Enterprises were actively participating in international market competition. More and more projects had been conducted independently, the projects level was getting better, the projects scale was getting bigger and the technical contents were getting higher. Government framework projects, engineering procurement construction and design, and construction general contract projects had occupied a considerable share [7]. Moreover, Chinese enterprises still lacked of persuasive when trying to adopt Chinese enterprise

standards for implementation international projects without corresponding standards translation versions as a supporting basis. Chinese companies were still very likely to miss those good opportunities due to language barriers even if some countries had the willingness to adopt Chinese standards. For instance: China Harbor Engineering Corporate Limited had successively contracted a large number of influential economic assistance and contracting projects, such as Pakistan's Gwadar Deep Water Port, Karachi OP-5 Liquid Terminal and Tide Channel Projects. Nevertheless, the construction designs were made by China but European and American standards were adopted since there had been no English translation version of Chinese standards for transportation construction. Another good example was Ethiopia's first highway undertaken by China Communications Construction Company Limited which could use Chinese standards and specifications expressed by the Minister of State of the Ministry of Public Works and Urban Development of Ethiopia, Alkabe Ochube, during his visit to China. Still, Chinese enterprise standards were only developed in Chinese and did not release English and French versions which made Chinese enterprise standards unable to be effectively implemented in project construction [8].

At present, under the situation of accelerate development of economic globalization and market integration as well as B&R development strategy, the new trend of competition facing the enterprises is from quality competition, service competition, price competition and brand competition to standard competition [3]. Without standard, there will be no quality. Therefore, in order to adapt to the international market, the formulation and implementation of international standard strategy has become an important research topic of enterprise development. The internationalization process of Chinese enterprise standards can be summarized through the three stages of international projects undertaken by Chinese enterprises, which is shown in table 1.

**Table 1. Internationalization of Chinese Enterprise Standards in Different Stages**

Stage	Chinese Enterprises Participate International Trade Characteristics	Strengths and Weaknesses	Standards Perspective
First stage 1980s	Export simple labor based on contract projects	Strengths: Low cost Weaknesses: low competitiveness and low influence	Not involving standards
Second stage 1990s	Engaged in labor-intensive construction general contracting projects	Strengths: low cost, having certain competitiveness, high efficiency Weaknesses: lack of advanced technology and standards	Recognize the importance of the standards
Third stage 2000s	Undertake engineering procurement construction projects	Strengths: technical advantages in some sectors, high efficiency Weaknesses: lack of high quality technical standards and international recognition	Promote internationalization of enterprise standards

### 3. Status quo of internationalization of Chinese enterprise standards

Standards internationalization refers to the internationalization activities to meet standards needs in other regions that adopts a series of bilateral or multilateral standardization strategies with the main purpose of promoting national or regional standards [9]. In 2015, the Chinese State Council issued "*The Plan for Furthering the Standardization Reforms*" [10], which clearly stated that it was necessary to improve the level of internationalization of standards, encourage social organizations, industrial

technology alliances and enterprises actively participating in international standardization activities, and increase the tracking, evaluation and transformation of international standards. Standards internationalization in advantages and distinctive fields needed to be promoted and Chinese standard brands should be created.

Chinese enterprises, especially state-owned enterprises, should implement the country's major mission of "going global", take the lead in a new mode of international trade in "B&R" construction and innovation. Their responsibility of leading the internationalization of China's enterprise standards is inexorable [11]. So, Chinese enterprises begun to promote the internationalization process with a positive attitude by attending international conferences and strengthening academic, technical and industrial communication and cooperation in order to thoroughly implement the Chinese national policy following China's economic, social and technological development and progress.

According to statistics from Standardization Administration of China (SAC), by the end of 2018, there were 1.58% international standards issued by the International Organization for Standardization and the International Electrotechnical Commission was proposed by China [12]. It could be seen that the overall number of international standards submitted by China was relatively small which did not exactly match the status of China's second largest economy in the world. At the same time, China was still lack of professional and international standardization talents and insufficient experiences in international standardization activities. However, it was undeniable that Chinese enterprises that used to export low-end labor services have increasingly expanded their overseas business in recent years. Chinese enterprise standards and China solutions had increasingly become global.

In 2016, Chinese standards internationalization became a highlight. Mombasa-Nairobi Railway connecting the Kenya's capital Nairobi and Mombasa which was the largest port in the east was built by Chinese enterprises. It was a key project for China and Africa cooperation to promote the construction of the B&R. Mombasa-Nairobi Railway was the first railway constructed since Kenya's independence and also the first modern new railway in the world that adopted Chinese standards, technologies and equipment. The railway was designed, constructed and operated by China. It established a new model for overseas cooperation in the entire railway industry chain in China and achieved an international new path for integrated construction and management through Chinese standards by Mombasa-Nairobi Railway construction. China Road and Bridge Corporation and the Kenya Railway Company signed an operation and maintenance contract for the Mombasa-Nairobi Railway before it was in use. In line with the contract, operation and maintenance services were provided and technology transfer, personnel training and other cooperation were also made by China Road and Bridge Corporation for the Mombasa-Nairobi Railway to Kenya. This indicated that China's railway construction projects had truly moved from engineering construction to the upper reaches of the industrial chain which drove all-round development of China's railway equipment, capacity and management [13]. Through the overseas cooperation of Chinese enterprises, the internationalization of Chinese enterprise standards had been promoted, and the internationalization of Chinese enterprise standards had in turn driven the overseas development of other related service industries which lead to the spiral upgrade of Chinese enterprises and technology internationalization.

#### 4. Key issues in internationalization of Chinese enterprise standards

The number of registered enterprises in China had exploded since Chinese Prime Minister Li Keqiang proposed to set off a new wave of “mass entrepreneurship and innovation” at Davos Forum in 2014. A number of enterprises had not only reached the world-class scale, but also strived to be at the forefront of the world in terms of technology, management and internationalization. Some of them had built the foundation and conditions to cultivate a world-class enterprise with global competitiveness. At present, China has made some achievements in the process of internationalization of enterprise standards, but problems and challenges still exist. Some enterprises do not know how to participate in international standardization work, or they have encountered one or more difficult problems to be solved in the process of carrying out internationalization of standards etc. Generally, there are three key issues which mainly influence the internationalization of enterprises standards.

Firstly, low level of Chinese enterprises' standardization and language barrier. The gap between Chinese enterprises' standardization level and national quality infrastructure and international advanced level is still quite obvious. Following the increase of the Chinese enterprises' standards in recent years, the contradiction of lacking of English version of Chinese enterprises' standards forms another issue. In the past, except for a small number of export enterprises that required foreign language enterprise standards, mainly Chinese enterprise standards were issued in Chinese. Thus, the pace of standards translation in foreign language was far behind the pace of Chinese companies' internationalization. The globalization of Chinese enterprises, capital, and technology urgently needs the Chinese enterprise standards to go abroad first. However, related language services are relatively lagging behind. Comparing with developed countries, English version of standards in Japan, South Korea, and Germany all account for more than 40%, and China is less than 5% [14]. Hence, it is great significance to provide foreign language versions of Chinese enterprise standards for other countries to evaluate, adopt, reference, read and use during project implementation.

Secondly, Chinese enterprise standards cannot meet all the requirements of foreign countries. How to solve the inconsistency of standards in international standardization cooperation is the key to promoting the implementation of standards. Different countries have different landform features, different national conditions, different cultures, and different stages of economic development. Affected by various factors, the international application of Chinese enterprise standards has adaptability problems in different countries. Taking the railway field as an example again, enterprises have encountered such issues as: local production conditions led to the failure of the implementation of standards; long rails required by China's railway standards cannot be transported because of without suitable means of transportation; railway operating capacity is not enough in local area with insufficient freight volume and lacking of talents. Such difficulties have directly caused it would not be easy to adopt Chinese enterprise standards in those projects [15]. Thus, the compatibility between standards is particularly important. Enterprise standards internationalization activities are better planed and stepped in line with the regional characteristics, natural conditions, standardization development levels, and engineering characteristics of different countries and regions targeted.

Finally, Chinese enterprises are still lack of participating and contribution to international standardization activities. There is still a big gap between China and developed countries though China has made great progress in participating in international standardization activities. According to 2015 data, China's total GDP

ranked second in the world, but international standardization participation ranked sixth [16]. “Standards first, technology follow-up” is the usual mode of industrial development in various countries. However, due to historical reasons, there are still many problems and challenges in the internationalization of Chinese enterprise standards. In accordance with incomplete statistics, the overall number of international standards proposed or participated in the formulation and release by China is still too small. On the one hand, it is due to the lack of standard international talents in China. On the other hand, it is due to the lack of experience of participating in international standardization activities by enterprises. Therefore, it is critical for more enterprises, scientific research institutions, and colleges and universities to strive to do better in training and selecting outstanding talents to actively participate in international standardization activities, learning from advanced standardization concepts from developed countries, and accelerating the conversion of technologies in advantageous areas to standards.

## 5. Comments on improving internationalization of Chinese enterprise standards

### 5.1. Improve Chinese enterprises standards quality

Quality and standards are inseparable. Standards are the basis for judging quality, and quality is the result of implementing standards. Whether a project is unqualified or a service can meet the requirements of consumers depends on the corresponding standards. Standards are a reflection of the hard power of core technology. In the process of internationalization, Chinese enterprises need first to improve their technological strength and fully reflect the advanced nature of Chinese enterprise standards. The absolute number of Chinese enterprise standards is quite large. According to a press conference held by the Shandong Provincial Government Information Office, as of the end of 2019, the number of enterprise standards which open to the public in Shandong alone reached more than 163,000, ranking first in the country [16]. However, there is still a lot of work to do for improvement in enterprise standards. It is necessary to promote the coordinated development of standardization, technological innovation, and industrial upgrading by deepening the reform of standardization work, advancing the standardization work system and mechanism innovation.

### 5.2. Enhance international applicability of Chinese enterprise standards

Just as the debate regarding to whether international enterprises should customize or standardize its products. Usually a modified commercial product is substantially similar in each country, but minor adaptations are made on the basic product to conform to local needs and regulations [17]. The modified product policy enables international enterprises to reap the benefits of standardization and centralized production, and local needs [18]. So do the enterprise standards. An in-depth research on the local market needs is especially necessary when Chinese enterprises undertake international projects. It is essential to timely adjust and optimize relevant contents of Chinese enterprise standards combining consideration of specific requirements of project local laws and regulations, market and user needs, economic and social environment, geographical conditions, and climatic characteristics. Through extensive consultations with local authorities of relevant project on the adjusted and optimized standards text, the local applicability of

Chinese enterprise standards can be improved for meeting the basic requirements, and the best solution of realistic problems can be provided to the project host country.

### *5.3. Establish an open concept and strengthen international communication and exchanges in standardization field*

The internationalization of enterprise standards needs to enlarge international exchange and cooperation. Enterprises should first establish the concept of openness, actively participate in international standardization activities, and strive to participate in the formulation and implementation of enterprise standards. International standardization work should not be limited just to accept foreign technologies, but also to promote Chinese enterprises' own technologies and brands. CNPC and Sinopec enterprises are good example on the topic for conducting their brand strategy. Nine measures for the enterprises to conduct the brand strategy are proposed and combination of the standards with the local culture to strain the ability of brand-innovation is one of them [19]. At the same time, enterprises can also actively carry out international standardization pragmatic cooperation for enhancing their ability and level of substantial participation in international standardization activities. International standards related with the enterprise industry or the project can be paid attention for information tracking and evaluation for accelerating the Chinese enterprise standards transformation into international standards. Enterprises can also carry out Chinese and foreign standards differential collaborative research by exchanging personnel, project research and academic exchanges etc. with standardization organizations or institutions in the project host country. It will help to understand the technology and standardization gap and offer an opportunity to learn from each other to absorb the advanced technology and experience from both sides, and then, to improve the overall level of internationalization of enterprise standards.

### *5.4. Adopt big data technology to enhance the enterprise competitiveness and standardization level*

Big data can realize the high efficiency and conciseness of enterprise process, and help enterprises deal with more and huger "data flow". At the same time, working in the distributed big data environment can greatly improve the enterprise competitiveness and its standardization level. The visualized description tool of big data can help decision makers and analysts to mine the relationship between different data, and can also use visualized tools to design special model to query the required data, such as querying the implementation progress of enterprise standardization construction plan at a certain time and place. Future development of big data, cloud computing and Internet of things will bring unprecedented opportunities for the standardization and internationalization of Chinese enterprises.

On the basis of the enterprise standards information public service platform hosted by SAC, it is possible to expand the information resources of enterprise standards at home, strengthen the network coordination and cooperation in the preparation and revision of enterprise standards, and carry out opening and sharing of network enterprise standards resources. Using advanced information technology, the Chinese enterprises may acquire the standard information of same sector enterprises accurately, timely and systematically, avoid decentralization and duplicate investment of standard information resources, and support the international development of enterprises to the maximum extent. Chinese enterprises should actively integrate enterprise standard construction

with international standard to unify the standard makers, users and managers to improve the efficiency and quality of the implementation of internationalization strategy of enterprise standards.

Supported by the big data technology and international standards organizations, Chinese enterprises may realize the localization, internationalization and globalization of enterprise standards driven by advantageous of our products and projects in order to support the internationalization of Chinese enterprise standards.

### *5.5. Produce more values for international community*

Chinese enterprises shall take the initiative to assume more social responsibilities in the process of internationalization of its standards. More profound values for local development shall be created with attention while enterprises themselves are developing and strengthening. Enterprises social responsibility can be reflected by cooperating with local communities, making beneficial investments in the local area, developing relationships with local employees and families, and participating in activities such as environmental protection, technology transfer, and community development. The Chinese enterprises may help local communities to maximize their benefits while striving to enhance its own strength and influence during process of internationalization of standards. At the same time, we should strengthen the translation and publicity of Chinese enterprise standards in foreign languages, help project host countries of B&R construction to understand and implement the Chinese enterprise standards, and better accomplish the tasks of high quality and standardized infrastructure construction.

## **6. Conclusion**

This paper summarizes the experiences and issues of Chinese enterprises in the process of undertaking international projects and demonstrates the important role of standards in the development of international projects. Several cases show that global oriented Chinese enterprise standards are the general trend of global integrated economic development and the necessary requirements for Chinese enterprises to cooperate with other countries in depth. It is also the most effective way to achieve the export of technology, products, management and services which is an inevitable choice to expand international market share and provide good quality services to the end users.

Through this research, it may be concluded that Chinese enterprise standards internationalization is a critical step in conducting B&R initiative, and the important mission of implementing China's "going global" strategy. Chinese enterprise should be a pioneer and leader in building a new international trade order and new mode of B&R. Its responsibility of leading the internationalization of Chinese enterprise standards is inexorable. Chinese enterprises have realized a great change from quantity accumulation to quality, from the initial simple labor output to the later engineering output, and then to the current standard and program output. Only when Chinese enterprise standards are closely integrated with international standards, carry out extensive international cooperation, establish a data sharing mechanism based on big data, and provide translation of both Chinese and foreign languages standards, can the compatibility, applicability and utilization of Chinese enterprise standards be continuously improved. Modern enterprises should export mature, reliable and advanced industrial standards, and give priority to the implementation and operation of all production and construction

activities in accordance with the norms and standards. Only in this way can we bring the most satisfactory return to the stakeholders and improve the competitiveness of the enterprise.

To solve the problems faced by the internationalization of Chinese enterprise standards, the paper puts forward some suggestions for the future development that includes improving Chinese enterprises standards quality, enhance international applicability of Chinese enterprise standards, establish an open concept and strengthen international communication and exchanges in standardization field, adopt big data technology to enhance the enterprise competitiveness and standardization level, and produce more values for international community and better contribute to the international standardized infrastructure construction. Chinese enterprises may further support the economic development strategies of relevant countries, improve ability to participate substantially in international standardization activities, and continuously increase the quantity and quality of Chinese enterprise standards in its advantageous technology and fields for better implementing of the enterprise standards internationalization in the future. By deepening bilateral and multilateral pragmatic exchanges and cooperation with other countries or regions in standardization, sharing of information resources and scientific and technological achievements, the purpose of coordinated development and win-win cooperation can be finally achieved.

Some other considerations for the research in the future can be concluded as: Following this research results, it is hoped that those of the national standardization organizations and foreign-related enterprises may be aware of the significance and far reaching influence of establishing overall standardization strategy deployment at enterprise strategy level. The foreign-related enterprises and the standardization community will pay attention to the issue of internationalization of enterprise standards. More experts and scholars can be attracted to carry out in-depth research in related fields by combing and summarizing the key issues and precautions for the internationalization of corporate standards. Particularly, further research on the applicability of standards, comparative analysis and complement of the enterprises standards between Chinese enterprises and the projects host countries shall be the future study topics in the near future. Establishment of regional standardization cooperation mechanisms and specific contents as well as standardized tools for countries along the “B&R Initiatives” can be explored which can benefit global and regional foreign-related enterprises to promote international projects.

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# “Leader-Employee” Power Distance Orientation and Employee’s Voice: Based on the Mediating Effect Employee’s Psychological Security

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**Abstract:** The purpose of this study is to explore the mechanism of employee’s voice behavior from the perspective of “leader-employee” power distance orientation. The study found that: (1) employee’s power distance orientation significantly negatively affects employee’s psychological security and employee’s voice behavior; (2) employee’s psychological security significantly positively affects employee’s voice behavior, and it plays a partial intermediary role between employee’s power distance orientation and employee’s voice behavior; (3) leader’s power distance orientation significantly positively affects the employee power distance orientation, and significantly negatively affects the employee’s psychological security and employee’s voice behavior.

**Key words:** leader’s power distance orientation; employee’s power distance orientation; employee’s psychological security; employee’s voice behavior

## 1. Introduction

The era of knowledge economy is also an era of VUCA that is intertwined with volatile, uncertain, complex and ambiguous [1]. In the context of the new era, the market competition environment facing enterprises is changing rapidly, and the speed of technological innovation is also accelerating. And as an important way for employees to participate in organizational management, employee’s voice behavior plays an important role in improving organizational operation efficiency and optimizing enterprise management mode[2][3]. However, employees are more willing to remain silent in the practice of enterprise management, even if employees find problems or improvements that can exist in the enterprise. Therefore, how to effectively dispel employees’ concerns and promote employee’s voice behavior is the focus of the business community and academia.

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Previous studies have shown that employee's voice behavior is a kind of active behavior that is willing to express constructive opinions. This behavior is not only to change the personal working situation, but also to help the organization improve and promote the development of the organization [4]. At the same time, it's also a risky behavior. Employees often worry that their "fallacy" and "dissent" will lead to troubles such as "offending leadership", career and interpersonal problems [5]. This is especially true in Chinese companies with prominent centralization characteristics (ie, the concentration of managers' power). It can be inferred from this that the individual's view on the power system may have an impact on employee's voice. That is, the individual power distance orientation (cognition of power distribution) is closely related to employee's voice behavior [6]. However, it has not received much attention from the previous studies. And according to the interpersonal interdependence theory, employee's individual behaviors or behavioral intentions will be influenced by leader's behavior traits (surrounding groups). So we decided to explore the mechanism of employee's voice behavior from the perspective of the power distance orientation of the "leader-employee" dual subject.

Therefore, the purpose of this study is to answer two questions: (1) How does the employee's power distance orientation at the individual level affect employee's voice behavior? (2) How does the leader's power distance orientation at the team level affect the employee's power distance orientation and employee's voice behavior at the individual level?

## 2. Theoretical Review and Hypothesis

### 2.1 Hypothesis at the individual level

#### ● Employee's Power Distance Orientation and Employee's Voice Behavior

Employee's power distance orientation refers to the degree to which individuals can accept the unequal distribution of power or the different levels of power within the organization[7][8]. It reflects employees' differentiated cognition of unequal power distribution in the organization, and such cognition will affect their behaviors in the organization. Employees with high power distance orientation believe that the power and status gap between them and the leaders is reasonable and they should obey the leader's instructions. However, employees with low power distance orientation are different. They will more likely to interact with leaders fairly and freely, and will often express their ideas to leaders more actively[9][10][11]. According to the self-consistency theory, individuals strive to maintain consistency in their beliefs, attitudes, and behaviors, whether this belief is positive or negative[12]. It can be inferred that when the power distance orientation of employees is high, they will have an attitude of unconditional obedience and reverence to their leaders. At this time, employees' behavior proposing their own suggestions to the leaders is contrary to their own cultural values and beliefs, so employees' voice behavior will be suppressed. On the contrary, when the employee's power distance orientation is low, they will hope to establish a close and friendly relationship with the leader, and they will be more willing to exchange their thoughts and opinions on the development of the organization with the leader. At this point, the employee's voice behavior will be stimulated. Therefore:

H1: Employee's power distance orientation negatively affects employee's voice behavior

- Employee's Power Distance Orientation and Employee's Psychological Security

The individual's psychological security comes from own internal security needs, and it is manifested as the individual's subjective perception of external environmental risks[13][14]. Evolutionary psychology believes that any stimulus that conflicts with individual expectations will consciously awaken the individual's psychological defense and put the individual in a lower psychological security environment[15]. And in this study, we believe that the higher the power distance orientation of employees at the edge of power, the more sensitive and concerned they are to the differences in power, status, and rank within the organization. As the saying goes, "Man struggles upwards; water flows downwards". As a result, the employees with high power distance orientation are more likely to develop a desire for high power status, which is far from its actual role of "Poor men's words have little weight". This contradiction between psychological expectations and reality will make them to have lower psychological security. On the contrary, the employees with low power distance orientation don't agree with unequal power distribution. This recognition determines that their desire for power and status is low, and there is no conflict with their actual status. At this time, employees' level of psychological defense will be reduced, thereby forming a higher sense of psychological security. Therefore:

H2: Employee's power distance orientation negatively affects employee's psychological security

- Employee's Psychological Security and Employee's Voice Behavior

Employee's psychological security is their perception of risks related to their careers, self-image and status in the process of interacting with leaders [13][16]. And this cognition will make employees have a psychological expectation about whether their behavior is safe or whether it will lead to negative consequences. When employees have a high level of psychological security, they will have positive psychological expectations, which will reduce their defense against others. But when employees' psychological security is low, they will have negative psychological expectations, and then strengthen their own alertness. From this we speculate that employees with a high level of psychological security will have a low level of psychological defense in their interactions with leaders. As a result, they are more likely to show positive interactive actions to leaders, and it is easier to express their true self freely[17]. That is, employee's psychological security will positively promote their voice behavior. Liang and Farh (2008) pointed out that if the company want to improve the enthusiasm of employees' voice behavior, they must improve their psychological security[18]. Therefore:

H3: Employee's psychological security positively affects employee's voice behavior

## 2.2 Hypothesis at the team Level

- Leader's Power Distance Orientation and Employee's Power Distance Orientation

Social learning theory believes that others (especially "foretype") in the surrounding environment are important sources of information for individual observation and learning, so individuals will consciously or unconsciously shape their social attitudes and behaviors by observing and imitating others. And the leaders are often the main objects observed and imitated by employees in organization[19]. The characteristics of leaders (such as cultural value orientation) will gradually trickle down to employees by their daily management behaviors, exerting a profound influence on

the characteristics of employees (such as cultural value orientation) imperceptibly. Deducing to this study, leaders with high power distance orientation often show an authoritarian style, and tend to build an "authoritative" image in front of employees to show their status cannot be challenged. When employees perceive such a strong signal, they tend to adapt themselves to the management style of their superiors through observation and imitation, thus gradually forming a higher power distance orientation. Similarly, it can be speculated that leaders' low power distance orientation will also promote a low power distance orientation for employees in this way. Therefore:

H4: Leader's power distance orientation positively affects employee's power distance orientation

● Leader's Power Distance Orientation and Employee's Psychological Security

Previous studies have shown that employee's psychological security may be affected by organizational situations and leadership behaviors [20]. In this study, leaders with high power distance orientation have a strong sense of hierarchy. Therefore, they are very concerned about the power and status gap between superiors and subordinates, and believe that subordinates should respect and obey themselves[21]. When employees realize this, they will consciously keep their distance and be cautious in their interactions with leaders, so as to avoid letting leaders think that their "authority" is offended and thus cause trouble for employees themselves. At this time, employees' uncertainty about the risks of their environment (e.g work environment, interpersonal environment) increases, and thus they are in a lower psychological security environment. On the contrary, leaders with low power distance orientation have positioned their role in power relationships as friends and partners that are beyond the constraints of hierarchical systems, so they will choose to actively close the relationship with employees to show their friendliness. When employees receive the "olive branch" from the leader, they will return to the leader with friendship and trust for emotional exchange. At this time, employees' perception of risks related to their own development, professional image, etc. will also be reduced, thereby gaining a higher sense of psychological security. Therefore:

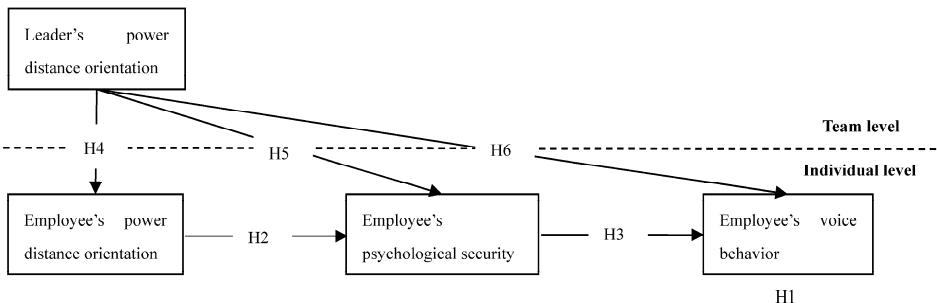
H5: Leader's power distance orientation negatively affects employee's psychological security

● Leader's Power Distance Orientation and Employee's Voice Behavior

The value-based leadership theory believes that leaders will bring their cultural values into management, and hope that their subordinates can resonate with them so as to improve the effectiveness of their leadership behaviors. For leaders with high power distance orientation, they often emphasize power concentration and use of power to control employees. They are confident in their management ideas and methods, and believe that it is reasonable for subordinates to obey their management. This kind of cultural values often makes leaders show authoritative and serious leadership style in daily management. What's more, the employee's voice behavior in this study belongs to a bottom-up risky feedback behavior. Therefore, when employees feel the leader's power distance orientation through the leadership management style, they will choose to be silent because of the risk (e. g offending the leader) of their voice behavior. In contrast, leaders with low power distance tend to ignore the hierarchy gap between superiors and subordinates. At this time, they are willing to communicate with employees, and also tolerate and encourage employee's voice behavior. When employees think that their opinions and ideas are advocated and recognized by leaders, employees are more willing to conduct voice behavior. Therefore:

H6: Leader’s power distance orientation negatively affects employee’s voice behavior

The theoretical model proposed in this study is shown in Figure 1.



**Figure 1** Theoretical model

### 3. Research Design

#### 3.1 Methods

This study uses electronic questionnaires for online data collection. And the questionnaire is divided into two versions: a leadership questionnaire (a survey of leader’s power distance orientation at the team level) and an employee questionnaire (a survey of employee’s power distance orientation, employee’s psychological safety, and employee’s voice behavior at the individual level). In the end, 338 questionnaires were effectively recovered, including 286 questionnaires of employees and 52 questionnaires of leaders.

The sample statistics of employees showed that male accounted for 53.846% and female accounted for 46.154%. In terms of age, 26-30 years old accounted for 32.867%, 31-35 years old accounted for 25.175%, and 36-40 years old accounted for 16.084%. In addition, bachelor’s and master’s degrees are the main academic qualifications, accounting for 49.301% and 35.664% respectively. In terms of working years, 3 years and below accounted for 28.322%, and 4-6 years accounted for 40.559%.

The sample statistics of the leaders show that male account for 63.462% and female account for 36.538%. In the age structure, the majority are 31-35 years old, accounting for 48.077%, and followed by 26-30 years old with 23.077%, and 36-40 years old with 19.231 %. The academic structure is still dominated by undergraduate and master degrees, with masters accounting for 51.923% and undergraduates accounting for 36.538%. In terms of working years, 7-9 years accounted for 50.000%, followed by 4-6 years accounted for 34.615%. What’s more, the average team size is 5.306.

#### 3.2 Research Tools

The scales selected in this study are derived from the maturity scales in the existing research, and have been partially revised in accordance with the specific research context of this study.

- Power distance orientation. The measurement of leader's power distance orientation and employee's power distance orientation in this study both adopt the single-dimensional scale developed by Dorfman and Howell[22]. And the finally measured Cronbach'α =0.886.
- Employee's psychological security. The measurement of employee's psychological security in this study is derived from the study of Carmeli[23]. And the finally measured Cronbach'α=0.878.
- Employee's voice behavior. In this study, the scale of employee's voice behavior measurement derived from Liang and Farh[18]. And the measured Cronbach'α = 0.922.
- Control variables. Referring to previous studies[2][25][26], this study mainly selects gender, age, education, and working years as individual-level control variables, and selects gender, age, education, working years, and team size as team-level control variables.

## 4. Data Analysis and Results

### 4.1 Data Quality Analysis

- Reliability. The Cronbach'α of all the variables in this study range from 0.878 to 0.972 and the CR(combined reliability) range from 0.878 to 0.922, which indicates that the measurement reliability is good. (Table 1)
- Validity. The AVE of each variable is between 0.545 and 0.596, and the square root of the AVE of each variable (data in the diagonal brackets in Table 1) is greater than correlation coefficients among variables, which indicating that the aggregation validity and discrimination validity are good (Table 1). At the same time, the results of CFA (confirmatory factor analysis) show that the four-factor model has the best fitting effect ( $\chi^2/df = 1.296$ , SRMR = 0.036, RMSEA = 0.041, GFI = 0.929, NFI = 0.942, TLI = 0.980, CFI = 0.971).
- Common method bias. We conducted a principal component analysis according to the Harman's single factor test, and the largest common factor explained 34.533% of the total variance (62.742%), and the common method bias is within an acceptable range.

**Table 1.** Analysis of reliability and validity of study variables

Variables	$\alpha$	CR	AVE	Mean	SD	1	2	3	4
Leader's power distance orientation	0.886	0.893	0.582	2.219	0.766	(0.763)			
Employee's power distance orientation	0.886	0.887	0.570	2.427	0.928	0.201**	(0.755)		
Employee's psychological security	0.878	0.880	0.596	3.597	0.784	0.146**	-0.177*	(0.772)	
Employee's voice behavior	0.922	0.923	0.545	3.602	0.682	0.274**	-0.153**	0.470**	(0.738)

Note: \* represents  $p < 0.05$ , \*\*represents  $p < 0.01$ . The numbers in parentheses on the diagonal are the square root of AVE.

#### 4.2 Regression analysis

This study uses HLM analysis software to conduct a multi-line model analysis on the relationship between variables. (1)The results of the statistical analysis of the relationship between variables at the individual level show that: employee's power distance orientation ( $r = -0.121$ ,  $P < 0.01$ ) has a significant negative effect on employee's voice behavior (Model 2), which indicates that H1 is supported; employee's psychological security ( $r = 0.408$ ,  $P < 0.001$ ) has a significant positive effect on employee's voice behavior (Model 3), which indicates that H3 is supported; employee's power distance orientation ( $r = -0.122$ ,  $P < 0.05$ ) has a significant negative effect on employee's psychological security, which indicates that H2 is supported. (2)The analysis results of the cross-level influence of the leader's power distance orientation at the team level show that: leader's power distance orientation ( $r = 0.250$ ,  $P < 0.001$ ) has a significant positive effect on the employee's power distance orientation, which indicates H4 is supported; leader's power distance orientation ( $r = -0.150$ ,  $P < 0.01$ ) has a significant negative effect on employee's psychological security, which indicates H5 is supported; leader's power distance orientation ( $r = -0.267$ ,  $P < 0.001$ ) has a significant negative effect on employee's voice behavior, which indicates H6 is supported.

In addition, this study uses Bootstrap test for further analysis. The analysis results show that the indirect effect of employee's power distance orientation on employee's voice behavior is  $-0.044$ , and the confidence interval of  $0.95 [-0.089, -0.021]$  doesn't include 0, indicating that the indirect effect is significant. This confirms that employee's psychological security indeed has a mediating effect between employee's power distance orientation and employee's voice behavior.

### 5. Conclusion

#### 5.1 Theoretical and practical implications

The main research conclusions and practical management implications of the study are as follows:

Employee's power distance orientation significantly negatively affects employee's voice behavior. This conclusion not only confirms the inhibitory effect of power distance orientation on employee's voice behavior[27], but also indicates that the main effect of employee's power distance orientation on employee's voice behavior exists objectively. Therefore, in order to promote employee suggestions, it is recommended that enterprises should take some intervention measures such as advocating and focusing on creating a harmonious and fair, equal and unity organizational culture atmosphere, or promote inculcation of team awareness during employee training to cultivate employee's low power distance orientation. On the other hand, managers can adopt flexible management methods to encourage employees to actively participate in the management process, thereby fostering their sense of ownership and stimulating employee's voice behavior.

Employee's psychological security plays a partial intermediary role between employee's power distance orientation and employee's voice behavior at the individual level. On the one hand, this conclusion echoes the previous research on employee's psychological security and employee's voice behavior [3][29], and also finds that

individuals' power distance orientation can have an effect on their psychological security. Based on this conclusion, it is recommended that managers should pay attention to the psychological state and spiritual demands of employees. Enterprises can enhance the emotional connection and interpersonal trust of employees by organizing collective activities and other methods, thereby enhancing the employees' psychological security and promoting their voice behavior.

When investigating the cross-level influence of leader's power distance orientation on employees, we found that: First, Leader's power distance orientation has a significant positive effect on employee's power distance orientation. Second, Leader's power distance orientation has a significant negative effect on employee's psychological security and employee's voice behavior. This not only confirms that the cultural values and organizational behaviors of leaders have a "trickle effect" on employees' cultural values and behaviors[29], but also illustrates the negative effects of the high-power distance orientation of leaders on employees. This reminds enterprises to take some necessary measures to weaken the negative effect of power distance orientation, such as focusing on creating a united, harmonious, equal and friendly organizational atmosphere. Moreover, we should also attach importance to cultivating the concept of collectivism of leaders to help leaders form low power distance orientation and change management styles. At the same time, enterprises should also consider the power distance orientation level test as one of the assessment indicators for talent training and selection.

## 5.2 Limitations and future research

The theoretical contribution of this study mainly lies in: (1) This study takes power distance orientation as an independent variable to explore how it affects employee's voice behavior. This conclusion not only confirms that power distance orientation as a representative variable of individual cultural value orientation is an important variable for interpreting employee's voice behavior, but also provides a reference for follow-up exploration about other cultural value orientation variables and employee's voice. (2) This study finds that employee's psychological security can mediate the relationship between employee's power distance orientation and employee's voice behavior. This provides a theoretical support for explaining the "black box" of the relationship between individual power distance orientation and employee's voice behavior. Moreover, it provides some ideas for further research about the influence mechanism of power distance orientation on employee's voice behavior. (3) This study takes into account the two-way perspective of leaders and employees. While considering the influence of employee's power distance orientation on their voice behavior, this study further explores the cross-level effect of leader's power distance orientation, and provides useful supplements for the study of leadership behavior theory and employee's voice behavior.

Certainly, this study also inevitably has limitations: (1) The sample collection of this study is concentrated in the same time period, and the sample coverage is limited, which may affect the external validity of the research conclusions of this study. Therefore, it is suggested that subsequent research can optimize the multi-period collection and wide coverage of samples to test the universality of the conclusions in this study. (2) Although this study finds that employee's psychological security will mediate the effect of employee's power distance orientation on employee's voice behavior, it is unknown whether employee's psychological security exists as a

mediation in cross-level effect. We suggest that it can be further explored and explained in subsequent related research.

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# Factors Affecting Mobile Banking Loyalty in Thailand

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**Abstract.** An extensive inquisition on service quality has been a significant subject matter for centuries and has now developed in a manner of self-service technology (SSTs). SSTs service quality has a complex influence on the behaviour of customers in terms of interaction with banking organisations that involve activities of M-banking to establish and develop more significant customer satisfaction, loyalty, and service results. This study would like to examine technological based services impact based on SSTs service quality, goal framing theory, and customer loyalty in the M-banking service of a developing country. 698 M-banking's users have been collected through the online survey. Structural Equation Modelling was applied, and the results indicate positive and significant relationships among proposed indicators, including SSTs service quality, goal framing theory, and customer loyalty. The findings can help the banking industry to improve and provide necessary insights for the Banking industry, especially in the developing country like Thailand.

**Keywords.** Self Service Technologies, service quality, m,-banking, goal framing theory, customer loyalty.

## 1. Introduction

Internet technologies are growing and developing along with an abundance of smartphone and mobile applications, which interfered with a variety type of organisations and institutions to gain the advantage and profit of the following circumstances. E-Commerce illustrates the influence of Internet technologies in the world society's stage, which are requiring more significant products and services to respond to the massive demand of consumers. Mobile banking (M-banking) is one of the solutions that would facilitate and satisfy the needs of consumers in this industry. M-Banking is giving the idea of operating financial transactions anywhere and at any time, which is the strength factor why people started to value and prioritise using M-Banking.

However, a minority of research has focused over factors of M-banking users' loyalty; as a result, no specific element would identify the customer loyalty in the new business model. Therefore, an essential strength of this study is to identify factors of

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M-banking users' loyalty. A primary key of this study is that its sample consisted of several executive research of intention in answering the customer loyalty on the impact of self-service technologies (SSTs) service quality on customer loyalty and behavioural intention [1]. Customer perspective of adoption and continuity intention are breaking M-banking barriers [2].

The purpose of this study is to identify and develop factors affecting M-banking users' loyalty by enhancing understanding of M-banking contribute to this research. This study would like to 1) identify factors impacting customer loyalty in M-banking users, 2) analyse impacts of critical factors on user's loyalty and satisfaction level in using M-banking, and 3) provide recommendations to banks strategic level management in terms of maintaining and increasing the level of loyalty by using M-banking. This article contents include introduction, literature review, methodology, results, and conclusion parts, respectively.

## 2. Literature Review

### 2.1 *Mobile banking (M-banking)*

M-banking is the alternative way for users to have the ability to access their banking information and perform tasks on the application. Unlike traditional banking [3], M-banking provides the ability for the user to perform banking transactions irrespective of place and time as the only requirement is the mobile network or wireless network access [4]. The M-banking application provides both users and bank with 24-hour basis operation. It gives the user easy access to the bank account through a mobile device and their ability to control their money transitions over the application platform [4]. M-banking application is the alternative ways for many developed and developing countries to access bank, and it had significant effects on the market [5].

### 2.2 *SST service quality*

Term of service quality implies a formulation that united the process of service outcome [6] and service delivery [7]. The following terms of service quality have indicated relating dimensions of service quality, and its criterion of each aspect operated effectively, which was generating outstanding results in the past [8]. Researches in the topic of service quality have been reviewed as for considering and examining related model [9]. Conceptualised service quality as five dimensions can be called SERVQUAL to refer to the face-to-face environment of the service process. Service quality has consisted of the three-dimensional quality model introduced by Gronroos [10] including technical quality, functional quality, and corporate image. To give customers a more exceptional experience, to reach customer loyalty and retention, to minimise the cost from employees, and apply advanced technology into the business, an organisation is offering SSTs service quality [11]. SSTs service quality is technological dimensions that have the ability of interface which lets consumer get what they desire, such as services free from the involvement of the service persons [12].

Most of the significant studies field associated with technology found out that SSTs and call-centre services are empowered to obtain more consumers that involved services activity [13]. In consumer's perspective is concerned in term of service quality uses by the different to specific ideal on nature of self-service employed [14]. SSTs can

increase and supplementing better services for the customer that can finish the transaction faster, anywhere, and anytime [15]. With more progressive of SSTs are speculated to reduce inessential delays in services, manage cost-effectively and consequently increase the level of customer's satisfaction that satisfy all the parties [16]

### *2.3 Goal Framing Theory*

An individual has their way of understanding in each given information, which advised by sociology and psychology. The purpose of goal framing theory is aiming to instruct the literature of education to illustrate individual characteristics and differences in student learning. Goal-framing theory (GFT) by Lindenberg and Steg [17] recognises whether these objectives are selected autonomously or by their setting, that actors frequently pursue several different goals at the same moment. The GFT believes that actors are limited in their perception and understanding of their context. Eventually, GFT assumes that actors expect it to assess the alternatives accessible before they perform and to sort alternative solutions based on their performance capability [18]. GFT is not a practical strategy. It claims to include, for example, personal consent, the objectives of stakeholders are multifaceted and go beyond own welfare and utilities [19]. Besides, attitudes and hence attitudes are primarily affected by one's primary purpose, which may be non-utilitarian at the risk of other secondary objectives, which may be useful.

As a consequence, GFT can compensate for goal-oriented activities that may damage one's well-being [20]. Lindenberg [21] stated that as the goal are activated, they influence people's feeling in a way that improves or preserve the way one feels in a different situation. It can be in positive and negative emotions such as happiness, comfort, joy, guilt, anger, shame, and discomfort [22]. The individual with gain goal frame is generally highly sensitive to their resources to maximise their benefits and securing their resources rather than caring about the negative external impact [22]. The normative goal frame acts as a sub-goal in determining how individuals think and work in the social group norm and long-term issues and control of passion. Each action of an individual in the normative goal frame would affect other people's possibilities.

### *2.4 Self Service Technologies service quality correlates to customer loyalty*

Relationship between SSTs service quality and loyalty refers to service that customers spread and share the received experiences that became a possibility of returning for excellent service or by the term of word of mouth. Moreover, loyalty service means to improve on increasing purchases from customers and promotion by the company's offering [23]. However, customer loyalty has other definition which focuses on the mind-set of the consumer that is individually pleasing and committing the company's product and service which turn into customer loyalty and endorsement to the firm [24]. The most necessary component is service quality that has been proving by many reviews [25].

Likewise, experts expect that the company's overall value created by value, loyalty web and service quality which can increase the level of customer loyalty [26]. According to the online market, factors that pushing to achieve customer loyalty are product's value and customer satisfaction which mainly impact to customer loyalty in service quality [27]. Standard service quality dimensions with a positive influence can change on customer loyalty and happiness in the field of technology-based banking

[28]. Consequently, brand equity becomes to be one of the most impactful service qualities in terms of customer loyalty [29].

When consumer appears to have positive senses to service experience and continuing good desire to return as a loyalty customer, one of the most influential factors considered to be the confines of satisfaction [30], satisfaction is a gratifying response of the customer. It was primarily an assessment of the attribute when a degree of delightfulness occurred from the consumption experience provided by the service or product [31]. Nevertheless, since satisfaction is corresponding, employing performance related to service or product has reached the expectation. At the same time, dissatisfaction occurs at the situation when the performance persists to be under the prospects [32]. Inquiry on the relationships among customer satisfaction and electronics service quality has also found a positive impact [33]. For retailer scenarios in airports, SSTs have a significantly positive effect on the joy of travellers [34].

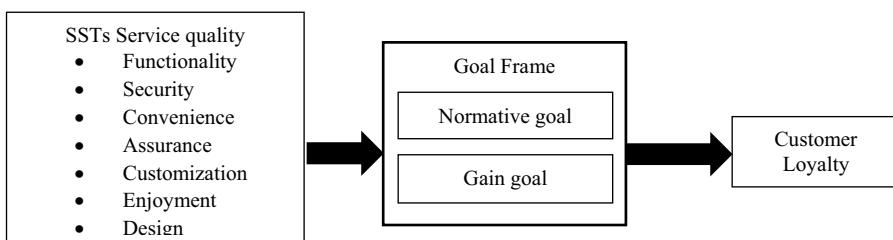
Based on the study, figure 1 shows the following hypotheses.

H1: SSTs service quality is a second-order construct reflected by the first order consists of function, enjoyment, security, assurance, design, convenience, and customisation.

H2: Goal frame is a second-order construct reflected by the first order consists of a hedonic goal, gain goal, and normative goal.

H3: SSTs service quality has a direct positive impact on Goal frame.

H4: Goal frame has a direct positive impact on customer loyalty.



**Figure 1:** Hypothesised model.

### 3. Methodology

This study attempts to identify the core loyalty of customers using the application. This study filtered the measures used from the present literature and studied their validity, reliability, and modifications necessary adjustment with their invaluable information and feedback. This study used a seven-point-Likert scale from (1) strongly disagree to (7) strongly agree to evaluate the results. Before initiating a formal survey, pilot test measures were carried out on a sample of 30 randomly chosen persons, which generated fortified results. The research used the technique from Hair [35] to identify the sample size by variable multiple by ten responses, which most acceptable to determine. The research had developed questionnaires by studying from previous theories, concepts, and related research. The purpose of creating the survey is to identify and verify the factors of user loyalty. The questionnaires were developed and sent for proofreading, the content coverage, sorting, and the characteristics of the question. Then the survey was redeveloped and adjusted. After collecting data, SPSS was used to identify validity and reliability. The pilot test indicates that the

questionnaire was in an acceptable internal consistency and reliability as the Cronbach's alpha of the whole measurement scale is higher than 0.7.

#### **4. Data Analysis and Results**

The research collected 710 online survey questionnaires. Table 1 shows demographic information, and also shows the associated behaviour of services on M-banking application. The respondents had marked "7s" throughout on the 7-point scales, indicating on the variety of responses. There were deemed unacceptable and suitably omitted [36]. After examining scripts for any missing values, leave with the 698 scripts available for further analysis. The missing values were less than 1% of the total amounts, and these were replaced using Expectation-Maximisation algorithms [37]. Also, the study examined a confirmatory factor analysis [38] to determine for any method bias and to estimate a single method factor. The mean of factors was between 5.372 and 5.837, and the standard deviation value range between 1.076 and 1.268. The highest mean, perceived value was functionality at 5.837 with standard deviation at 1.268, and the lowest mean was at 5.372 of security and privacy, and the standard deviation value at 1.123. All correlations were positive, and all pairs were significantly positive.

**Table 1.** Demographic and behaviour of services on M-banking application.

Characteristics	Category	Quantity	Per cent (%)
Gender	Male	264	37.8
	Female	434	62.2
Education	Undergraduate	97	13.9
	Bachelor's Degree	42	6.0
	Master's Degree	499	71.5
	Doctoral Degree	60	8.6
Income level	Below 10,000	307	44.0
	10,001 – 20,000	164	23.5
	20,001 – 30,000	99	14.2
	30,001 – 40,000	64	9.2
	40,001 – 50,000	64	9.2
M-banking application Usage Frequency (per month)	Below 3	21	3.0
	3-6	97	13.9
	7-9	115	16.5
	Over 10	465	66.6

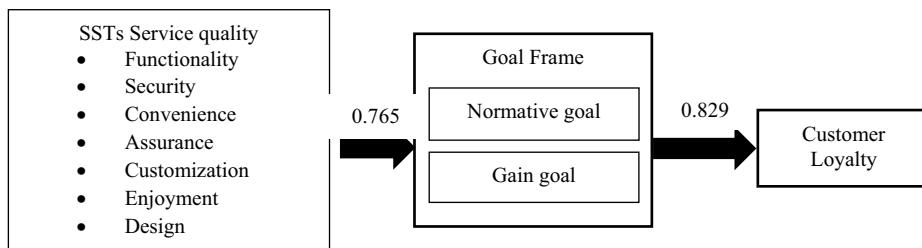
**Table 2.** General theoretical model-fit.

Fit index	Recommended value	SST	Goal framing	Second-order CFA	Hypothesised model (SEM)
Chi-square/df	$\leq 3.00$	2.765	1.523	2.170	2.236
GFI	$\geq 0.80$	0.959	0.988	0.933	0.931
AGFI	$\geq 0.80$	0.938	0.978	0.917	0.916
CFI	$\geq 0.90$	0.983	0.997	0.976	0.975
RMSEA	$\leq 0.08$	0.050	0.027	0.041	0.042

AMOS 26 was applied for data analysis. Model fit results are shown in Table 2. This research uses confirmatory factor analysis (CFA). The second-order CFA fit indexes are demonstrating a congenial fit to data (Normed  $\chi^2 = 2.170$ ; CFI = 0.976; GFI = 0.933; AGFI = 0.917; RMSEA = 0.041) which introduce construct validity. Further tests of validity and reliability were also prosecuted. Supported by Hair et al. [37], every item in standardised loading was higher than 0.50 proposing sufficient

convergent validity, additional support by the AVE scores also higher than 0.50 [39]. All constructs in composite reliability estimates and Cronbach's Alpha were over 0.80, representing acceptable reliability. Discriminant validity was advocated for most of the constructions as the primary constructs of AVE was larger than the successive standardised correlation coefficient with most of the other construction [39].

After inspecting the fit of the measurement model, this research inspected the second-order path loadings of SSTs service quality. This research noticed that self-service technology significantly interpreted the first-order dimensions: function (standardized beta coefficient,  $\beta = 0.822$ ,  $p < 0.001$ ), enjoyment ( $\beta = 0.869$ ,  $p < 0.001$ ), security, ( $\beta = 0.894$ ,  $p < 0.001$ ), assurance ( $\beta = 0.926$ ,  $p < 0.001$ ), design ( $\beta = 0.929$ ,  $p < 0.001$ ), convenience ( $\beta = 0.899$ ,  $p < 0.001$ ), and customization ( $\beta = 0.928$ ,  $p < 0.001$ ). The first-order CFA fit indexes of SSTs variables are demonstrating a congenial fit to data (Normed  $x^2 = 2.765$ ; CFI = 0.983; GFI = 0.959; AGFI = 0.938; RMSEA = 0.050) which suggest construct validity and support H1. For hypothesis H2, this research noted the first-order dimensions of GFT as Gain goal ( $\beta = 0.993$ ), and Normative goal ( $\beta = 0.931$ ). The first-order CFA fit indexes of goal framing variables are demonstrating a congenial fit to data (Normed  $x^2 = 1.523$ ; CFI = 0.997; GFI = 0.988; AGFI = 0.978; RMSEA = 0.027) which suggest construct validity. The result supports hypothesis H2.



**Figure 2:** Hypothesised.

The hypothesized measurement model of this research yielded was at Normed  $x^2 = 2.236$ ; CFI=0.975; RMSEA=0.042; CFI = 0.975; GFI = 0.931; AGFI = 0.916. Self-service technology exerted a significant influence on values perceived in Goal framing theory ( $\beta = 0.765$ , CR = 17.459,  $p < 0.001$ ). The result of the model reached path coefficients of 0.765, supporting hypothesis H3. Moreover, completion of GFT exerts a significant impact on customer loyalty ( $\beta = 0.829$ , CR = 20.761,  $p < 0.001$ ), the result of the model reached path coefficients of 0.829. Therefore, hypothesis H4 is supported.

## 5. Discussion and Conclusion

This study applies the SSTQUAL scale [30] to measure the service quality of SSTs in the context of Thailand service sector. This study has shown that younger customers have more significant trends toward the utilising of SSTs. SSTs service quality has a positive and meaningful relationship with customer loyalty. The outcome tells that customer loyalty towards the SSTs will be greater, the more customers receive high service quality from SSTs they are utilising. The findings are in line with McKechnie et al. [28] that the impacts of generic service quality aspects in a technology-based banking framework and identified a positive effect of service quality aspects on

customer loyalty. GFT mediates the association between SSTs service quality and customer loyalty to a certain degree. As well as the structural model, the SSTs service quality is positively and significantly affected the customer's perceived values through one of the goal frames in GFT. Finally, an affirmative act upon each goal frame from GFT is associated substantially with SSTs user's loyalty and intention of continuous use. The outcome of the study research provides a significant role in the practical and managerial implications of the banking industry that gives knowledge of consumer's perspective and expertise to understand the attitude through the model of SSTs service quality, GFT, and customer loyalty. Hence, banks should have prioritised, giving more efforts to understanding reaction and behaviour that can affect the satisfaction and dissatisfaction of involving M-banking customers. This study can help banking industry to improve quality of service to allow users be able to access to necessary information that solve the pain point of customers. They can do so by improving on consistent monitoring, management, and service delivery process towards the use of following provided models. This study has several limitations. First, the data that this study collected data only from M-banking users in Thailand. Due to this condition, the data of other provinces may have different outcomes and attitudes according to the theoretical methods system simultaneously. Finally, this study research has a limitation on data collection time.

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# The Effect of Open Innovation Implementation on Small Firms' Propensity for Inbound and Outbound Open Innovation Practices

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**Abstract.** Small- and medium-sized enterprises (SMEs) face limited resource capability to implement open innovation. Understanding a robust mechanism of knowledge management, organisational structure, and networks can benefit managerial and organisational drivers to achieve open innovation in general. The paper sheds the new light in developing the open innovation implementation as a latent endogenous variable influence inbound OI and outbound OI. We used structural equation modelling (SEM) on a data set of 636 Thai SMEs. The results reveal that open innovation implementation reflected by managerial and organisational dimensions has a positive impact on contributing to both inbound and outbound OI. A key finding is that open innovation's diffusion helps SMEs to overcome their technological capabilities to implement OI.

**Keywords:** Open innovation implementation; organisational structure; knowledge management; networks; inbound open innovation; outbound open innovation; structural equation modeling

## 1. Introduction

Recently, innovation has been growing to crucially reduce the time and cost related to product development to increase efficiency, leading to the practical use of a collaborative business design model in any industry [1]. As a result, open innovation (OI) is the ultimate solution to customer needs and market conditions [2]. Although SMEs seek external collaborators out innovative solutions through implementing crowdsourcing innovation [3], there is the number of issues unclear in managerial and organisational aspects to apply open innovation theory due to its broad concept. Thus, it is pivotal to specify the elements for opening up their innovation process. This research undertakes an evaluation of managerial and organisational drivers to develop into a new exogenous dimension of “*open innovation implementation (OII)*”. In this context, this research poses two research questions: (1) how do the organisational and managerial dimensions (i.e., organisational structure, knowledge management, and

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networks) affect the implementation of open innovation? and (2) how OII contributes to inbound OI and outbound OI in practice? Prior studies have mostly paid attention to the effect of OI practices (e.g., inbound, outbound, and coupled [4], [5]) on innovation performance and firm performance. Yet, the effect of organisational and managerial dimensions on the implementation process is relatively constrained to investigate. The exploratory evidence reveals that organisational structure, knowledge management, and networks contribute to driving the firms' open innovation strategy [6]. Due to the in-depth the large firm's experience in adopting the open innovation, the case study's results do not demonstrate the empirical support. This current research aims to propose the new exogenous dimension of "open innovation implementation as motivated by Thailand's knowledge economy and industrial sustainability. The second objective is to investigate the contribution of OII to open innovation practices empirically. We follow the scope of "implementation by Huizingh [7] that the process by which the firms open up their innovation process. More recently, Thailand is moving towards Thailand 4.0, which is driving the economy through innovation, focusing on science, technology and innovation to drive the economy. Also, Thailand has invested in research and development, only 0.2% of GDP [8]. Hence, Thailand serves as the field to investigate open innovation for the current study. Our key finding contributes to building a positive environment that stimulates people to leverage and develop the existing technological capabilities across the firm's boundaries. In addition, firms benefit from the outsourcing of knowledge so as to enhance recent technological development. Our results contribute to the insight into open innovation approach derive in small firms to use a unique data set collected from mainly CEOs, entrepreneurs, business owners, and managers across 636 SMEs. In particular, we find that managerial and organisational factors such as organisational structure, knowledge management and networks magnify the effect of open innovation implementation on inbound and outbound open innovation significantly. Understanding this effect would allow practitioners and policymakers to implement the motives of open innovation. The remaining sections of the paper are outlined as follows. Section 2 reviews the theoretical background literature and develop our conceptual framework and hypotheses forwards. Section 3 sets out the empirical application with Structural Equation Modeling (SEM) by which allows us to test OII as a latent endogenous variable. Section 4 discusses the main findings of the survey, along with the factor analysis and the latent regression analysis, and followed by Section 5 concludes and implies in practice.

## 2. Theoretical Background

### 2.1 Theory of open innovation: Open innovation implementation (OII)

This current study traces back academic support in the theory of open innovation [9]. We attempt to understand the implementation process. Inside the adoption stage, Rogers [10] indicate that the implementation stage involves the ways firms put an act of innovation into use based on the situation. While Huizingh [7] explains the implementation stage as the transitioning process from closed innovation towards open innovation. Chesbrough [9] defines open innovation as the process by which firms apply outside ideas as well as inside ideas, and inside and outside paths to market, as the firms seek to advance their technology. Boscherini, Chiaroni, Chiesa, & Frattini [11] highlighted the implementation process toward open innovation which often starts

with searching and outsourcing technological service firms. To transform from closed innovation to open innovation, managerial, organisational, and contextual dimensions (e.g. knowledge management, organisational structure, and networks respectively) are prerequisite to organise this change [6]. Beyond opening up the innovation process, the main managerial change has taken place in the managerial systems of firms. Lichtenhaler [5] suggested the OI paradigm can be opened up in a two-directional innovation process such as external technology acquisition (inbound OI) and internal technology exploitation (outbound OI). As prior studies (e.g., Boscherini et al. [11]; and Chiaroni et al. [6]) addressed, the implementation of open innovation reflects three main variables (knowledge management, organisational structure, and networks). These variables should be considered and taken action by the innovative firm to run an opening up as the process under the open innovation paradigm. Our research takes all three subconstructs of open innovation implementation into account and explores, whether they explain an valid dimensionality of the latter is needed.

## *2.2 Knowledge management*

Knowledge management can be defined as the capability of organising or employing the information in a means by which it contributes to reaching set goals [12]. Singh, Gupta, Busso, & Kamboj [13] indicate that knowledge management affects open innovation; for a reason, that open innovation implementation specifies the adoption of knowledge management. Knowledge management enables people to diffuse, share and transfer knowledge [6] as well as create, utilise, and store it within internal and external context. Mahmoudsalehi, Moradkhannejad, & Safari [14] point out that knowledge management comprehensively includes the efforts activities of facilitating in acquiring and exploiting knowledge. While knowledge management is represented as an outcome of firm structure and strategy, it is essential to create, share, and utilise knowledge across the functional boundaries of firms [15]. Therefore, it is possible that knowledge management plays an essential role in explaining open innovation implementation and also affects organisational structure to support the mechanism of open innovation implementation. Our literature analysis linking knowledge management and organisational structure to open innovation implementation leads to the following hypotheses:

- H1.** Knowledge management positively influences open innovation implementation
- H2.** Organisational structure positively mediates the influence of knowledge management on open innovation implementation.
- H3.** Organisational structure

Organisational structure can be defined as how the organisation is connected for the most efficient operations, tasks, systems, operating processes, employees, and teams to accomplish business objectives [16]. Bai, Feng, Yue, & Feng [17] argue that mechanical and organic organisation structure have an impact on innovation performance (e.g., new product development). Innovative product development requires multi-disciplinary knowledge for open innovation. Thus, the characteristics of the organisational structure have an impact on the operation of new goods advancement. Lee, Min, & Lee [18] find that the decentralised structure in terms of decision-making affects outside-in and inside-out open innovation, indicating that

decentralised workflow promotes discussion before the acceptance or rejection of recommendations from external collaborators.

#### **H4.** Organisational structure positively influences open innovation implementation

### *2.3 Networks*

Networks can be defined as the scope of depth and breadth of inter-firm relationships that build during the project level with external actors. Such actors include universities, research institution, customers, government, and suppliers [19]. Perkmann & Walsh [20] argue their finding that the network of inter-organisational relationships is needed to pay more attention, especially between universities and firms. This will help unlock the innovation problem once the openness comes at the door through the research area. To explain the features of a network for innovation, Laursen & Salter [21] highlight two factors: breadth and depth. First, search depth is measured as the degree of the various search channels or external sources is drawn by firms. Second, search breadth is quantified as the number at which firms rely on their search channels or external sources. Taking all the above into account, we develop the following hypothesis:

#### **H5.** Networks positively influence open innovation implementation.

Taking all hypothesis 1, 2 and 4 into account, we attempt to measure these latent constructs with the second-order model, whereas the arrows are reversed to reflect that organisational structure, knowledge management, and networks are the sub-dimensional influence explaining open innovation implementation. Thus, when the process of OI implementation is set up, and the next process will be explored the manners which how small firms practice whether their inbound or outbound activities.

### *2.4 Open Innovation Practices: Inbound and Outbound*

During the implementation phase, firms plan to either externally acquire, internally exploit, or combine technological knowledge for innovation development [6]. Given its importance, a firm's strategies on technology play a key role in opening up the innovation process. In addition to acquiring external knowledge, firms can actively commercialise technology; for example, by means of out-licensing. The rise of inside and outside technology transactions reflects the new open innovation paradigm [22]. Wang, Chang, & Shen [23] also explore the impact of inbound open innovation strategy on firm performance; their result suggests that external resources relying on horizontal and vertical technology collaboration are significant to the high-tech industry. Yoon, Shin, & Lee [24] find that outbound open innovation usage, including outward technology transfer, venture business, joint venturing, and open platform, is most relevant to the active technology exploitation. We can conclude firms open up and establish networks with external firms access their competencies to improve firm innovation performance, referring to the process of how to do open innovation. Thus, this stage is related to the implementation stage. To summarise, our analysis linking the essence of managerial and organisational factors to inbound and outbound practices, and the practice stage tends to unfold an open innovation perspective onto existing processes.

- H6.** Open innovation implementation as a second-order factor positively influences inbound open innovation in practice
- H7.** Open innovation implementation as a second-order factor positively influences outbound open innovation in practice

### 3. Research methodology

#### 3.1 Data collection and sampling

From a whole population list of 699,382 firms, we elicited registered SMEs from DBD Data Warehouse. We collected data using a postal and electronic-mail survey questionnaire of a sample of 636 Thai SMEs. As suggested by Kline [25], the sample size acceptable for structural equation modelling was 10 observations per indicator variable. The 636 samples were designed based on the two-stage sampling approach. The cluster sampling is the first stage units to be sampled depending on the geographical region of Thailand and divided into 6 clusters, namely the North, Northeast, Central, East, and South. As firms sorted by geographic area, we apply purposive random sampling in the second stage, which allows us to access a purposeful category of small firms as our target. In this current research, small and medium enterprises (SMEs) are defined as the firms with no more than 250 employees, operating the production, distribution and service activities. SMEs are one of the focal points to drive Thailand's economic vitality and economic development [3], creating the number of employment for more than 10.5 million Thais. In Thailand, SMEs are considered as a beneficial source of innovation, new products into the market and aggregate productivity growth [26]. It can be concluded that Thai SMEs serve as the locale to examine the effect mechanism of open innovation implementation on inbound OI and outbound OI of SMEs.

#### 3.2 Measures and variable settings

The constructs of the study were used measuring a 7-point Likert-type scale [27] ranging from 1 (strongly disagree) to 7 (strongly agree) and from 1 (strongly not important) to 7(strongly important). In our research, open innovation implementation (OII) was estimated as the exogenous latent model caused by latent endogenous variables of knowledge management, organisational structure, and networks. On the other word, the first-order constructs of knowledge management, organisational structure, and networks will be used as indicators forming to measure open innovation implementation (OII). The measures were adopted with the major and minor change from the literature. Knowledge management was adapted from [15] measuring three items; how firms manage knowledge to create, share, and utilise innovation. The organisational structure was operationalised using five items from [15], [17] to measure activities that are designed to capture decentralisation (i.e., maintain open communications channels in operations), organism (i.e., encourage team collaboration and capability improvement to handle change), and mechanism (i.e., have both formal and informal procedures). Networks were adapted eight items from previous research to measure the scope of depth and breadth of external partners [19], [21] in terms of collaborations with industrial enterprises, university or other academic institutions, and public or government institutions. Inbound OI and outbound OI were adapted from [5],

[23]. Inbound activities are designed to observe the technological and knowledge acquisition from external firms, the search for new trends and knowledge, and the ties with and reliance on external usage of innovation technology. While activities—the selling of technological knowledge and intellectual property, non-co-exploitive technology, and the establishment of a dedicated unit—are used to capture outbound open innovation.

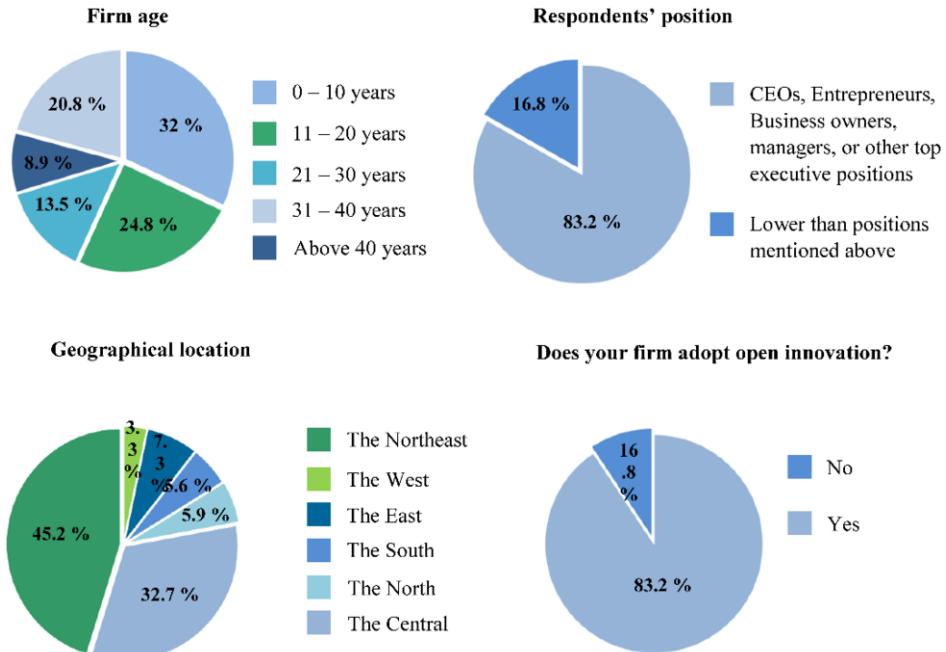
### 3.3 Descriptive statistics

Figure 1 exhibits that 32% of firms had an operational age of 0 to 10 years, businesses that had operated between 11 to 20 years made up (24.8%) and those above 40 years comprised (20.8%). The remaining firm's age comprised 21 to 30 years and 31 to 40 years has the followed distributions of 13.5% and 8.9% respectively. The result was found that 83.2% of respondents who are CEOs, Entrepreneurs, Business owners, managers, or other top executive positions. The other 16.8% of respondents were in lower positions. For the firm's location, almost half (45.2%) of the firms are located in the Northeast region, followed by the Central Region (32.7%). The other four regions are; the East Region (7.3%), the North Region (5.9%), the South Region (5.6%), and the West Region (3.3%). Finally, we asked to ensure small firms' OI adoption, and the results showed that up to 90.6% of SMEs had adopted OI, and the rest (9.4%) of firms having not adoption yet.

## 4. Reliability and validity analysis

The analysis was conducted in several steps. First, unidimensionality was conducted through exploratory factor analysis (EFA) using varimax rotation. The EFA results explained 61.34% of the total variance, indicating that all the measurement scales are well loaded on their constructs. Second, the analyses of Cronbach's alpha and composite reliability are greater than 0.70, demonstrating the constructs are reliable [28], [29]. Third, the assessment of the construct validity is composed of convergent and discriminant validity to measure the conceptual variables. Using confirmatory factor analysis (CFA), the standardised factors loadings (see Table 1) obtained with a value of more than 0.70 [30]. The results of composite reliability (CR) exceed 0.70, which means that the variables did converge at some point [30]. The values of average variable extracted (AVE) are over 0.50, indicating the effective measure of the single latent construct [30]. This step 3 of convergent validity shows that there are the convergences on the latent variables to measure the same thing. Fourth, to test the discriminant validity of the measurement model, the results of the maximum shared variance (MSV) and the average squared variance (ASV) are less than the values of average variable extracted (AVE), meaning there are the divergences from other variables to measure different constructs. Fifth, the measurement model indices for open innovation implementation as a second-order factor explained:  $\chi^2 = 251.722$  ( $p \leq 0.001$ ); CMIN/df = 2.967; RMR = 0.042; GFI = 0.95; AGFI = 0.928; PGFI = 0.665; NFI = 0.95; RFI = 0.944; IFI = 0.97; CFI = 0.97; PNFI = 0.764; RMSEA = 0.056. This indicates the good model fit [30]. To summarise, results confirm that open innovation implementation is represented as an overarching concept (i.e. second-order factor) consisting of knowledge management, organisational structure, and networks (first-order factors). Sixth, the structural model was tested. The fit indices for the structural model were as follows:  $\chi^2 = 244.709$  ( $p \leq 0.001$ ); CMIN/df = 2.913; RMR = 0.041;

GFI = 0.951; AGFI = 0.929; PGFI = 0.665; NFI = 0.956; RFI = 0.945; IFI = 0.971; CFI = 0.971; PNFI = 0.765; RMSEA = 0.055. All indices provide a good fit [30], revealing that the model fits the data well. The high standardised regression estimates further suggest that the proposed indicators support well the constructs being hypothesised to measure.



**Figure 1.** The characteristics of the sample and its distribution

**Table 1.** Discriminant validity, convergent validity, and reliability of measures.

Constructs	Dimensions	Items	Factor loadings	Cronbach's alpha	CR	AVE	ASV	MSV	Sqrt AVE
Open Innovation Implementation (OII)					0.857	0.969	0.74	0.874	0.984
Inbound Open Innovation (IOI)	Knowledge Management (KM)	KC1	0.746	0.828	0.830	0.620	0.384	0.425	0.787
		KS2	0.821						
		KU3	0.794						
	Organisational Structure (OS)	OS1	0.74	0.743	0.792	0.559	0.241	0.266	0.748
		OS2	0.80						
		OS3	0.701						
	Networks (NWK)	NWK1	0.834	0.847	0.849	0.653	0.425	0.475	0.808
		NWK2	0.827						
		NWK3	0.761						
	Outbound Open Innovation (OOI)	IOI1	0.74	0.813	0.788	0.553	0.306	0.309	0.774
		IOI2	0.748						
		IOI3	0.743						
	Outbound Open Innovation (OOI)	OOI1	0.757	0.742	0.762	0.604	0.247	0.336	0.777
		OOI2	0.766						
		OOI3	0.767						

## 5. Discussion and contributions

This research attempts to test open innovation implementation as a second-order construct reflected by the first-order dimensions of knowledge management, organisational structure, and networks. We then investigate the influence of open innovation implementation (OII) on inbound and outbound practices. The coefficients and their standard estimates obtained structural equation modelling (SEM) in SPSS Amos v26, are in **Figure 2**. Hypothesis 1 to test the influence of knowledge management on open innovation implementation was confirmed ( $\beta = 0.945$ ;  $t\text{-value} = 19.874$ ;  $P < 0.001$ ). The findings indicate that knowledge management plays an important role in innovation—how firms create, share, and utilise knowledge across firm boundaries—and knowledge management as an enabler can help firms manage decision-making and procedure with external partners. Meanwhile, Hypothesis 2 ( $\beta = 0.503$ ;  $t\text{-value} = 2.79$ ;  $P < 0.001$ ) were confirmed to knowledge management influence open innovation implementation via the mediating role of organizational structure. We find that knowledge management systems can be integrated when organisational structure as the mediating variable is a critical antecedent which allows firms to have open communication to share ideas and impact cross-functional innovation implementation to across firm boundaries. Besides, this result suggests that small firms acquire knowledge from the inside and exploit external knowledge in order to create new knowledge to the Hypothesis 3 ( $\beta = 0.47$ ;  $t\text{-value} = 2.814$ ;  $P < 0.001$ ) found support, indicating organisational structure as the key important aspects firms need to authorise decisions, rules, and procedures to collaborate with external parties appropriately. The finding of hypothesis 4 tests networks contribute to open innovation implementation is acceptable ( $\beta = 0.874$ ;  $t\text{-value} = 21.113$ ;  $P < 0.001$ ). indicating a variety of knowledge and technology sources need to obtain innovation that can be searched from external partners, especially from university-industrial collaboration. Regarding the confirmation of open innovation implementation construct, its impact has significantly on inbound and outbound open innovation practices. Thus, hypotheses 5 ( $\beta = 0.98$ ;  $t\text{-value} = 20.606$ ;  $P < 0.001$ ) and 6 ( $\beta = 0.995$ ;  $t\text{-value} = 21.552$ ;  $P < 0.001$ ) were supported that outbound OI and inbound OI are contributed positively to the firm's open innovation implementation process. Open innovation can be implemented through the knowledge management system, organisational structure, and networks, which leads to open innovation practices (i.e., inbound OI and outbound OI). This lends support to the work of Lichtenthaler & Ernst [22] that aggressiveness of technology highly influences the strategic approach of firms toward open innovation. The theoretical contribution of this paper is twofold. First, we incorporate organisational structure, knowledge management, and networks into the research model, and find that they have different impacts on open innovation implementation (OII). When SMEs implement open innovation field by being connected through organisational management and dialogue such as the structure of management, the managerial system of knowledge, and business networks [6]. Second, this study also contributes when the underlying mechanisms that describe the causal effect of open innovation implementation (OII) on open innovation practices (OIP) have been appropriately created on the prior conceptual study of Huizingh [7]. From this view, our paper, emphasising on CEOs', entrepreneurs', business owners', managers', or other top executive positions' open innovation implementation as a critical contributing factor to inbound OI and outbound OI, advances our understanding of open innovation practices from three managerial and organisational drivers. To the best our knowledge,

this paper demonstrates a new first scale on open innovation implementation, which establishes on recent qualitative and conceptual research on open innovation implementation that shows multiple dimensional constructs of open innovation implementation. For practical implications, the importance of organisational structure helps planning and decision making activities to come up with a new product or process innovation to be distributed to other technical expertise under business collaboration networks. Meanwhile, the focus of knowledge management is pointed at knowledge created, shared, and utilised inside and outside the firm to develop and exploit innovation through personal conversations, teamwork, training, and social media. Therefore, one of the main determinants of the extent to which firms attempt to open up the innovation process is constituted in a technology-based strategy. In addition, a flexible and knowledge incentive workplace can support team collaboration and makes it simple for them over their call of duty. All these implementation mechanisms can positively impact the outbound and inbound open innovation efforts of small firms. As a whole, these results of our study provide some policy initiatives and guides: (1) SMEs need a new venture fund from networks (e.g., university, public institutions, and industry); (2) compete for the market with co-creation and development; and (3) promote the cross-functional team in order to share knowledge across firm boundaries.

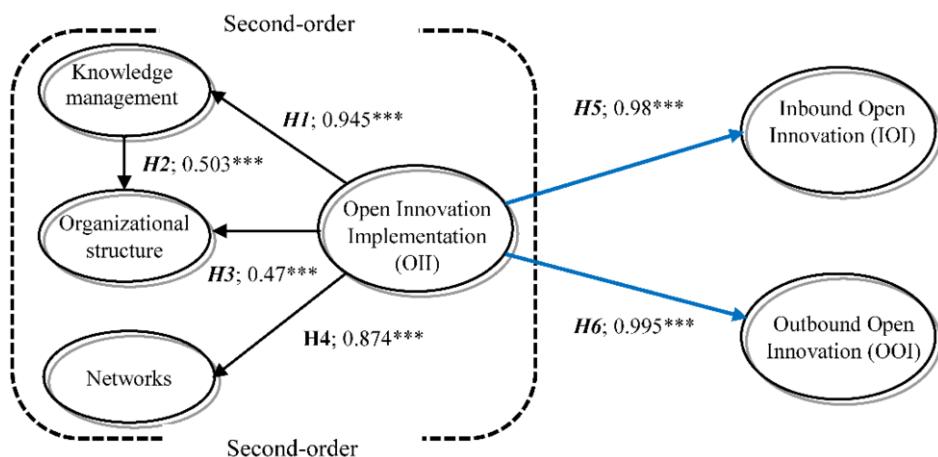


Figure 2. Structural model

## 6. Conclusion, limitation, and future research

By considering open innovation implementation as a three-dimensional construct and investigating its relationships with inbound and outbound open innovation practices in a single model, this study offers new theoretical insights to small business practitioners and policymakers. The open innovation implementation as a second-order model provides a significant insight into organisational structure, knowledge management, and networks. We reach the two research objectives by confirming that three managerial and organisational dimensions can be represented as the elements of open innovation implementation. The results prominently demonstrate there is a positive effect of open innovation implementation on open innovation practices, which both

stages are relevant significantly. SMEs are encouraged to analyse their internal capabilities to adopt open innovation and evaluate the external dynamics to come up with new technology to the market. Eventually, these three strategic management and organisational dimensions assist in pushing open innovation strategy and bringing firms to innovative solution through internal and external collaboration. This study is not without limitations. First, open innovation implementation may have limited relevance in the case of large firms. Further investigation is encouraged to collect both large and small firms to compare the differences in their application. Motivated by [21], networks variable should be more validated through the measurement in the breadth and depth matrix to obtain the accurate number of external partners.

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# Barriers and Facilitators of Front Identification in China's Pork Traceability System

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**Abstract** The identification is the sole carrier of the whole-process information of the pig traceability system. The front identification is the first component, an indispensable part of the proper traceability of the product. This paper conducts in-depth study on company B, company S and company Z from Beijing, Shandong and Zhejiang to understand their specific management process, cooperation model and interest allocation, identification method, willingness to implement, the cost and benefit before and after the implementation as well as the effect of the implementation. The Cannikin Law is also employed to conduct the comparison analysis on the implementation of the system, so as to set an example for the pig traceability system in other relevant companies of the sort. The results show that, the organization model plays the most important part in the front identification management, with “company + bases + farmers” as the most conducive mode for the implementation of front identification yet not prone to be promoted; “company + cooperative + farmers” is more apt to promotion. Other important impact factors of the implementation level of front identification in pig traceability system include the education level of the implementation subject, the scale and the location of the company.

**Keywords** pork traceability system; supply chain; front identification; cost-benefit analysis

## 1. Introduction

China takes the lead in the amount of pork stock, slaughter, and consumption, taking up half the production and consumption of pork products globally. Pork ranks at the top of the meat products consumed by Chinese urban residents, whose meat consumption is over 60%<sup>2</sup> of the total consumption in China. This brings its own substantial safety problems. In recent years, food safety incidents, such as clenbuterol contamination in the meat produced by Shuanghui, double-dead meat, and zombie meat, are haunting the Chinese market, with 13,278 incidents between 2005 and 2014 [1]. These incidents

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<sup>2</sup> Data source: Food and Agriculture Organization of the United Nations database.

severely damage consumers' benefits, reducing their faith in purchasing and causing turmoil in China's economic development and social stability.

The traceability system, which can trace whole-course information of the supply chain, is widely deemed an effective method to eliminate asymmetric information on food safety, identify food safety risk and responsibility, and elevate food safety levels [2]. It has been adopted by several countries including France, the US, and Denmark. The pork traceability system now plays an active role in solving safety problems in pork and pork products [3]. The pork traceability system started relatively late in China and is still in its infancy, with great support and promotion from governmental authorities. In 2016, China's state council issued the 'Suggestions on propelling the development of traceability systems for important products' as guidelines for developing the product traceability system. In 2017, seven departments, including the Ministry of Commerce, Ministry of Agriculture, and General Administration of Quality Supervision, issued the 'Guidance on the development of informationized product traceability system', with the aim of establishing a nationwide, unified, open, advanced, applicative, synchronized, and informationized product traceability system by 2020.

The pork traceability system depends on the identification to record, store, and inquire about key information from every link in the supply chain, including information on breeding, slaughter, processing, and sales [4-7]. When products are found with safety issues, the system's search function can help clarify the responsibility of relevant corporations in accordance with pertinent regulations and contracts to enforce targeted product recall and punishment on such corporations [8,9].

The identification is the sole carrier of all the information of the pork traceability system [10,11]. It is the most important information management link of the traceability system. It is a process of labelling and identification that includes allocation of the identification number, labelling, identification document creation, registration in the central database, and identification of other changeable information. So identification is the basic carrier of information flow for the whole supply chain chased by the traceability system, and it connects consumers or governmental authorities with product information.

Front identification, as the first part of product identification in the pork traceability system is the carrier of farmers' pork breeding information during this process, not only determines the quality of pork products but also traces the problem's root cause, which is the weakest part of the supply chain [12].

In this context, this study examined the front identification issue of China's pork traceability system, covering the implementation status quo and important impact factors of front identification management in the system.

Existing studies on the traceability system had the following three characteristics. 1) they conducted basic research on the definition, features, and functions of the traceability system. 2) three major research methods were established: transaction cost analysis, cost-benefit analysis, and consumers' willingness to pay. 3) Some scholars focus on the development and application technology of the traceability system.

As regards the pork traceability system, many studies were conducted from the perspective of stakeholders' willingness to pay. Zheng *et al.* (2012) [13], Wu *et al.* (2016) [14], and Ying *et al.* (2016) [15] analysed consumers' preference and willingness to pay for traceable pork; Zhou *et al.* (2012) [16] and Wu *et al.* (2014) [17] studied the company and farmers' willingness to invest in the pork traceability system. Some studies provided improvement plans for this system [18,19]. Front identification, the weakest part of the pork traceability system, however, is left untouched with

insufficient material and data.

This study contributes from the following three aspects. First, field research and in-depth interviews are employed to investigate front identification issues of the pork traceability system in companies B, S, and Z from Beijing, Shandong, and Zhejiang, respectively, with a grasp on primary data and information to enrich the database of domestic research on traceability systems. Second, new attempts are made from the supply chain management perspective to study front identification of the pork traceability system, thus expanding the relevant literature. Third, comparative analysis of multiple cases was conducted to study the implementation status quo, organization model, profit distribution, and willingness to implement, with greater representation and worth of promotion, thus serving as reference to other companies for implementing a pork traceability system.

## 2. Theoretical basis of front identification in traceability systems

The pork traceability system's objective is carrying information of every link of the supply chain. The system chases relevant information from breeding, slaughter, processing, and sales [20]. The front identification is the first component and indispensable for proper traceability of the product.

The Cannikin Law describes the importance and special position of front identification in the pork traceability system. According to the extended Cannikin Law, the capacity of a barrel depends on the compactness of the planks to avoid leakage, regardless of its size [21].

From the supply chain perspective, implementation of the pork traceability system involves every link of the supply chain. Presently, there exists a severe problem of the lack of product identification as the first link of the system, that is, of front identification. The system can only function normally if the problem is tackled properly.

Thus, ensuring effective synergy of the information from each link of the supply chain requires tracing the whole process of the pork traceability system. Incomplete front identification of pork creates a chasm of information between farmers and the pork butchers and processors, preventing effective realization of the traceability system.

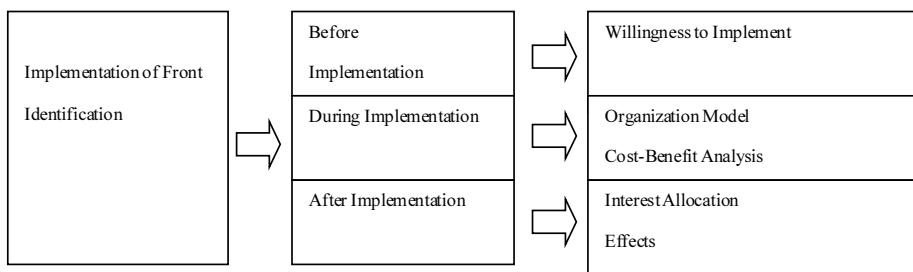
## 3. Methods and materials

A multi-site, cross-sectional qualitative research design was employed to provide in-depth understanding of the barriers and factors influencing front identification in China's pork traceability system. Eligible participants included production managers, quality and safety supervisors, and policymakers. The study received ethical approval from the Bureau of Reclamation of China's Ministry of Agriculture.

The study employed several data collection methods, including focus group discussions, field notes, face-to-face interviews, and organizational document analysis on front identification of traceability systems. The focus group was conducted with eight government officers of the Bureau of Reclamation and face-to-face interviews with top managers of companies B, S, and Z from Beijing, Shandong, and Zhejiang, respectively. An interview guide with a series of open-ended questions was developed

and pretested based on literature review and expert opinions [8,9]. The guide's main domains included questions about the front identification management process, cooperation model, interest allocation, identification method, willingness to implement, cost and benefit before and after implementing front identification, and effect of the implementation. On average, audio-recorded in-depth interviews with each participant lasted about one hour, while focus group discussions took about one and a half hours to complete. Overall, data from primary sources comprised 15 in-depth interviews with representatives of the three entities and focus group discussions with 12 respondents from governmental and non-governmental organizations (3–5 participants per group) conducted during March–July 2015.

Various research techniques were applied to ensure credibility and transferability of the study [22–24]. Credibility was reached through regular peer debriefings among research team members. Provision of detailed description of the study setting and sample characteristics (Figure 1) and the data collection and analysis process helped enhance the findings' transferability.



**Figure 1.** Impact factors of front identification implementation in China's pork traceability system while applying the supply chain theory

Source: Chen *et al.* (2017)

#### 4. Comparative analysis of three cases

##### 4.1 Sample profile

In the food sector, three respondent organizations have implemented front identification in their traceability system.

Company B (Beijing Black Pork Seed Stock Station) is a member of China's local pork protection and utilization cooperation group. In 2004, the company passed the authentication using the standardization system of the Beijing Municipal Administration of Quality and Technology Supervision.

Company S in Shandong was established in 1986 and has become a top national large enterprise group with fine breeding of pork, standardized raising, fodder production, veterinary drug administration and quarantine, pork slaughter, meat processing, and bioengineering.

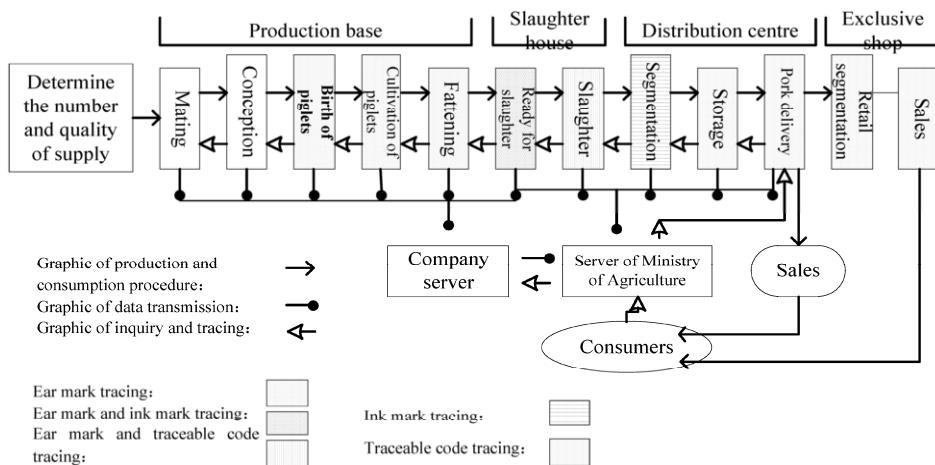
Company Z in Hangzhou, Zhejiang province, was established in January 1998. This food processing company together performs the functions of pork slaughter, high/low temperature meat processing, logistics and delivery, and sales.

## 4.2 Status quo of front identification of pig traceability system in three enterprises

### 4.2.1 Status quo of front identification in company B

The pork traceability system in company B was established in October 2009. The company is subordinate to Beijing Capital Agribusiness Group Northern Suburbs Farm and is among the second group of companies with a traceability system in the agricultural reclamation system (under the command of the Ministry of Agriculture's Bureau of State Farms and Land Reclamation).

This company possesses black pork seeding and breeding bases in Beijing. It is committed to independent seeding and breeding methods and covering the processes of seeding, breeding, creation of commercial pork product, slaughter, processing, delivery, and sale at an exclusive shop. Its black pork receives an ear mark, which will be used in the whole process within 12 hours of the pig being born. Thus, all the processes are within the control of the company and completed by the employees, except for the slaughter process, which is outsourced to the Beijing 5<sup>th</sup> Meat Processing Plant (Figure 2).

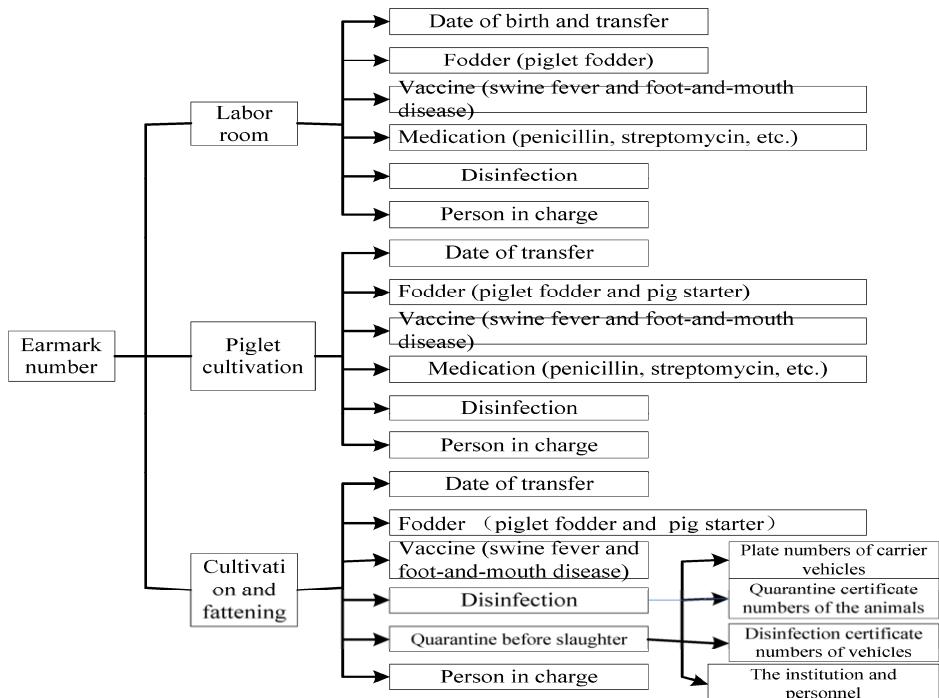


**Figure 2.** Flow diagram of the pig traceability system in company B

Data source: drawn by the author

The traceability system in company B employs the 'ear mark + ink mark' method. Black pork should receive an ear mark at the company's veterinary station within 12 hours after birth, as its sole identification.

There are two main stages in the front identification management of company B. Stage 1 is from the birth of porklets to pork being ready for slaughter. In this stage, it is possible to record information about each pork's feeding, medication, and management through its identification or ID, that is, the ear mark number. Figure 3 shows the structure of the traceability chain and relevant breeding information.

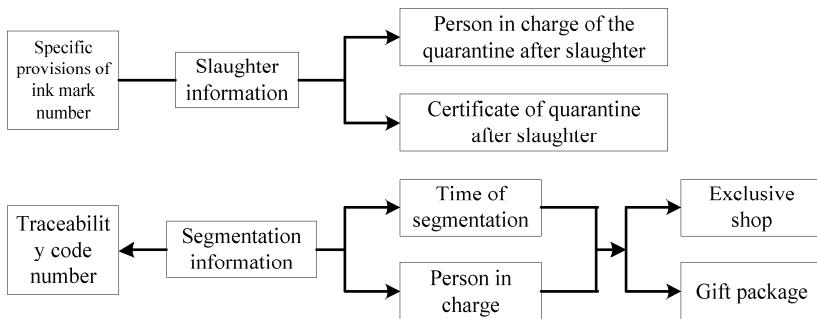


**Figure 3.** Structure of the traceability chain and relevant cultivation information in company B

Data source: drawn by the author

Stage 2 covers the processes after the slaughter. When the pork is ready for slaughter, an ink mark is attached to both sides of the loin with a special tattoo hammer. Each pork carries both the ear mark and ink mark, and the latter is input into the traceability system database in the mapping table of ink and ear marks. The mapping table is submitted to the delivery centre within four hours after the slaughter, and records of the breeding bases are entered accurately. The number of pork for slaughter in every breeding base is uploaded to the database and its information is entered (Figure 3).

The slaughter is done by the Beijing 5<sup>th</sup> Meat Processing Plant. Even after segmenting the pork into head and carcass, its ink mark will continue providing information for identification. Every black pork is packed completely in a labelled case with a traceable code, which proffers its detailed information to the staff upon delivery to the supermarket. The traceable code is run during storage and sales of the segmented product and made available to consumers, revealing every piece of the pork's front information, including the fodder and health condition, through inquiry of the identification code. However, presently, it is only possible to trace each pork instead of specific parts of the pork. Figure 4 provides information on the ink mark number, traceability code, and slaughter.



**Figure 4.** Information on ink mark number, traceability code, and slaughter for company B

Data source: drawn by the author

#### 4.2.2 Status quo of front identification in company S

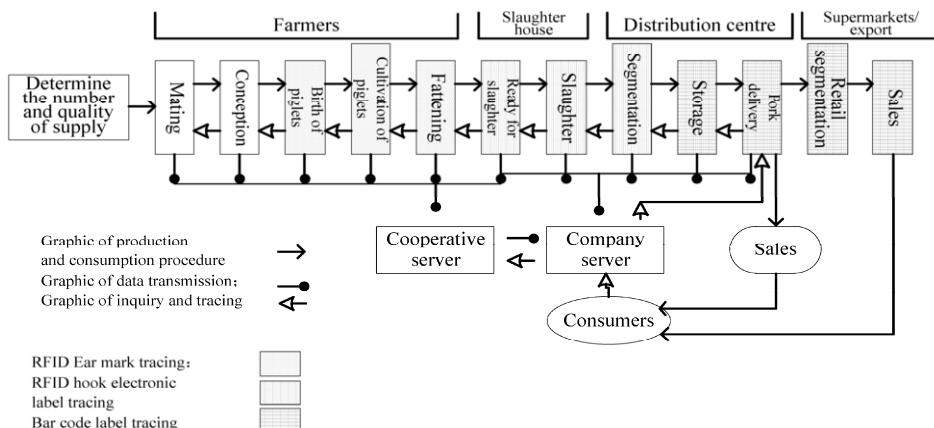
To guarantee the safety and quality of meat product from the source, company S adopts the ‘company + cooperative + farmers’ model and conducts ‘six unified links’ management with unified supply of boar, unified artificial insemination, unified fodder supply, unified veterinary drug administration and quarantine, unified technological service, and unified purchase of fat pork. Each farm conducts independent breeding and breeding in accordance with the regulation, operates closely, and benefits from purchase by the company at the conservation price.

Therefore, the pork traceability system in company S incorporates the following five parts: purchase, slaughter, processing, storage, and logistics. Information of the whole process is traced by an electronic ear mark through radio frequency identification devices (RFID). Company S also installed the safety traceability system in multiple hypermarkets for consumers to check detailed product information starting from the farm to the point of sale via traceability code scanning.

The electronic ear mark is a major type of individual identification of pork as it can trace each pork unit, and it also contains basic information of the farm. There are two stages in its front identification.

Stage 1 is from the birth of porklets to pork being ready for slaughter. Company S’ ‘company + cooperative + farmers’ model requires farm employees to organize RFID ear-mark printing on pork within a certain period after the birth of porklets during the breeding process. Member farmers from each cooperative will keep a record in the breeding file for casual inspection of the cooperative on the completeness and authenticity of information and for collection of relevant information.

Stage 2 covers the processes after the slaughter. The RFID electronic label is attached to the slaughtering line; when qualified pork enters the slaughterhouse, its RFID ear mark information is transferred to the RFID electronic label information on the hook, enabling effective synergy between front and rear identification (Figure 5).



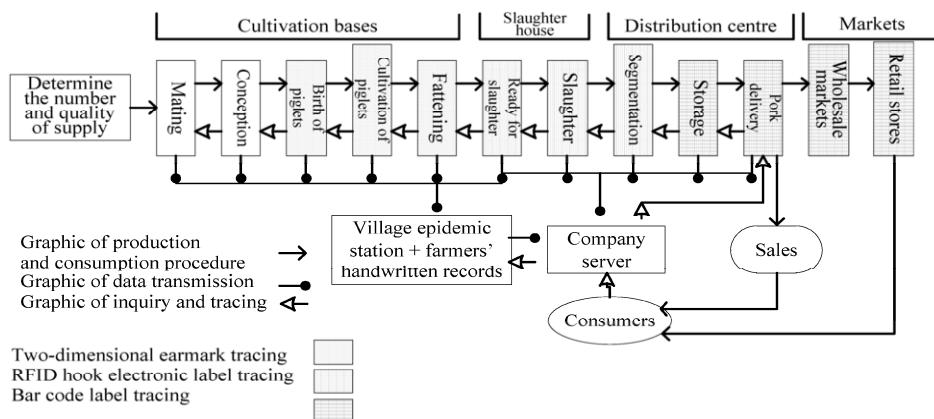
**Figure 5.** Flow diagram of the pig traceability system in company S

Data source: drawn by the author

#### 4.2.3 Status quo of front identification in company Z

In response to the call for establishing an animal identification and disease traceability system by the Bureau of Animal Husbandry and Veterinary Medicine in the county, company Z joined the first group of trial units to establish a relevant traceability system, using the ‘company + bases + farmers’ development model.

The information platform of company Z’s pork traceability system was freely developed by the Hangzhou Agricultural Bureau as part of the information management system on meat quality and safety in Hangzhou province, and it comprises breeding, slaughter, wholesale, and retail (Figure 6).



**Figure 6.** Flow diagram of the pig traceability system in company Z

Data source: drawn by the author

The two-dimensional ear mark serves as a major identification method of individual pork, which can be applied freely by the local epidemic station. This ear

mark type can trace down each pork, and there are two stages in its front identification management.

Stage 1 is from the birth of porklets to pork being ready for slaughter. The company practices collaborative breeding with farmers using the ‘company + bases + farmers’ model. During the breeding process, porks receive two-dimensional ear marks from the village veterinarians within a certain time after the birth of the porklets. During this process, individual farmers usually keep a handwritten record of information, including on introduction and breeding, whereas farmers at a certain scale record each piece of information through ear mark reading.

Stage 2 covers the processes after slaughter. After slaughtering of pork, company Z conducts purchase at the stated price. Nonlocal clients need to have three certifications—for exiting the county, animal origin, and vehicle disinfection (local clients only need to have certification of animal origin and vehicle disinfection)—to sell pork to company Z.

Qualified pork is put into the sty for slaughter by the staff, and it receives pre-test by the quality control staff of company Z. Pork passing the pre-test rests quietly for 24 hours at company Z, during which an ‘ID card’ (a small black card with a wireless microwave tracing system) is made for each pork and ‘dispatched’. After resting, the pork goes through the quarantine, slaughter, and segmentation production line with 18 links. From the production process to cold chain transportation to the end point, an information file for each piece of pork keeps record of the responsibility of the breeding source and the 18 links including quarantine, similar to an ‘ID’ profile.

When pork products reach the points of sale, consumers can check relevant information on the pork traceability query machine in the supermarket based on sellers’ names and products’ certification number on the receipt.

#### *4.3 Problems of implementing front identification of pig traceability system in three enterprises*

##### *4.3.1 Willingness to pay*

Company B is subordinated to the agricultural reclamation system with the pork traceability system as part of the requirement of the product quality traceability system project. Apart from the regulation by the agricultural reclamation system, company B stays committed to the idea of quality elevation of the black pork product as a whole through front identification of the pork traceability system, which guarantees safety of the primary pork product and is responsible to the consumer. Thus, company B shows strong willingness to implement front identification.

With increasing demand for consumer food safety, Company S began pork traceability in 2007 with the Shandong Standard Cooperative Research Institute. The system’s purpose is to improve the product quality and safety level, further enhance the company’s competitiveness, and avoid the trade barriers in developed countries. Therefore, company S shows strong willingness to implement front identification.

Company Z is the first pilot site for implementation of the traceability system. As the system’s economic effect is not obvious, the company’s willingness to implement front identification needs to be improved.

#### 4.3.2 Organization model

Company B uses the ‘company + bases + employees’ organization model of front identification implementation, even though the pork breeding business is managed by externally hired personnel with salary. The processes covering the labour room, porklet breeding, and grown-up pork are all under the control of company employees, along with unified fodder management, epidemic prevention and control, and fodder supply in accordance with strict standards. The recording and storage of the pork breeding file from the breeding link is completed by company employees, guaranteeing absolute control of all front breeding links as well as implementation and accuracy of the front identification of the pork traceability process. Moreover, the Bureau of State Farms and Land Reclamation conducts yearly spot tests at company B.

Company S uses the ‘company + cooperative + farmers’ organization model of front identification implementation. The cooperative was established by Livestock Science & Technology Co. Ltd. A company S subsidiary with the registered trademark ‘Ou De Lai’ (ODL). It has 3,500 member farmers and registered capital of 100 million yuan. The cooperative is based on the ODL brand and company S. When the cooperative signs the contract for pork breeding with its members, it pays with share capital as one of the members. The members’ investment methods include cash, storehouse, processing equipment, transportation equipment, intellectual property, other property rights excluding labour, credit, name of a natural person, business reputation, and assets with equivalent voucher.

The cooperative’s management model has the features of ‘six unified links, one ensured part’, which includes unified hog house design with standardized breeding, unified supply of pork lets; unified supply of fodder to ensure better quality supply at cheaper price under the unified fodder supply agreement; unified veterinary drug administration and quarantine to prevent disease outbreak with better quarantine; unified technological service that organizes monthly training classes on pork breeding skills since the cooperative’s establishment; and unified purchase of fat pork to make the business lucrative for farmers.

Company Z uses the ‘company + farmers’ organization model of front identification implementation. Famers must meet five standards to be selected: secondary education at least for farmhands; suitability of the hog house and surroundings for pollution-free pork production; design of farmland, orchard, and fish pond to ensure the scale of four porks per acre; relatively stable income flow; and regulation of pollution-free production by the company base.

#### 4.3.3 Cost and benefit of completing front identification

In Company B, the cost of completing front identification of the pork traceability system incorporates the following five categories.

*Machinery.* This includes two computers for Beijing black pork stock base; two computers for Beijing black pork breeding base; one computer for the black pork slaughter shop at the Beijing 5<sup>th</sup> Meat Processing Plant; one set of servers for the company, data centre, and delivery centre; five additional computers, counter tops, storage racks, and transit cases. All are acquired at 500,000 yuan from the Bureau of State Farms and Land Reclamation with no extra cost.

*Information platform development.* The unified organization of the Bureau of State Farms and Land Reclamation provides free access for a few years.

*Human resources.* The three collection points require an additional five to six people, but the cost can be ignored if the pork traceability system is linked to company management.

*Label.* This requires 0.03 yuan per paper. Cost of text recording and receipt printing, which is very low, can be omitted.

The black pork product of company B does not go through a drastic price hike because of the front identification of the pork traceability system, thus bringing no significant economic effect so far. However, according to the statistics of the points of sale at each hypermarket and exclusive shop, the sales volume of company B's pork product is on the increase, with the black pork brand taking up a certain market share and a prospect of further increase.

In Company S, the cost of completing front identification of the pork traceability system incorporates the following five categories.

*Machinery and human resources.* The company is already equipped through former adherence to the Hazard Analysis and Critical Control Points and thus has no additional need in these two categories.

*Information platform development.* This is provided free under the national '863' project at Shandong Institute of Standardization.

*Label.* This requires 0.03 yuan per paper. Text recording and receipt printing is done at very low cost.

#### *Cost of information storage and management.*

The pork products of company S are aimed towards markets both at home and abroad, with the company's brand taking up a certain market share with optimistic prospects of sales. With the increase in consumers' awareness of food safety, company S commenced cooperative efforts with the Shandong Institute of Standardization in 2007 for implementation of the pork traceability system. It accomplished front identification of the pork traceability system and aimed to further elevate the company's competitiveness to transcend the trade barriers from developed countries.

The management of front identification in company S can be expanded relatively easily. However, there are still problems: Under the leadership of the leading company, farmers, as the vulnerable group with generally low education, can become overly dependent and inclined to resort to speculation. Moreover, vast coverage of the bases results in incomplete supervision or high supervision cost to the company which is pushed on to farmers."

In Company Z, the cost of completing front identification of the pork traceability system incorporates the following six categories.

#### *Machinery.* This costs around 500,000 yuan.

*Information platform development.* The information management system on meat quality and safety is developed for free by the Hangzhou Agricultural Bureau.

#### *Label.* This requires 0.03 yuan per label.

#### *Two-dimensional ear mark.* This is provided by the state for free.

*Human resources.* Veterinarians with contracts with the village are selected through negotiation with the animal husbandry and veterinary medicine technological department in the county (in charge of the whole region).

*Paper.* Cost of text recording and receipt printing, which is very low, can be omitted.

In response to the call for establishing the animal identification and disease traceability system by the Bureau of Animal Husbandry and Veterinary Medicine in the county, company Z joined the first group of trial units to establish a relevant

traceability system. The economic gain is not significant until a certain period of operation, which reduced the company's willingness to implement front identification.

#### *4.3.4 Benefit allocation*

Company B's employees are in charge of black pork breeding. When short of hands, the company hires labour for front identification of the traceability system, but company employees still supervise them to ensure better quality. The employees are governed by the company's salary system, and the relationship between the two is stable and controlled.

Company S conducts unified purchase of fat pork from the cooperative's member farmers to provide them a decent profit. Of the surplus, the cooperative sets aside 60% as reserved funds for expanding production, covering deficit, or investing by members. Moreover, it uses 15% of the annual surplus as a public welfare fund for technological training; cooperative education; and support regarding culture, welfare, and livelihood. When the costs of production, operation, management, service, deficit coverage, reserved funds, and public welfare funds are taken out of the surplus, the member assembly decides on the refund based on the trade volume between members and the cooperative. The total refund amount should be at least 80% of the distributed surplus, while the remainder is rationed to the members' recorded accounts according to their contributions to the investment and reserved funds, as well as the per capita amount of direct national subsidies or donations from other parties to the cooperative.

Company Z is committed to sharing the profit and risk; providing unified fodder; ensuring proper vaccination, disinfection, and healthcare procedures; providing training and instruction on breeding and management skills; increasing the ration of fodder sold on credit with yearly increase in pork raising; and uniform settling of the account at delivery. The company sets a conservation price for pork purchase, allowing farmers to sell pork through their own channels or uniformly to the company (at conservation plus bonus price) when the market is at its peak, or to sell it at the conservation price to the company when the market is at its low.

However, farmers might forge or leave out information in the front identification process for the pursuit of individual interest, leading to an unstable relationship between the relevant parties.

#### *4.3.5 Expansion of front identification management of the pork traceability system*

When it comes to expansion of the management, company B sticks to the policy of independent breeding and breeding, using the organization model of 'company + bases + employees' for front identification implementation, which gives control of all the breeding links to company employees for unified management. The employees are better educated than regular farmers, and speculation of individual farmers can be nipped in time to ensure the completeness and authenticity of front identification information, thus cutting the surveillance cost dramatically. Company B, an affiliate of the agricultural reclamation system, has received decent funding and technological support from the higher authority; thus, it saved a large amount of investment cost.

However, the 'company + bases + employees' model poses some difficulties for expansion. The bases have a limited breeding field in Beijing, of which the scale is too small to drive the income increase for individual farmers and reach a desirable level of technology. If the breeding field is expanded, to different areas even, the small number

of employees can cause the management to easily fall apart, giving rise to incorrect front identification information among other problems. The company will find it hard to bear the additional heavy surveillance cost for complete management.

Coding rules of the front identification of company B's pork traceability system are formulated by the company itself, instead of following the national standard. This makes it difficult to ensure synergy with the information base of the follow-up slaughtering and processing companies, creating obstacles for expansion. The slaughter procedure of company B is outsourced to the Beijing 5th Meat Processing Plant, and the coding problem might cause issues in the alignment of the front and rear identification information of the pork traceability system, leading to dislocation of the identification of the system.

The management model in company Z is difficult to expand. Even though the company has signed a contract with farmers from the bases, there is still a large amount of extra cost for farmers to ensure standardized breeding. Farmers still can take initiative in selling pork and refuse to sell to the company. Company Z brings no punishment to the farmers, leaving them with the mindset of having the ability to take a chance and sell pork without sticking to the contract.

#### 4.4 Results of case comparison

Table 1 displays the comparison and differences in the front identification of the three companies. According to the case study of the three companies, the differences of the front identification implementation level lies in the aspects including the organization model of the front identification implementation subject, region, the scale of the farmer, education level of the farmer, economic level of the company, the cost and benefit of the company and farmer, the additional technological support to the farmer from the company, the risk expectation of the farmer, the company's supervision system on the farmer and the identification method.

**Table 1** The comparison of front identification implemented in three companies

Items	Company B	Company S	Company Z
If possible to trace to the front cultivation link	Yes	Partly	Partly
Business type	Cultivation (independently)	Group company -unified production, supply and sales (the cultivation is still outsourced)	Slaughter and process company (with the cultivation outsourced)
Organization subject of implementation subject	Company + bases + employees	Company + cooperative + farmers	Company + bases + farmers
Vertical cooperation level of the organization subject	Tight	Half-tight	Loose
Reporter of the front identification information	Employees	Staff from the cooperative	Epidemic prevention workers from the village
Subject of front identification information record	Employees	Cooperative members	Farmers
Education level of the subject recording the information	College	Vary from primary to high school	Vary from primary to high school

Subject's willingness to record the information	Willing to	65% of the members find it necessary, while the rest don't	A small part of the farmers are willing to
Technological instruction from the company	Yes	Yes	Yes
Boar, veterinary medicine and fodder from the company	Yes	No	Partly
Management model of the front identification	Unified management	Not sure if it is unified	Not sure if it is unified
Carrier of the front identification	Earmark + ink mark	RFID earmark	Two-dimensional earmark
Type of cost	Internal management cost	Transaction and contract cost	Transaction and contract cost
Transaction cost	Low	Average	High
Organization cost	High	High	Low
Cooperation	Strong	Average	Low
Stability	Strong	Average	Low
Motivation for adjustment	Organization planning	Negotiation, multi-player game	Market supply
Risk on farmers	Low	Average	High
The stability of farmers' income	High	Average	Low
Farmers motivated by the whole cause	Few	Many	Many
Level of the organization, socialized labor division and intensive usage of resources of the pig industry	Low	High	Average
Completeness of the front identification information	Complete	Incomplete	Incomplete
Authenticity of the front identification information	Authentic	Not sure	No sure
Supervision model of the company	Cyclic	No	Spot check
The reward and punishment system of the company	Yes	No	No
Company location	Central	East	West
Pig source	Company	Company + purchase	Purchase
The subjects in the front and rear links	One-to-one	Many-to-one	Many-to-many
Company scale	Medium	Large	Small
Difficulty of implementing the front identification	Easy	Difficult	Difficult
Implementation level of the front identification	Good	Average	Poor

Data source: drawn by the author

## 5. Conclusions

(1) The organization model of front identification of pig traceability system plays an important role in front identification management. “Company + bases + employees” is the most conducive to the completeness of the front identification, but also very difficult for expansion.

Among the three companies, the front identification implementation of company B's pig traceability system is relatively better than the other two, due to the “company + bases + employees” model adopted in company B, providing a closer vertical cooperation of the implementation subject and exerting stricter restriction on employees to complete the front identification thoroughly, and the operation throughout the cultivation process uniformly and normatively. Moreover, the company possesses employees with higher level of education, so as to fill in and upload the cultivation information and date correctly and timely, without reporting false information or incapability in handling the equipment. The only shortcoming lies in the synergy system between the front and rear identification, which can be compensated from the practice of company S. The model used in company S, however, creates some difficulties for expansion, since its bases are only located in Beijing with relatively small scale, and limited ability to boost the income and skills of the individual farmers. Once the scale of pig cultivation expands to even different regions, the lack of employees will give rise to porous management, with the abovementioned problems such as fake front identification information. The complete management requires large amount of extra supervision cost, which can be tricky for the company.

(2) “Company + cooperative + farmers” is relatively suitable for expansion among the models of front identification management.

Company S has the better front identification implementation in comparison with company Z. The model “company + cooperative + farmers” adopted by company S might has the principal-agent problem, but the front identification can still be improved with stricter management. What's more, farmers raising pigs in China are mostly disperse with small scale, and this model can help introduce more farmers of this kind into the front identification of the pig traceability system, therefore it is regarded as more suitable for expansion.

(3) Apart from the organization model, there are multiple factor affecting the front identification implementation of China's traceability system, including the education level of the implementation subject, identification technology and method, the company scale, the traceability notion of the heads of the company, and the location of the company as important factors, directly proportional to the implementation level of the front identification of pig traceability system.

A tight organization model of the implementation subject of the front identification, high education level of the farmers and heads of the company, a better pig traceability notion, an identification method with advanced technology and company at large scale are all the requirements of a complete front identification of the pig traceability system.

The promotion of front identification of pig traceability system is a work requiring incremental effort. Presently the farmers and companies lack relevant understanding, and based on the Chinese national condition, starting from the easier part, and giving a leading role to the companies as demonstration to influence the whole region eventually. At the same time, as a developing country with a large population, the

implementation of pig traceability system not only improves the level of food safety in China, but also provides reference for other development in the world.

## Acknowledgments

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# Development of Entering and Reporting Registration System Platform of the CAU Library in COVID-19 Epidemic Period

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**Abstract.** This article elaborates briefly development of entering and reporting registration system platform according to the requirements of the CAU Library to prevent and control the epidemic COVID-19. The development of the system are extremely significant in supporting the teaching progress of the university and protecting the users on the campus. It has clarified the system development principles and implement methods used in developing the system for facilitating the prevention and control of the epidemic COVID-19 on the campus including good compatibility, comprehensive user management permissions, perfect business processes, multi-mode login, and custom entering record data output. Based on the B/S model, various open source technologies such as LAMP architecture, Bootstrap and LayUI framework, AJAX technology, JSON data exchange format, combined with QR code technology are mainly adopted in developing the system after literature review. The major system functions are realized by five functional modules: user login, application management, QR code management, entering library record management and system management. Each module carries out strict operation control according to different use-permission of users. Compared with the traditional manual record management mode, the research result shows that compared with the traditional manual record management mode, the platform management mode of the library entering and reporting registration system has the advantages of high efficiency, convenience, accuracy and reliability which achieved 100% of the library entrance registration. Because of its strong practicability and high expansibility, it has been widely adopted by other colleges of the university and achieved very good expected results.

**Keywords.** Reporting and registration system; LAMP; WeChat authorized login; Responsive webpage; Quick respond code technology; LayUI

## 1. Introduction

The COVID-19 has been spreading since the end of 2019. There were 10,719,946 confirmed cases, including 517,337 deaths, reported by World Health Organization (WHO) till the end of June, 2020 [1]. Currently, the entire world is struggling against the virulent pandemic COVID-19. Everyone is witnessing the unbounded global spread of the disease. The pandemic has brought a revolution not only in the online teaching of higher education but also in the effective ways academic libraries can deliver their

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services virtually [2]. Libraries need to leverage their position as a primary source of trustworthy information by providing quick and easy access to those looking for credible information about what to do in an emergency [3]. In order to implement the China national policy guidelines for the prevention and control of the epidemic, China Agricultural University (CAU) urgently issued relevant policies to strictly control the returning of its staffs and students to the university and implemented closed management at the university.

As one of the important service departments of scientific research and education activities in universities, the library is also facing huge challenges during this epidemic prevention and control work. It is necessary to provide resource services for students of various departments in a timely manner, and also to resolutely undertake epidemic prevention and control to avoid cross-infection caused by personnel gathering and book borrowing. To this end, the China Agricultural University Library has carried out a comprehensive and meticulous deployment. One of the most important tasks is to develop a library entering and reporting registration system to provide basic guarantee for the daily management and operation and maintenance of the library. It has realized various functions such as personnel identity verification and entering registration approval as the system combines the computer and mobile terminals. Many technologies have been chosen for the development of this system, such as: LAMP, Responsive webpage, Quick respond code technology and LayUI etc. The advantages of the system clearly shows that the data of entering and leaving the library can be traced, checked and controlled, and the system is convenient and fast to use and manage.

This automatic management alternative has been adopted by many other colleges of the university which has effectively replaced the inefficient manual management model. This article comprehensively summarizes the design, development and practical application of the system.

## 2. Literature review

### 2.1. Software architecture

Browser/Server (B/S) mode and Client/Server (C/S) mode are two commonly used software development modes. In order to build an efficient, sample and convenient system of face recognition based on the video streaming, a mixed mode of software development is proposed in this research. Although some experts think mixed of B/S and C/S modes makes a system more flexible and convenient for user to use [4]. However, C/S mode is more suitable for LAN, special software needs to be installed in the client, so the cost of maintenance and upgrade is high. B/S mode is a kind of network structure mode, which can be realized by only one browser without installing the client. The installation and operation of the system are all operated on the server. B/S mode has the advantages that C/S mode can't compare with [5].

LAMP architecture is a combination of Linux, Apache, PHP and MySQL which is used under B/S mode. It is a popular web development architecture widely used in the world at present. Its web components include Linux operating system, Apache network server, MySQL database and PHP server scripting language. All components are open-source free software. Compared with Java EE and asp.net, LAMP architecture has

higher performance, lower cost, faster development speed and more flexible execution [6].

### *2.2. Bootstrap and LayUI front-end framework*

Response web design was proposed by Ethan Marcotte, a famous web designer, in 2010. Its design concept is that the design and development of the page should respond and adjust according to the user behavior and the equipment environment (system platform, screen size, screen orientation, etc.). In short, it can automatically adapt and recognize the screen size, so as to adjust the appropriate web page, which can be normally displayed on any device or on each terminal [7]. The so-called front-end framework refers to gathering of a series of productized HTML/CSS/JavaScript components. Using the front-end development framework, developers can use the least effort to create responsive websites that meet user requirements, making the whole development process simple and consistent. The Bootstrap framework has a complete set of basic modules, predefined style sheets, etc. Among them, the global grid system is responsible for the adaptive matching of display terminals of different sizes and resolutions, to ensure that the display content is presented to users in a clean and smooth manner, and to bring good experience to users [8].

Bootstrap has beautiful style and well packaged plug-ins, which is more suitable for page design, but in terms of data interaction with back-end servers, compared with the domestic front-end LayUI framework, it appears to be somewhat bloated and slow. The LayUI framework is a front-end UI framework written with its own module specification. It follows the writing and organization form of native HTML/CSS/JS. Driven by the document object model, a large number of program interfaces are built in to realize the front-end and back-end data interaction. It really achieves more functions with less code. Using it to develop the front-end data interaction can greatly shorten the development cycle, improve development efficiency [9].

### *2.3. AJAX technology*

Asynchronous JavaScript and XML (asynchronous JavaScript and XML for short, AJAX) is a web development technology that creates interactive web applications. If the traditional web page needs to update the content, it must overload the whole web page, which is easy to increase the server load. When the data volume is large, the user friendliness will be greatly reduced. AJAZ technology's application in library system, implements asynchronous data transmission in the case of no page refreshing, enhances interactive of network teaching resources library system, and improves the efficiency of the network teaching resources server [10]. By using AJAX to exchange a small amount of data with the server in the background, the web page can be updated asynchronously, that is, the whole web page will not be reloaded, and only the local information of the web page needs to be updated as required, so as to achieve faster and friendly response to user operations [11].

### *2.4. JSON data format*

JavaScript object notation (JSON for short) is a lightweight data exchange format with good readability and fast parsing features. JSON file is a common text file, which can be edited by using common text editor. The back-end program extracts and sends various data of different structures from the database. As long as it is converted to

JSON format, it can be directly used to write some parts of the web page. At the same time, the analytic speed of JSON in browser is very fast, which can effectively improve the system efficiency [12].

### 2.5. QR code and its RSA anti-counterfeiting technology

QR code is a kind of black-and-white figure that storing data symbol information in horizontal and vertical directions according to certain rules. It uses a certain geometry figure on the basis of one-dimensional code. QR code has the advantages of representing a variety of text information such as Chinese character image, large storage capacity and strong reliability [13]. Theoretical perspective studies in [14] outlined that QR code is one of technologies that could be applied in library management system. It has been suggested that the use of QR code for library offer some advantages involving such as fast process, able to store big data, uses standard technology (only camera to percept the code), which can be used by user without specific skills. So it would be able to enhance service quality such as to shorten borrowing or returning transaction as well as increasing security of the books from theft in low cost.

Because QR code itself does not have anti-counterfeiting ability, in order to ensure its security, QR code and RSA anti-counterfeiting technology are better combined to make it having a high anti-counterfeiting ability. RSA algorithm was proposed by Ron Rivest, ADI Shamir and Leonard Adleman in 1977, which is called RSA algorithm for short. It is a relatively mature and perfect public key cryptosystem so far, and a typical representative of asymmetric cryptosystem. It is widely used in many aspects in network development and information security [15]. QR code of the system is completely encrypted by RSA, which makes the operation convenient, fast and efficient, while maintaining high security.

### 2.6. LayUI excel component

The downloading of files can be simply divided into two ways: fixed link downloading and dynamic program downloading. Because of the single target resources, the fixed link downloading cannot meet the system requirements, while the dynamic program downloading can be flexibly downloaded and output according to different needs, which is widely used at this stage. The traditional dynamic program download includes back-end download and front-end download according to the different location of Excel file generation. Back-end download is a more extensive way of data output and download. Its principle is that the back-end program uses the corresponding operational programs to generate Excel files in the server according to the condition settings, and then returns them to the browser in the way of data flow for export and download. The principle of this method is simple and clear, but the actual operation is relatively cumbersome and consumes server resources, which will have a harmful effect on server performance.

The realization of front-end download is based on LayUI Excel, the export component base of LayUI framework. It is a relatively simple, flexible and powerful open source component in the existing front-end operation Excel files. In the process of data export and download, less server resources are used. The back-end is only responsible for returning JSON format exchange data. The front-end LayUI excel component extensions is responsible for data format conversion, style and Excel file

generation and download. After testing, it takes about 7 seconds [16] to output 100,000 items with 9 columns of Excel data, which is the best download and output solution that meets the needs of the system.

### 3. Methods

#### 3.1. Demand analysis

With continuous mitigation of the domestic epidemic in China, especially in Wuhan, Hubei province, was lifted the lockdown, thousands upon thousands of people return to Beijing. It is necessary to carry out preliminary examination and approval of the whereabouts of the users whom entering the library, and to record detailed and qualified physical conditions of them in order to strengthen the library entering management. Most of the traditional management methods are manual records by filling out paper application forms, which was time consuming and inefficiency. All of them involve a lot of data management, search and statistical analysis. Each task requires a lot of manpower, material resources and time cost to complete, and the completion effect has yet to be tested. Such a management method not only has low efficiency, but also easy to have human error sometimes, which cannot meet the actual needs of personnel information management during the current epidemic period of time. So, an effective and quick tracing system is particularly needed during the epidemic period at the university. The system is required to be flexible and friendly to manage and update all the basic information of users entering the library, such as whereabouts registration and verification of the 14 days before the first entering of the library, and records of physical temperature and health status when entering.

Through detailed demand analysis and in-depth research for solving the above problems, China Agricultural University library has specified the functional requirements for the development of the library entering and reporting registration system platform, which mainly include a system interface with strong compatibility and good user experience; strict and complete user rights management; detailed application form and perfect business process; support multiple ways to log in; custom batch export data of library records and other functions.

##### 3.1.1 A system interface with strong compatibility and good user experience

Due to uncertainties in the personal schedule and use of library equipment during the epidemic, sometimes only a small number of people use computers and most of users will use a variety of mobile devices such as Pad or mobile phones. Therefore, compatibility issues should be fully considered to provide users with a friendly system interface compatible with different browsers and screen resolutions at the beginning of system development.

##### 3.1.2 Strict and complete user rights management

The users of the system mainly consist of managers, teachers, researchers and students, as well as other staffs. Strict authority management must be adopted to set different operation authorities for different types of users considering the security needs of the system. The administrator has the maximum authority and can set different usage rights

for different users, such as: whether may apply for library entering, or have approval authority, effective use period of quick respond code (QR code), blacklist setting, etc.

### 3.1.3 Support multiple ways to log in

Users need to log in to the system using mobile phone and present the QR code when they pass the application review and prepare to enter the library. The traditional login method of accessing to the library website is tedious and error-prone as the user name and password were required to fill in. Based on the library's WeChat public account, combined with WeChat's "sweep" function for WeChat authorization login. It is easy to operate, accurate and efficient, and at the same time it conforms to the characteristics of public behavior. Thus, it is the best way to log into the system. WeChat authorized login is a WeChat OAuth 2.0 authorized login system built on WeChat OAuth 2.0 protocol standard. It can be used to quickly and securely login to third-party applications or systems through WeChat [17]. This method can be used as an effective supplement to the system login.

### 3.1.4 Custom batch export data of library records

Users system administrator needs to download and export the record data of users entering the library within a certain period of time and submit the records data according to the relevant requirements of the superior management department. Therefore, the system must have the function of batch export of data, which can be filtered and retrieved by user-defined multiple retrieval conditions, such as date range, user type etc., and batch export data set records to Excel file according to the retrieval results.

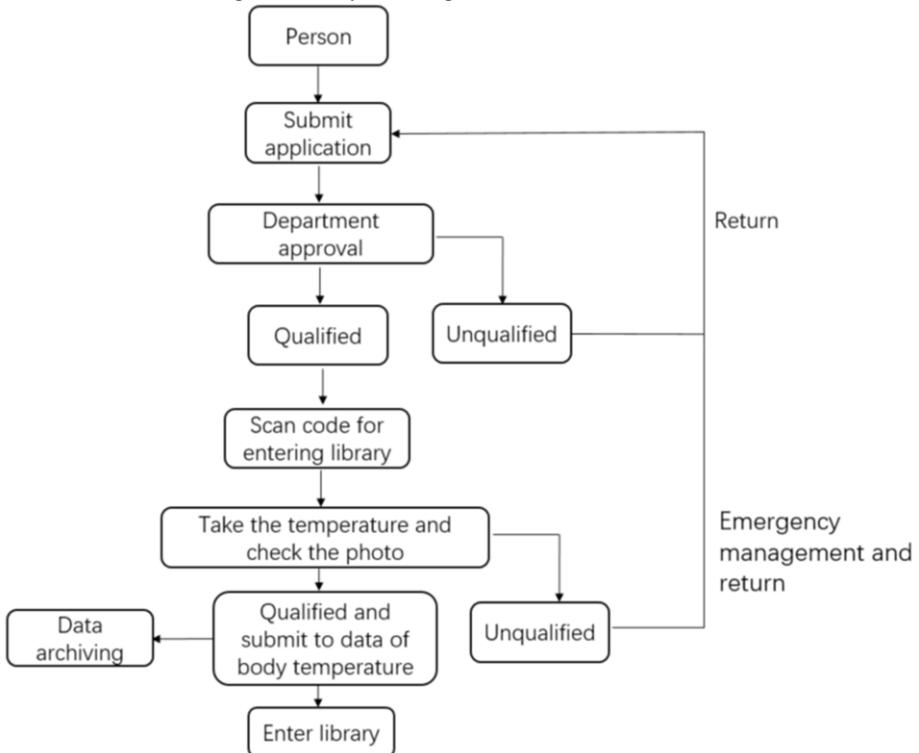
## 3.2. System design

In order to collect data and monitor the various function of the system in real time, the scheme of data visualization interface for library entering and reporting registration system is proposed based on the combination of front and rear end technologies of Internet. The system has realized various system functions by using the structural characteristics of B/S mode with the LAMP architecture design pattern. Bootstrap and LayUI front-end framework are used to realize responsive web page design. AJAX technology is adopted for data exchange at front and back ground of the system. JSON data format is adopted for heterogeneous data exchange between front and back end of the system. QR code and its RSA anti-counterfeiting technology are implemented. Download and export technology of front-end Excel data file based on LayUI excel component are also utilized.

### 3.2.1. Detailed application form and perfect business process.

The different types of users entering the library need to be managed differently during the epidemic period. Especially for those who return to Beijing from areas where the epidemic is serious. It is necessary to grasp the information of returning to Beijing in a timely manner, accurately grasp the isolation and physical condition information before one entering the library. "Library Entering Application Form" is required to be filled in details and submitted through the system. The application needs to be reviewed by the superior, QR code needs to be scanned after passing the review before entering the

library, physical temperature will be measured and recorded (all personal temperature records need to be kept on file for reference), and finally personal photo will be checked before entering the library (see Figure 1).



**Figure 1. Flow chart of admission approval.**

### 3.2.2. System functions design.

According to the needs of the epidemic situation, the system mainly includes five functional modules:

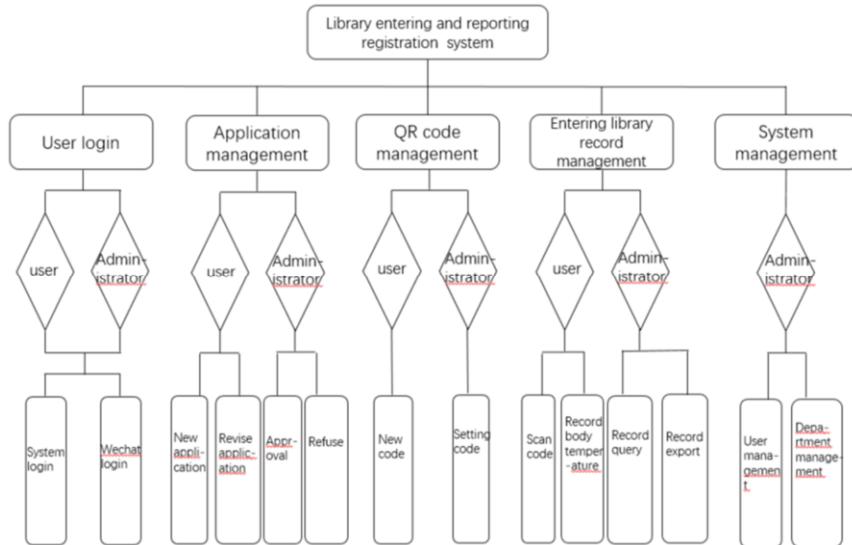
- user login,
- application management,
- QR code management,
- entering library record management,
- and system management.

Each module carries out strict operation control according to different user permission of users. And sub modules for each module have been designed and developed as the following:

- the user login module includes two sub modules: system login and WeChat login;
- the application management module includes four sub modules: new application, revise application, approval and refuse;
- QR code management module includes two sub modules: new code and setting code;

- entering library record management module includes four sub modules: scan code, record body temperature, record query and record export;
- and the system management module includes two sub modules: user management and department management.

The system function design block diagram can be seen from figure 2.



**Figure 2. System function design block diagram.**

## 4 Results

In this part, four functional sub modules which include WeChat login in the user login module, new code in the QR code management module, scan code in the entering library record management module, and batch export of record data to Excel file have been taken as examples to illustrate the implementation of this system.

### 4.1. Database table design

The design of database table structure is an important step in database development. Whether the model structure design is reasonable directly affects the efficiency of subsequent program development. According to the business process and specific requirements of the system, database tables such as user information table, application information table, QR code information table and entering library information table should be established in the database. Taking "user information table" as an example, the "user information table" is used to record the basic information of all users entering the library (see Table 1).

**Table 1. User Information Table**

Field name	Field type	Null	Constraint	Explanation
uid	varchar(50)	no	primary key	staff id
uname	varchar(50)	no	/	name
password	varchar(50)	no	/	password
cellphone	varchar(50)	no	/	mobile phone

utype	int	no	foreign key	user type
typename	varchar(50)	no	/	type name
labid	int	no	foreign key	team id
labname	varchar(50)	no	/	team name
depid	int	no	foreign key	department id
depname	varchar(50)	no	/	department name
application	int	no	/	application or not
lab_lead	int	no	/	leader or not
lab_right	int	no	/	department approval auth
dep_lead	int	yes	/	department leader
dep_right	int	no	/	department approval auth
admin	int	no	/	administrator
photo	int	yes	/	photo image
status	int	no	/	status

#### 4.2. Website form design of “application form for entering the library”

For users first time entering the library, they must fill in and submit the application forms. The contents of the application form include: the location in recent 14 days, the physical condition of the recent 14 days, whether he/she has been to Hubei area in recent 14 days, whether he/she has been exposed to the person in Hubei area, and whether he/she has contacted the person of the Covid-19 and so on (see Figure 3).

Figure 3. Application form for entering the library.

#### 4.3. Realization of system functions

##### 4.3.1. Realization of login function based on WeChat authorization system.

The key to login through WeChat is to get the OpenID of users. OpenID is the only sign of users under WeChat official account. With the help of the WeChat official account of the library, OpenID can be verified, and the authorized login system of WeChat can be realized. The specific steps include: (1) Generation of login QR code. According to the authorization interface provided by WeChat, the following URL is generated:

[https://open.weixin.qq.com/connect/oauth2/authorize?appid=wx4c4af2cf65b36bc2&redirect\\_uri=http%3A%2F%2Flibwx.cau.edu.cn%2Fgetopenid.php&response\\_type=code&scope=snsapi\\_base&state=123##wechat\\_redirect](https://open.weixin.qq.com/connect/oauth2/authorize?appid=wx4c4af2cf65b36bc2&redirect_uri=http%3A%2F%2Flibwx.cau.edu.cn%2Fgetopenid.php&response_type=code&scope=snsapi_base&state=123##wechat_redirect). And convert this URL to QR code as login QR code. (2) User scanning code to login. Users can login to the system normally after passing the validity verification by scanning the WeChat code.

The realization of the function of generating QR code for entering the Library. After users login to the system by mobile phone, the system will automatically adapt to the resolution of the mobile phone, and automatically shrink the system menu bar to a pull-down menu bar. After clicking the button of "scan code to enter the library", the system will pop up the "enter the library QR code" window. This QR code is the only anti-counterfeiting QR code generated by RSA algorithm.

#### *4.3.2. Realization of the security client's function of scanning code and submitting body temperature.*

After security personnel scanning the anti-counterfeiting QR code, measuring the body temperature, checking the photos, and submitting the temperature information, the user may enter the library.

#### *4.3.3. Realization of batch export Excel file function of entering library record data.*

The batch export of record data in this system adopts LayUI Excel extension component, which generates Excel file and downloads it asynchronously through front-end technology AJAX, and the back-end program is only responsible for outputting corresponding JSON format data.

## 5 Conclusion

The development of the entering and reporting registration system platform of the CAU library has made full use of a large number of open-source frameworks and technologies after literature review, realized the functions of supporting the online use of a variety of client devices in the way of traditional web applications combined with mobile terminals, and ensured the timely and accurate information tracking management of the users entering the library in a special epidemic period. The system has the characteristics of high security, strong practicality and high scalability.

Since the system has put into operation, it has recorded and summarized all kinds of user information in detail during the epidemic period. It has achieved 100% of the library entrance registration. By the middle of June 2020, more than 2,300 user records have been leading into the system, with more than 2,700 users recorded for entering the library in total. On average, nearly 100 users enter the library each day.

The use of the system reduces the probability of personal contact, simplifies the process of manual management, improves work efficiency, and provides convenient conditions for follow-up information tracking, statistics and analysis. In addition to the CAU library, the system is also accepted by other departments and colleges at the University with excellent feedback from all of them.

With the increasing number of users registering to the system platform, the system functions still need to be optimized. For example, some functional modules of the system should be improved and modified according to the needs from different departments/colleges, adding the functions of request for withdrawal and verify refuse,

the user-defined setting of QR code aging, the further refinement of user rights management, and the further strengthening of art design etc.

The development and utilization of the system platform for the CAU library will meet the actual needs of epidemic prevention and control in current special epidemic period, and play an extremely important role in ensuring the smooth progress of the scientific research, teaching and personal safety of staffs and students at the university.

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# Research on the Path of Data Literacy Cultivation for College Students

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**Abstract.** The theoretical and practical achievements in domestic studies on data literacy are summarized by bibliometric analysis and network investigation in aspects of the connotation of data literacy, requirements of data literacy, assessment of data literacy and education of data literacy with suggestions proposed for working out the policies of data management and data literacy education, implementing the embedded data literacy education, designing the data literacy teaching contents and constructing the data culture.

## 1. Introduction

The number of various data in the public domain has increased exponentially under the background of big data, and the data has begun to have a profound impact on people's behavior and decision-making. As a standard of basic consciousness and basic ability to measure social and personal data processing, data literacy has increasingly become a key issue of the whole society, in which college students come into contact with and use data more and more frequently. It has become the main body of the provision and social data in the future, and its level of data literacy also determines the development and progress of the whole society. How to improve the data literacy of college students has become an important problem that colleges and universities are facing.

## 2. The significance of improving data literacy of College Students

Scholars at home and abroad do not have a unified definition of data literacy. Foreign scholars generally believe that data itself should be interpreted in a general way, for example, data literacy refers to the ability to master different measurement methods, process different types of data and draw correct conclusions in scientific research [1]. Calzada and other scholars believe that data literacy refers to the ability to acquire, understand, critically evaluate and manage data, and in this process, they should have the awareness and ability to abide by the moral norms [2]; Koltay believes that data literacy not only refers to the ability to obtain data and make critical evaluation and use, but also includes the ability to discuss the relationship between data lit-

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eracy and other literacy [3]. Different from foreign scholars, domestic scholars tend to think and express data literacy from the perspective of ability. For example, Huang Ruhua believes that data literacy is an extension and expansion of information literacy, mainly including data awareness, data ability and data ethics [4]; Meng Xiangbao believes that data literacy refers to the ability to use data resources to find, analyze and solve problems in the era of big data [5].

Combined with previous research results, from the perspective of talent cultivation in higher education, we can express data literacy as, which refers to people's ability to effectively discover, evaluate and use information and data. As China's higher education under the guidance of the fundamental task of moral education, how to cultivate and realize the all-round development of students is an issue of The Times. As a new era, data literacy is in urgent need of students' ability, which should be attached importance to and planned by colleges and universities.

At the same time, students should also be trained to have certain professional ethics of big data, and not to do things that violate professional ethics. On this premise, students should constantly improve their big data information processing skills [6].

### **3. The current situation of College Student's data literacy**

#### *3.1. The level of data awareness is low*

Data consciousness refers to the process in which human brain makes judgment on data information and connects with the actual situation by analyzing the deep connotation of data information. Some college students think one-sided that data is a simple number and do not establish a preliminary data awareness[7, 8].There are also some students who can realize that data is more information-based than digital, but they can not fully analyze the essential difference between the two.Some students think that data is just interrelated digital information, and there is no essential difference between them.

#### *3.2. Data processing capacity is relatively weak*

Data processing mainly includes data collection, data arrangement, data expression and data analysis. From the overall analysis, today's students lack of theoretical cognition, of course, this is also a learning process, which can be improved through learning. However, through practical analysis, we found that the neglect of data collection ability makes students lack the ability to organize and select data, and can not effectively summarize the collected data. Furthermore, it seriously affects the ability of other parts of data processing, making the weak data processing ability become a common phenomenon of college students.

#### *3.3. The lack of communication ability*

In the time of big data demands the data processing ability of contemporary college students. First of all, college students should have the ability of data analysis and prediction. Secondly, college students should have the ability to integrate information. After analyzing and summarizing, they can share their analysis results with others to

ensure the accuracy of data and information. Finally, we should have a certain ability of official document writing, which can transform the data information into text, and accurately reflect the data relationship and information logic. But the common problem of college students is that they lack the ability to transform information into words, and can't communicate data effectively.

#### **4. The influencing factors of college students' data literacy**

##### *4.1. Information dimension factors*

In the absence of current education, college students obviously lack sufficient understanding of the types, USES and main data platforms of data, and they cannot carry out relevant data activities in a targeted way when data demands are generated. What has attracted special attention is that data ethics and data security have not been paid enough attention to, and academic misconduct in all kinds of public opinion events has aroused wide attention and intense discussion in all sectors of society, which should be paid more attention to by colleges and universities.

##### *4.2. Information technology factors*

With the improvement of information retrieval methods and the development of various search engines, the acquisition of data information is no longer as difficult as before, Students can obtain the data they need in a variety of ways. On the contrary, the data analysis software and platform generally have a certain threshold, in front of the skilled use level usually need to be constantly learning and practicing, Python and R language, for example, to master such a new data processing programming language learning cycle, generally in two to three months above, therefore in the process of the improvement of data quality, the need of the two kinds of ability are more energy and resources.

##### *4.3. Information environment factors*

Data infrastructure is the premise of developing and receiving various data literacy education. Only by gaining access to various hardware and software, data literacy can be improved. At present, due to the protection and reward of intellectual property rights and labor achievements, most legitimate software and platforms are charged. These fees are generally relatively high for students. If schools fail to provide students with appropriate access to use, students will lose interest in using or even choose pirated software.

#### **5. The path of cultivation of college students' data**

##### *5.1. Strengthen the safety awareness in order to enhance data intelligent*

Protection ability in data quality education should strengthen the cultivation of student's data security first, using the data of beginning and let students form the habit

of scientific, accurate, standard, because if you don't have enough safety protection consciousness and measures, light lead to loss of data, or lead to property are violated, can be installed by local backup, the cloud remote backup, security scanning software means to ensure that data is not because the physical or network virus attacks and damage or loss, gradually develop students with data analysis, management and decision Thinking habit of big data to improve students' data intelligent protection ability.

### *5.2. Set up data analysis course to improve students' data processing ability*

Colleges and universities should strengthen the training of teachers, offer courses such as data analysis and data mining to improve students' data literacy, and provide a variety of teaching projects, including thematic lectures, flipped classes, MOOC, etc. Many world-renowned institutions of higher learning pay attention to the development of data literacy education, such as Purdue University Cornell University, University of Minnesota and University of Oregon jointly carry out the data information literacy project (DIL), analyze the requirements of graduate data literacy education in different disciplines, and take effective measures to meet these requirements; Peking University, Zhejiang University and Fudan University all carry out data literacy teaching courses online and offline, covering data retrieval, data statistics, data software operation and data analysis, etc., in a flexible and free form. The development of cloud computing and big data technology has changed the speed and environment of data transmission. Therefore, the course system of data analysis should be optimized to meet the diverse data processing needs of students.

### *5.3. Create an ecological environment conducive to improving students' data literacy*

As the base of cultivating high-level talents, colleges and universities should strengthen the construction of digital teaching environment, build a big data resource platform, provide new data products and data analysis technology, and create a good objective environment for the improvement of students' data literacy. At the same time, colleges and universities should strengthen the investment of funds, such as purchasing copyrights such as genuine software and database, and provide students with free use rights, so as to avoid the lack of data literacy caused by objective factors. In this process, teachers and students can also set up a data literacy communication team, create a sharing and collaborative communication atmosphere, take the relevant projects of data analysis as the guide, cultivate students' data analysis and processing ability, decision-making ability and innovation ability in the face of practical problems, and jointly promote the improvement of data literacy of college students.

### *5.4. Make data literacy assessment for students according to the characteristics of their majors*

Different majors have different emphasis on the data literacy requirements of college students. In addition to their abilities of data acquisition, analysis, selection and utilization in the general sense, students majoring in data mining and analysis, data marketing and other majors will have higher requirements on data literacy in the future. According to the professional characteristics, the data literacy evaluation standards of

college students are formulated and evaluated. First, the current situation of students' data literacy can be understood. Second, it can make students change their data concept, form scientific data thinking, and improve the understanding of data ability through evaluation. Thirdly, it can evaluate the effect of data literacy training in a certain stage in a timely and effective manner, and then adjust the training objectives and strategies in the next stage.

## 6. Conclusion

We need to learn from the successful experience of foreign countries, actively explore the content and model of data literacy education, continuously optimize the curriculum system, actively carry out data literacy education, which needs coordination and mutual assistance, unified planning, long-term cooperation, so as to achieve the long-term and stable development of data literacy education. Data literacy education is not a one-way indoctrination process, all kinds of opportunities can be created to achieve their own data literacy driven by scientific research, learning and life needs.

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# Review of the Application of Social Media Data in Disaster Research

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**Abstract.** Social media data (SMD) is a new data source in disaster research, which can be used in hazard identification, disaster analysis, risk assessment and emergency rescue. This data-driven disaster research needs to find an appropriate method considering the aspect of data sensitivity. So far, the research in this area is focused on the types of hazard, but rarely considers the relationship between the technical methods and applicable tasks. By emphasizing data and method dependencies, we have attempted to summarize the characteristics of SMD in disaster research, *viz.*, “sociality, rapidity, subjectivity, and un-authenticity”, and explore the processing methods in the applications of disaster management. Our work provides ideas and reference to the researchers working in this area from the perspectives of data and research goals.

**Keywords.** Social media, disaster research, data mining

## 1. Introduction

Disasters caused by natural hazards are receiving increasing attention globally. They cause enormous casualties and huge economic losses, and adversely affect social stability. Simultaneously, social media popularity for sudden major disasters has also surged. Many individuals employ social media as an effective channel for timely accessible information in emergencies. Government agencies and departments also use social media to disseminate and communicate crucial information in emergencies [1]. Social media data (SMD), as a typical type of big data, is featured with massive data scales, rapid data flow transfers, diverse data types, and low-value density. It can benefit for the whole process of disaster management by quickly obtaining the disaster

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information, identifying the scale and location of relief in near real-time, as well as by providing vital information on disaster recovery. This can provide a potential direction for customizing the emergency response, disaster rescue schemes and planning for reduction of the disaster risk in various disasters.

Currently, the SMD-based disaster research is receiving growing attention. However, the existing research in this field is mostly summarized from the perspective of the types of hazard [2][3]. Additionally, the perspective of the applicability and effectiveness of data and methods has not been extensively studied. In this pursuit, we aim to systematize the knowledge about the SMD-based disaster research in recent years, emphasizing the characteristics and processing methods of SMD for disaster research. We hope our work can provide a reference to the researchers working in the area of SMD-based disaster research.

## 2. Methodology

We employed two different approaches to investigate the application status of SMD in disaster research.

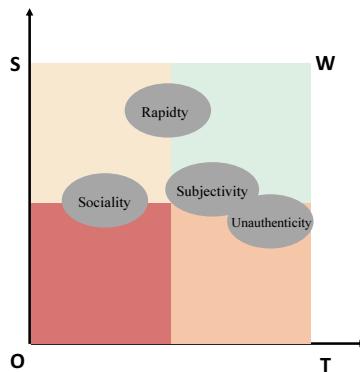
Initially, a Strengths Weaknesses Opportunities Threats (SWOT) analysis [4] was applied to state the general characteristics of SMD in disaster research. SWOT analysis is a powerful method in strategic planning and research, especially in developing a complete understanding of the key factors. It has been widely applied in the field of technology innovations [5], company actions [6], and energy planning [7].

Subsequently, a literature review was conducted. From the perspective of data formats and tasks in the process of disaster management, we studied the research results of SMD-based disaster research in recent years and summarized the processing methods. The data forms included structured numeric data and unstructured data (text and images). Application tasks included disaster identification, disaster spatiotemporal analysis, disaster intensity assessment, public sentiment analysis, rumor identification, communication node analysis, and information display.

## 3. Characteristics of Social Media Data in Disaster Research

Using the SWOT analysis, we outlined the characteristics of SMD in disasters into sociality, rapidity, subjectivity and un-authenticity (Fig. 1).

Sociality refers to a large number of users about the wide coverage of social media platforms and a huge amount of crowdsourcing data, which is the major advantage of social media-based disaster research and brings many opportunities for big data research and application. Rapidity refers to the swift information production, transmission, and reaction to emergencies in social media, which is an advantage for sudden-onset natural hazards, but sometimes becomes a disadvantage in the research of slow-onset hazards. Subjectivity refers to SMD by means of the subjective factors including user literacy, personal experiences, different mindsets, which is a disadvantage and challenge faced by SMD in disaster research. Un-authenticity refers to the formidability in verifying the authenticity of social media, when the information occurs. Rumor is a major inference in SMD-based disaster research, and also a disadvantage to some extent.



**Figure 1.** SWOT analysis of SMD in disaster research

### 3.1. Sociality

Currently, 3.48 billion people worldwide are active on social media [8]. Users on the social media are both consumers and producers [9], and information is generated spontaneously. When a natural hazard occurs, the internet users in the affected area often share their perceptions on the hazard intensity and disaster relief processes. As a result, the researchers can directly collect near real-time disaster information [10]. Furthermore, the sociality of SMD is also reflected in the mutual feedback mechanism between the individuals and the administrators. Individuals provide the disaster-related data promptly by means of crowdsourcing. The relevant government departments and institutes apply SMD to disaster management or research for focusing on the real-time dynamic monitoring, analysis and comprehensive cognition, and attempting disaster relief by disaster insurance and other policies to serve the public. In turn, social media plays a positive role in promoting disaster reduction and supervising disaster management. For example, massive SMD related to Beijing air pollution in 2011 pushed Beijing to become one of the first cities in China with Air Quality Index-PM2.5 monitoring and data release, which accelerated the air pollution governance in Beijing.

### 3.2. Rapidity

Social media data is updated rapidly spatially and temporally. Since a portion of SMD has location information, there is no need for the secondary spatial positioning processing. Compared to traditional interviews and surveys, this method can get prompt feedback on disaster situations. Even when sudden-onset natural hazards occur, some social media information dissemination can be faster than the broadcasting of a monitoring system. Several institutes in the United States [11], Japan [12], the Netherlands [13], and Australia [14] utilize the promptness of SMD to improve emergency warnings, disasters identification by tracking and monitoring the social media dataflow.

The rapidity of SMD acquirement is conducive to seizing the golden period of post-disaster response after the occurrence of a sudden natural hazard. However, social media is information-centric, which indicates that new hotspots can effortlessly weaken the attention of the original events. Therefore, the unstable social data flow is not beneficial for slow-onset hazards. Rapidity is a double-edged sword in the social

media-based disaster research. It is indispensable to consider the limitations and applicability of different hazard types.

### 3.3. Subjectivity

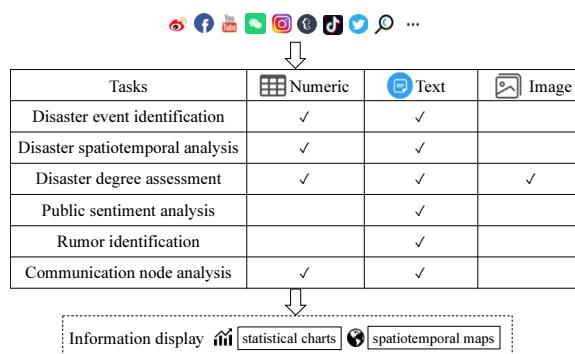
Social media data is a record of netizens, rather than a group of professionals and scientists, so the data may be inaccurate, and the scientific meaning of the data may not be satisfying. The experience and expression of hazards will affect the reliability and validity of disaster-related SMD. Some scholars suggest that people who have experienced disasters have a higher sensitivity to climate change and higher awareness of local natural environment vulnerability [15][16]. There may be unconscious errors when the netizens express about the disasters on social media, and the impact of subjective intention on data quality should not be ignored. To the best of our knowledge, there is no existing work that studies the problem of subjectivity in SMD-based disaster research.

### 3.4. Un-authenticity

Social media data has a wide coverage and a fast propagation without verification [17], which indicates that the Internet may amplify or attenuate the risk and social impact of disasters [18]. The propagation speed of rumor is six times that of fact, and the probability of fake news being forwarded is 70% higher than that of real news [19]. Disaster-related rumors are often more likely to attract the attention, which may not only cause negative public emotions but also result in a large-scale panic and economic losses. This conscious data error can severely interfere with disaster analysis and emergency management.

## 4. Processing Methods of Social Media Data in Disaster Research

The use of SMD for disaster research is one of the applications of data mining technology. It must be noted that the performance of different processing methods depends on the quality and availability of its underlying data, since it is a well-known weakness of any data-driven approach. The data formats and general tasks used during the research are depicted in Fig. 2.



**Figure 2.** Application tasks of SMD-based disaster research

#### *4.1. Disaster Event Identification*

By monitoring the abnormal fluctuation of social media related to disasters in real-time, we can identify a disaster event and broadcast disaster information promptly. Lee et al. monitored the number of updated posts, active users, and the regional mobile population in a certain space. A large change in this dataflow with the historical data suggests an emergency in an area [20]. However, this method does not filter the noise in social media. Sakaki et al. introduced a particle filter and Kalman filter in the signal processing algorithm to preprocess noise text data [12]. Robinson et al. pre-defined earthquake-related keywords and then monitored the fluctuation, and focused on the continuous alarms based on the time series to reduce the false alarm rate [21]. Abhik et al. calculated the text similarity based on the TF-IDF algorithm for clustering and then identifying the disaster sub-events [22]. Yin et al. optimized the method of online incremental clustering and offline merging to detect multiple hazard types [23].

#### *4.2. Disaster Spatiotemporal Analysis*

The spatial pattern and temporal process of disasters can be analyzed in a data-driven manner.

Temporal analysis normally extracts the social media information published in the first instance, and then analyzes the situation or trend of key indicators in a continuous period for a disaster information theme (such as a hot spot of social attention, hazard intensity and affected areas). The methods for time series analysis include the trend fitting [24], ARIMA model [25], and the gray forecast model [26]. However, the information release time may not necessarily be the same as the disaster occurrence time, and the bias between the two is often ignored in the current research.

Spatial analysis of the geographical location is generally obtained in an event to analyze the coverage of a hazard or disaster trend. There are three common steps: providing the longitude and latitude information directly; converting the coordinates according to the IP address of the equipment; extracting the words involving the place names, administrative area codes, postal codes or Points of Information (POI) in the text, and then analyzing them into coordinates by matching with the toponym database [23]. But the toponym ambiguity during extracting the words from text has not been solved completely, and there is still a bias in the fine-grained positioning. Besides, due to the regional differences in user distribution, the spatiotemporal distribution of the disaster events is possibly biased towards the population gathering areas [27]. Some studies introduce the user activity weighting [28] or disaster-related ratio weighting [29] to alleviate the spatial heterogeneity of user distribution.

#### *4.3. Disaster Intensity Assessment*

Social media data related to disasters generally describes the impact of the disaster. The challenging part of this task is latent semantic analysis. There is few social media-based term thesaurus or corpus with enough data in the field of natural hazard and emergency management, and the direct use of existing data sets in other fields may reduce the accuracy of disaster intensity classification. Some researchers share tweet labeled sample sets of several disasters such as CrisisNLP [30] or CrisisLex [31].

The near real-time disaster assessment is mainly carried to identify the affected area and estimate the loss of the exposure. The static affected area can be identified by

spatial clustering algorithms [27]; the dynamic tracking affected area can be identified by spatial logical growth model [32]. The loss of disaster bearing body can be estimated by combining with emotional analysis [33] or extracting specific location and affected degree description of damaged infrastructure [34].

Image data in social media by satellite remote sensing, unmanned aerial vehicle (UAV) or ground shooting by individuals are widely used to extract the disaster information. The image of satellite remote sensing or UAV can be used to study the spatial distribution of population, houses, crops, transportation and other disaster situations. Data processing methods are deep learning algorithms and image processing algorithms including the Digital Terrain Model (DTM), Digital Elevation Model (DEM) and the Digital Surface Model (DSM) model [35]. The image data uploaded by netizens is heterogeneous to social media, which can be used for the disaster degree assessment, such as the storm intensity, flood depth and inundation area. However, there is no existing disaster image dataset, and the quality of social media image is inconsistent. Hence, the image data from ground shooting in social media has not been widely used for quantitative assessment of disasters, but can provide a rough qualitative estimation by visual inspection. Besides, due to the lack of samples, the transfer learning based on small samples [36] also brings a new direction for the application of SMD in disaster research.

#### 4.4. Sentiment Analysis

Public sentiment reflected in disaster-related posts can be used to identify the disaster situations, relief attitudes, and potential risks. Sentiment analysis interprets the meaning or polarity of larger text units (sentences, paragraphs, articles) through the semantic composition of smaller elements. The process takes a language as a digital signal, using some word vector algorithm to represent words, and then use the traditional machine learning algorithms including Bayesian, support vector machine (SVM), random forest or deep learning neural network algorithms including Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Bidirectional Encoder Representation from Transformers (BERT) to train the vector features in text for emotional polarity classification or regression[37].

Besides, emoticons are frequently used in social media, such as "candle" to express solidarity with the disaster victims, and "bawling" to express the uneasiness. Emoticons can reflect public sentiment changes in the process of disaster, but existing studies often filter emoticons directly.

#### 4.5. Rumor Identification

Rumor identification is a technical difficulty of social media monitoring. The common method is to classify SMD simply by trigger words and initial release time. However, social media texts are diversified, matching templates cannot cover all linguistic phenomena and ensure the consistency of rules.

Researchers say that they can rely on computer technology to find rumors through big data statistics [38] or combined with other data sources [39], and estimate the data credibility [40]. Social media itself provides a mechanism to suppress the rumor spreading, and users can question the information from low credibility sources [41]. Zhao et al. used the planned behavior theory and the normative activation theory in the field of psychology to identify the rumors in social media [42]. Wang et al. studied

social media users' rumor awareness and response behavior in the disasters by content analysis method in the field of communication and decision tree model [43]. It is very formidable to supervise the social media content and put an end to rumor. At present, it is still a major bottleneck in SMD-based disaster research.

#### *4.6. Communication Node Analysis*

To explore the communication mechanism of disaster information in social media, network diagram is a useful tool. We can identify opinion leaders by forwarding and comment data [38] by refining different groups by clustering the whole network or core network, identifying the information propagation path in different disaster management stages by the time evolution of network diagram, and analyzing public behavior by node changes of spatial mobility [44].

#### *4.7. Disaster Information Display*

The disaster information forms based on SMD mainly includes the statistical charts and the spatiotemporal maps. The statistical charts focus on the event trend [24], keywords [25], hot topics [13], website statistics, social network map [38], and communication path. Spatiotemporal maps focus on the location of disaster events, the spatial distribution of public opinions [45], disaster-affected area, and rescue points. The method employs the extraction of the spatial attributes from SMD, convert into latitudes and longitudes, and then use GIS spatial interpolation or programming for visual display.

### **5. Conclusion**

Social media data plays a supporting role and has immense potential in disaster analysis and emergency management, as a result of which it is attracting increasing attention. The social media-based disaster research is a data-driven approach, so the consideration of its underlying data type and quality is essential. Considering the strong dependence between data and methods, this review comprehensively summarizes the characteristics and application tasks of social media data in disaster research. Social media data has the advantages of sociality and rapidity for onset hazards but also has the disadvantage of subjective errors and rumor distortion in an application. Current major social media-based research tasks include disaster identification, disaster spatiotemporal analysis, disaster intensity assessment, public sentiment analysis, rumor identification, communication node analysis, and information display. However, there are still many unsolved technical difficulties. We hope that our study stimulates more researchers to actively participate in this field.

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# Factors Influencing Farmers' Willingness to Pay for Weather Index Insurance Through Fuzzy-Set Qualitative Comparative Analysis: Insights from a Pilot in Jiangxi Province, China

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**Abstract.** Weather index insurance plays an important role in helping farmers avoid their economic loss from weather risk. There is increasing numbers of pilot areas of weather index insurance in China while the studies show its take-up has been disappointing low in many other developing countries. This study aims to explore the status of weather index insurance and its processing problems in China through the factors influencing farmers' willingness to pay for Low-Temperature Index-based Mandarin Orange Insurance in Nangfeng County. The Fuzzy-Set Qualitative Comparative Analysis is conducted for the influencing factors, including strike level, premium, pay-out, planting cost, effect of low temperature, insurance claim process, trust in insurance and government subsidy. The result shows the combination of expensive premium, low payout, high planting cost, low government subsidy and distrust in insurance company causes farmers' unwillingness to pay for Low Temperature Index-based Mandarin Orange Insurance, among which distrust is core factor. Expensive premium, low payout, high planting cost and low subsidy from government are main influencing factors.

**Keywords.** Low-Temperature Index-based Mandarin Orange Insurance, Fuzzy-Set Comparative Qualitative analysis, Low-take up, Distrust, Expensive premium, Low payout, High planting cost, Low government subsidy

## 1. Introduction

The implications of climate change for agriculture and food are global concerns, and they are very important for China [1]. In order to help farmers avoid their economic loss from weather risk, Chinese government actively takes measures to enhance agricultural

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insurance programs. However, in operating the traditional agricultural insurance, it will face up moral hazard and adverse selection. Moral hazard refers to the insured person's optimal decision may change as a result of taking out insurance[2]. Adverse selection means that people who are more likely to suffer the insured event will be more willing to insure at a give rate[2]. Both moral hazard and adverse selection occur because of asymmetric information. As the traditional agricultural insurance's payout is linked with farmers' individual-losses, farmers will show an adverse selection behavior tend to grow the crop with high income but vulnerable to natural disaster. After purchasing insurance, farmers will not actively seek ways to protect insured crop from disasters, this is thought to be moral hazard behaviors. These two behavior will let agriculture insurance company face the compensation pressure and even lead to a failure of agricultural insurance market. Moreover, the geographical dispersion of agriculture production makes the operational and administrative costs of delivering insurance high in comparison with other types of insurance [3]. Weather index insurance is novel type of insurance contract for smallholder farmers and other rural inhabitants affected by uninsured covariate weather risks. It links insurance payout from weather event(temperature, precipitation, wind) that are defined and recorded over a pre-specified period of time at local weather station. Weather index insurance contract is typically written for a single peril such as temperature, the weather risk of greatest concern to local different crop production. For example, the first weather index insurance contract in Anhui Province, China insured against late spring coldness for wheat farmers as assessed by temperature in spring. On the other hand, another weather index insurance in Wuhu, Anhui Province is implemented for rice farmers against the local high temperature temperature in summer. Compared with traditional agricultural insurance, weather index insurance selects weather index as subject matter of insured, which can not be controlled by people's behavior, so it is recognized as having the advantages of reducing operating costs, avoiding moral hazard and adverse selection. China, like many other countries, starts to focus on weather index insurance to hedge weather risk in agriculture. In 2007, China piloted its first agricultural weather index insurance in Shanghai. Recently, Chinese government has successively introduced relevant policy to promote the development of weather index insurance in agriculture. By 2019, the pilots of weather index insurance in China has been expanded to include 16 regions, and covered different types of crops, such as rice, wheat, apple and tobacco. In spite of increasing numbers of pilot areas in China, take-up has been disappointing low in many other developing countries. Therefore, the purpose of this paper is firstly, selects one of weather index insurance pilot areas- Jiangxi Province as research object to explore the status of weather index insurance and its processing problems through the factors influencing farmers' willingness to pay for Low Temperature Index-based Mandarin Orange Insurance in the pilot area. Secondly, to identify problems in the pilot process and make appropriate countermeasures and relevant suggestions to insurance company to improve insurance product design and help the government to re-think the next phase of development of weather index insurance program.

It's not surprise that there is growing numbers of literatures on farmers' preference and willingness to buy weather-index insurance. These researches are divided into two types. One type of the literatures focus on identifying factors that influence farmers' preference to pay for weather index insurance based on contingent valuation (CV). The other type of studies target farmers' satisfaction with current weather index insurance in the pilot areas. The results of both types of studies aim to help insurance company, government

and institution have a good understanding of how to design products, implement a policy and provide subsidies to attract more farmers to participate in this scheme. It is possible that farmers simply avoid a very high premium on the insurance they were offered [4,5,6,7], as well as a clear preference for insurance contracts with higher payouts[8]. The participants may not have placed a high value on the insurance if they realized that weather recorded at the reference weather station was not highly correlated with weather index on their own plot, i.e., basis risk was very high [4,9,10,11,12,13,14]. In the investigations, lacking of trust in insurance providers is also a key factor negatively influence the demand for weather index insurance[15]. In the aspect of subsidy, Wang HH [16] addressed that in order for wide spread adoption of weather insurance farmers will require an 80 per cent discount or subsidy to current crop insurance initiatives. Petri Liesivaara, Sami Myyrä [17] stated the prospect of government disaster relief affects the willingness to pay for crop insurance products. Many scholars tried to find other factors that influence farmer's decisions on purchasing weather index insurance. Anthony Patt [8] suggested a better understanding of basic insurance concepts with greater willingness to purchase index insurance. Ruth Vargas Hill [12] finds that educated, wealthier individuals are more likely to purchase insurance. Ntukamazina N [5] suggested that the age of farmers, land tenure and farm size have negative impact on the uptake of these products.

The literatures summarized the factors affecting the purchase of weather index insurance from different perspective, however, mostly based on data-set observations with discrete choice experiment. The innovation of this study is firstly attempt Fuzzy-Set Qualitative Comparative Analysis (fsQCA) to field visits, interviews and discussions with insured farmers to explore the farmer's attitude with Low Temperature-Index based Mandarin Orange Insurance in Jiangxi Province, China. The result will further provide some certain references for Jiangxi Province and other regions of agricultural weather index insurance pilot in China, so as to suggest ways of improving insurance uptake.

The rest of this paper is organized as follows. Section 2 presents research design, which includes overview of Low Temperature Index-based Mandarin Orange Insurance in Jiangxi Province, questionnaire design and data collection. Section 3 explains Fuzzy-Set Qualitative Comparative Analysis(fsQCA) method. Section 4 reports the main results and discussion. Lastly, Section 5 contains the conclusions and recommendation of this study.

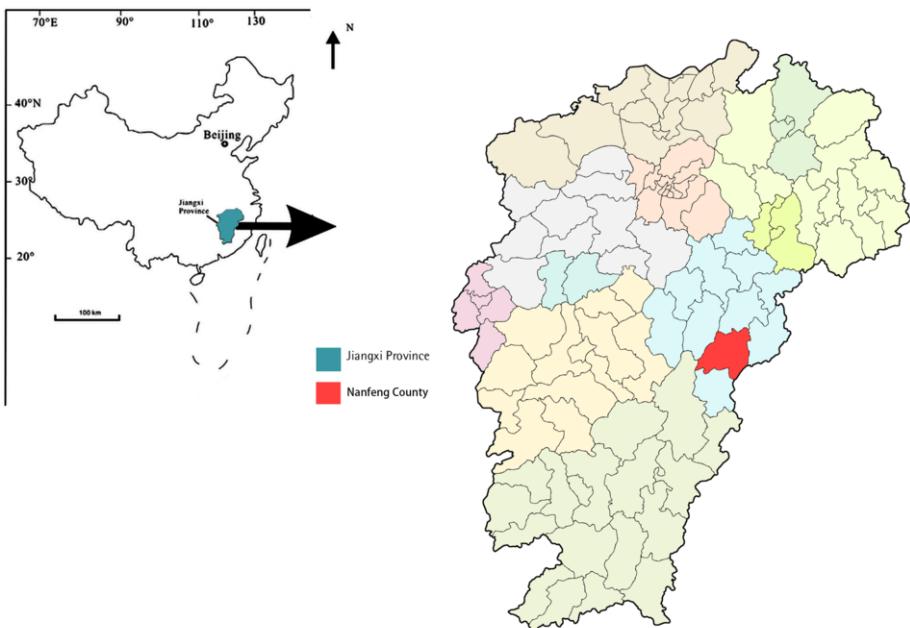
## 2. Research design

### 2.1. Overview of Low Temperature Index-based Mandarin Orange Insurance in Jiangxi Province

Nanfeng County is located in the southeast of Jiangxi Province (Figure-1). It consists of 10 towns with 140 villages. As one of the most important producing areas of mandarin orange in China, mandarin orange production contributes 80% to total farmland and already become pillar industry here.

The topography of Nanfeng County is dominated by hills. Mandarin orange is extensively grown on the hills. As mandarin orange market expansion and its increasing profit, farmers expanded cultivated areas of mandarin orange to their cropland in Nanfeng County. Both hills and cropland are suitable for mandarin orange growth and the

topographical variation will not affect mandarin orange production. Among natural factors, mandarin orange cultivation is highly dependent on the temperature, especially the low temperature in winter.



**Figure 1.** Location Map of Nanfeng county in Jiangxi Province, China

In order to help farmers against low temperature, the People's Insurance Company (Group) of China (PICC) of Jiangxi Branch cooperated with the Jiangxi Provincial Climate Center to implement Low Temperature Index-based Mandarin Orange Insurance (LTIMOI) in Nanfeng County, which covered mandarin overwintering stage from December to February of the following year. Low Temperature Index-based Mandarin orange (LTIMOI) was started in 2011 with underwritten areas of 28,400 mu( $667m^2$ ) and premium income of 2.3156 CNY million.

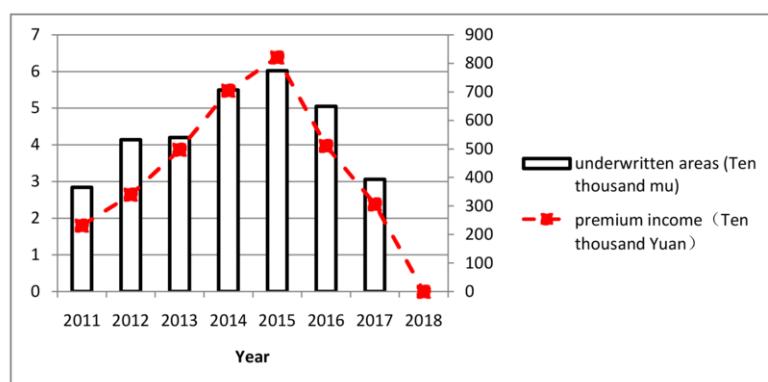
The insurance policy period lasts up 1 year, from March to February of the following year. Considering effects of various temperatures on mandarin orange in winter, LTIMOI contract sets 11 strike levels and mandarin orange farmers can select to buy insurance at threshold of -1°C or -4°C based on their own experience. The premium was initially set as 72 CNY/mu and now is increased to 100 CNY/mu for every farmer. As a Policy-oriented agricultural insurance, Jiangxi governments directly subsided premiums for insurance company with total subsidy ratio of 40%. Farmers bear 60% of premium, ie. 100 CNY. According to the insurance contract, if the daily minimum temperature falls below (inclusive) the threshold, a pay-out is triggered for all farmers holding a contract with reference to the particular weather station. The maximum pay-out is 2,000 CNY /mu, and pay-out for each strike levels follows the formula of maximum payout per mu multiplies a given premium ratio. The details about thresholds and payout are shown in Table-1.

**Table 1.** The pay-out stage of Low Temperature Index-based Mandarin Orange Insurance

Daily Minimum Temperature (DMT)and Duration	No.1 Pay-out Phase	No.2 Pay-out Phase
	DMT $\leq$ -1°C	DMT $\leq$ -4°C
-2°C $<$ DMT $\leq$ -1°C	Per Mu of Pay-out*4%	
-3°C $<$ DMT $\leq$ -2°C	Per Mu of Pay-out * 5%	
-4°C $<$ DMT $\leq$ -3°C	Per Mu of Pay-out * 6%	
-5°C $<$ DMT $\leq$ -4°C	Per Mu of Pay-out * 7%	Per Mu of Pay-out * 4%
-6°C $<$ DMT $\leq$ -5°C and Duration $<$ 3 hours	Per Mu of Pay-out * 8%	Per Mu of Pay-out * 5%
-6°C $<$ DMT $\leq$ -5°C and Duration $\geq$ 3 hours	Per Mu of Pay-out * 10%	Per Mu of Pay-out * 6%
-8°C $<$ DMT $\leq$ -6°C and Duration $<$ 3 hours	Per Mu of Pay-out * 20%	Per Mu of Pay-out * 15%
-8°C $<$ DMT $\leq$ -6°C and Duration $\geq$ 3 hours	Per Mu of Pay-out * 30%	Per Mu of Pay-out * 20%
-10°C $<$ DMT $\leq$ -8°C and Duration $<$ 3 hours	Per Mu of Pay-out * 50%	Per Mu of Pay-out * 30%
-10°C $<$ DMT $\leq$ -8°C and Duration $\geq$ 3 hours	Per Mu of Pay-out * 70%	Per Mu of Pay-out * 60%
DMT $\leq$ 10°C	Per Mu of Pay-out *1 00%	Per Mu of Pay-out * 100%

Source: the content is provided by PICC of Jiangxi Branch

The data in Figure-2 shows the underwritten areas and premium income of LTIMOI from 2011 to 2018. We can find it presents an encouraging take-up from 2011 to 2015, but the purchasing for LTIMOI sharply decreased after 2015, and even almost no farmers bought this insurance in 2018. This surprising result gives us an access to explore the reason for the disappointing take-up of LTIMOI. The reason will be explained by applying collected data to fsQCA analysis methodology and the more detail will be showed in next sections.

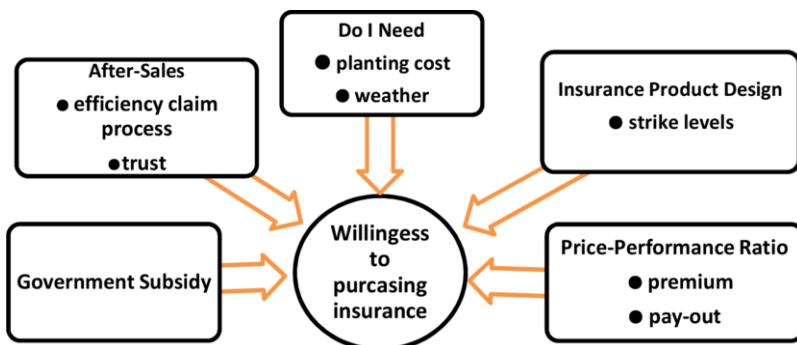


Source: the data is collected by authors from the survey in Nanfeng County

**Figure 2.** The underwritten areas and premium income of Low Temperature Index Insurance-based Mandarin Orange in Nanfeng County

## 2.2. Questionnaire design

The questionnaire of farmers' willingness to pay for LTIMOI consists of two parts. The first part is asked for socio-demographic characteristics information about mandarin orange farmers' education level, planting experience, farmland cultivated, total planting cost and annual net income. The second part focuses on the factors influencing farmer's willingness to purchase weather index insurance depend on a review of relevant literature. We made five aspects of influencing factors based on farmers' perspectives in Nanfeng County, which conducted as casual conditions in the data analysis. These casual conditions are: insurance product design(strike level), Price–performance ratio(premium and payout), Do I need this insurance product( planting cost, effect of low temperature on mandarin orange planting), After-sales(claim settlement processes, trust in insurance company), and government subsidy. The outcome condition is farmers' willingness to purchase insurance. Figure-3 shows independent conditions and outcome condition, and we use weather to instead of effect of low temperature on mandarin orange planting.

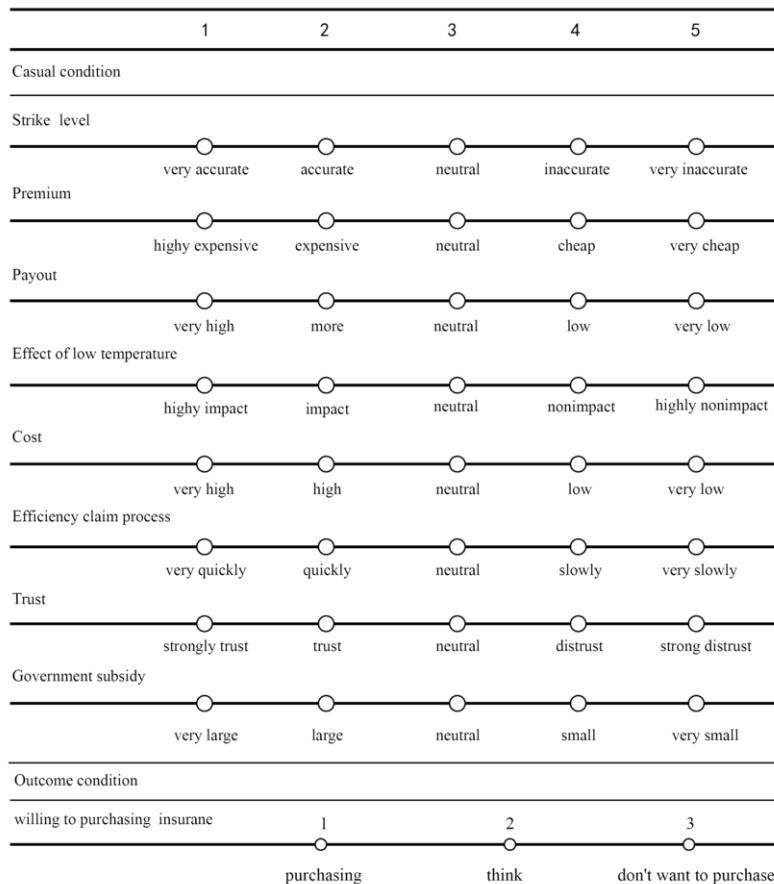


**Figure 3.** The Casual Conditions and Outcome Condition

We performed 5 point Likert scale to the casual condition. For example, the answer of strike level was rated on a scale anchored by 1, "very accurate"; 2, "accurate"; 3, "neutral"; 4, "inaccurate"; 5,"very inaccurate". The outcome condition of farmers' willingness to purchasing LTIMOI is measured by 3 point Likert scale using purchasing for a value of 1; thinking for a value of 2 and don't want to purchase for a value of 3. The Likert scale of casual conditions and outcome condition is showed in Figure-4.

## 2.3. Data collection

This survey was undertaken 6 villages in Nanfeng County based on field visits, interviews and discussions with insured farmers, who were insured at the time of the survey or had purchased an insurance contract in previous years. The data was collected from November 9, 2019, to January 18, 2020 and covered 360 people. Finally, we got valid questionnaire from 110 people. In order to ensure the accuracy of the investigation, the surveyed people are all men with the age among 45-60. This is because in the rural areas of Nanfeng County, the farmer households still follow the traditional customs of the "male breadwinner and female homemaker". In addition, the young people, whose age is among 28-40 are migrant workers in the city. Therefore, both female and young people seldom know the details about index insurance.



**Figure 4.** The Likert Scale of Casual Conditions and Outcome Condition

### 3. Method

#### 3.1. Fuzzy-Set Qualitative Comparative Analysis method

We adopt Fuzzy-set Qualitative Comparative Analysis (fsQCA) to surveyed data of second part of the questionnaire analysis. FsQCA is derived from Qualitative Comparative Analysis (QCA), which is proposed by Ragin. QCA builds on the logic of qualitative, case-oriented research as it is practiced in comparative sociology and comparative politics and uses set-theoretic methods of comparison, representing each case as a combination of causal and outcome conditions [18]. The distinct advantage of QCA method is that it combines the advantages of both qualitative and quantitative analysis. For example, QCA begins with a bottom-up approach that pieces case together to illustrate a grander pattern, and then as in quantitative research, QCA uses stepwise paired comparisons strategically simplify complexity and expose various patterns within a system [19].

fsQCA overcomes the binary classification in QCA, and describes cases as the combination of causal conditions and the outcome, rather than constituting just a single con-

dition [20]. Moreover, fsQCA allows analysis with both small sample size and large sample size. Calibration is core task of fsQCA. It transforms ordinal scales or continuous data into numbers expressing the degree of membership to the sets that represent the conditions under study [21]. All fuzzy-set values for all simple conditions range from 0 to 1 [21], and these values indicate the degree of membership to each set representing each condition [22].

The steps to applying an fsQCA for data analysis are as follows: (1) transform variables to calibrate. (2) perform the analysis of necessity; and (3) perform the analysis of sufficiency[23].

### 3.2. Calibration of original data

As mentioned above, the key step in fsQCA analysis should transform variables into calibrated, we directly assigned calibration to both independent measures and outcome condition which follow Ragin (2008). A continuous-fuzzy set and are made for independent measures: “1, 2, 3, 4, 5” (five point score) to “0, 0.2, 0.4, 1” (continuous-fuzzy membership) and three values fuzzy set for outcome condition: “1, 2, 3” (three point score) to “0, 0.5, 1” (three values fuzzy membership). Table-2 shows the result of calibration of independent measures and outcome condition.

**Table 2.** The Calibration of causal conditions and outcome condition

variable of casual condition	Calibration				
	0	0.2	0.4	0.6	1
strike level	very accurate	accurate	Neither accurate nor inaccurate	inaccurate	very inaccurate
premium	highly expensive	expensive	Neither expensive nor cheap	cheap	very cheap
payout	very high	more	Neither high nor low	low	very low
Weather	highly impact	impact	Neither impact nor nonimpact	nonimpact	highly nonimpact
efficiency	very quickly	quickly	Neither quickly and slowly	slowly	very slowly
claim process	very quickly	quickly	Neither quickly and slowly	slowly	very slowly
cost	very high	high	Neither high nor low	low	very low
trust	strongly trust	trust	Neither trust nor distrust	distrust	strongly distrust
government subsidy	very large	large	Neither large not small	small	very small
outcome condition	0	0.5	1		
willingness to purchasing insurance	purchasing	thinking	don't want to purchase		

## 4. Empirical results

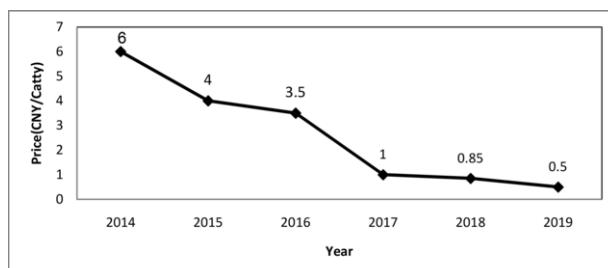
### 4.1. Characteristics of sample farmers

This study obtains usable information of mandarin orange cultivation from questionnaires and interview and discussion with farmers. Table-3 is demographic and agronomic information of surveyed mandarin orange farmers in Nanfeng County.

It is clearly find that 90% mandarin farmers with lower education level. Only 8% and 2% reached high school degree and college degree, respectively. Nanfeng County has a long history of planting mandarin orange, so the information in Table-3 shows all the farmers have rich plant experience in mandarin orange cultivation: 85% have 15 years-20 years; and 15% have 20 years-30 years. Every household plants mandarin orange here, but the land cultivated are typical smallholders, 75% with planting size of around 5mu-10mu, 20% with farmland size of 10mu-15mu, only 5% farmer has 50mu-60mu farmland. The main planting cost of mandarin orange consists of graft cost, pesticide and fertilizer costs and labor cost. Table-3 exhibits the 75% total planting cost of mandarin orange are around 20,000 CNY-30,000 CNY, which is consistent with small-scared household farmer's mandarin orange planting areas. The surveyed farmers also reported planting cost of mandarin orange has continued to increase these years, meanwhile, its wholesales price decreases. Figure-5 shows the wholesale price of mandarin orange in Nanfeng County recent years. In the Figure-5, we can clearly find that the wholesale price of mandarin orange has continued to fall. In 2019, the wholesales price even falls to 0.5 CNY/Catty. Mandarin orange planting is the major source of income for farmers in Nangfeng County. The information in Table-3 indicates annual net income of most of mandarin orange planting households is ranged from a low of 20,000 CNY-30,000 CNY. 20% of households' annual net income is around 50,000 CNY-60,000 CNY and only 5% of households have a net income more than 100,000 CNY.

**Table 3.** The demographic and agronomic information of surveyed mandarin farmers (N=110)

Level of Education(%)	Plant Experience(%)		
Junior high school or less	90	10 years~15 years	10
high school	8	15 years~20 years	75
college	2	20 years~30 years	15
Farmland Cultivated(%)		Total Planting Cost (%)	
5 mu~10 mu	75	20,000 CNY~30,000 CNY	75
10 mu~15 mu	20	40,000 CNY~50,000 CNY	20
20 mu or more	5	more than 60000 CNY	5
Annual Farmer Net Income(%)			
20,000 CNY~30,000 CNY	75		
50,000 CNY~60,000 CNY	20		
more than 100,000 CNY	5		



Source: the data is collected by authors from the survey in Nanfeng County

**Figure 5.** The Wholesales Price of Mandarin Orange in Nanfeng County

## 4.2. FsQCA result

### 4.2.1. Descriptive statistic

Table-4 presents descriptive statistic of both causal conditions and outcome condition. According to calibration of original data, it clearly shows that almost all the people select ‘don’t want to purchase insurance’ when filling in the questionnaire and all the farmers in the survey express their distrust of insurance company. Most of farmers consider the design of LTMOI is neither accurate nor inaccurate. Farmers’ attitudes toward the effect of low temperature are more inclined to ‘nonimpact’. The descriptive statistic shows that most of farmers think the premium of LTMOI is expensive. In addition, its claim process is not efficient and the compensation is negligible compared to the planting cost. Moreover, the subsidy from government is not enough.

**Table 4.** Descriptive statistic of calibration of original data

Variable	Mean	STd.Dev	Minimum	Maximum
strike level	0.46	0.13	0.2	0.6
premium	0.31	0.16	0.2	0.6
pay-out	0.57	0.22	0.2	1
cost	0.25	0.19	0	0.6
weather	0.56	0.26	0	1
efficiency	0.58	0.3	0	1
subsidy	0.57	0.06	0.4	0.6
trust	1	0	1	1
willingness	0.94	0.19	0	1

### 4.2.2. Necessity analysis

Following the second step of fsQCA analysis, the necessity analysis of the causal conditions for the outcome condition is tested. The consistency determines whether the causal condition is necessary condition for outcome condition or not. According to Schneider [23] stated in his study, if the consistency score exceeds the threshold of 0.9, it can explain a condition is ‘necessary’ or ‘almost necessary’. As presented in Table-5, only the consistency of ‘trust’ exceeds 0.9 this requirement. This result indicates the trust in insurance company is highly associated with LTMOI purchases.

**Table 5.** The necessity analysis of causal condition for the outcome condition

Condition	Consistency	Coverage
Strike Level	0.48	0.98
Premium	0.72	0.97
Pay-out	0.60	0.98
Cost	0.62	0.95
Weather	0.24	0.96
Efficiency	0.52	0.99
Trust	0.92	0.96
Government Subsidy	0.59	0.97

#### 4.2.3. Results of configurations

Next, the results of configurations through the truth table based on the calibration of original data is performed. Table-6 presents five configurations of 8 causal conditions. Following Ragin and Fiss [24] suggestion, in Table-6, the black circle ('•') indicates presence of a condition. Circle with a cross out ('⊗') denotes absence of a condition and the white circle ('○') indicates a situation of either present or absent, which is not care. All configurations in Table-6 are meaningful and empirically important because their unique coverage is more than 0. Furthermore, these configurations show a consistency score of 0.62% and the solution consistency of 0.96, which means the explanation of those causal outcomes on the effect of willingness to insurance purchase is relative high.

The first configuration indicates the combination of expensive premium, low payout, high planting cost, no effect of low temperature, low subsidy from government and distrust of insurance company result in w=1, that is mandarin farmers are unwilling to buy LTIMOI. In contrast, the second configuration shows the opposite pattern with absence of premium and presence of strike level. The third configuration exhibits inaccurate strike level, low indemnity, high planting cost, slow efficiency claim processes, insufficient government subsidy and distrust will influence farmers to buy insurance. Comparing third configuration and fourth configuration indicate that combination of expensive premium, less payout, higher planting cost, low government subsidies and distrust of insurance company will lead to farmers' unwillingness to buy weather index insurance. The fifth configuration indicates a third path to farmers' dissatisfaction with insurance, combining only weather, smaller subsidy from government and distrust of insurance company.

**Table 6.** FsQCA result

Configurations	solutions				
	1	2	3	4	5
<b>Insurance product Design</b>					
Strike level	⊗	•	•	○	⊗
<b>Price-performance ratio</b>					
Premium	•	⊗	•	•	⊗
Payout	•	•	•	•	⊗
<b>Do I need</b>					
planting cost	•	•	•	•	⊗
weather	•	•	•	⊗	•
<b>After sales</b>					
efficiency claim process	⊗	○	○	⊗	⊗
trust	•	•	•	•	•
Government subsidy	•	•	•	•	•
Raw coverage	0.14	0.16	0.21	0.42	0.28
unique coverage	0.05	0.01	0.05	0.06	0.01
Cosistency	0.92	0.93	0.90	0.98	1
overall solution coverage: 0.62					
overall solution consistency: 0.94					

### 4.3. Discussion

Table-5 and Table-6 show that interviewed people are not willing to buy LTMOI again. According to the result, we found the pilot of LTMOI is not successful in Nanfeng County. The reason for unsuccessful pilot dues to expensive premium, lower indemnity, high planting cost, low government subsidy and distrust of insurance company, which is indicated by the fourth configuration.

From Table-6, clearly, distrust in insurance company is the core factor that influences farmers' purchasing for insurance. It is very common phenomenon that migrant workers entrust their own mandarin orange cultivation to other farmers in Nanfeng County. The farmers purchased insurance for the entrusted mandarin orange trees, however, with the name of migrant worker in the insurance policy. Most of migrant workers didn't know their mandarin orange trees are insured when insurance company return insured farmers who received payout. Therefore, without any investigation, insurance company has identified this common phenomenon as 'fraud'. Many farmers didn't receive payout for this event. Because of information asymmetry, insurance company and farmers lost trust in each other. This also can explain why all the surveyed famers selected fully distrust in the questionnaire.

The key reason for farmers not to purchasing LTMOI is expensive premium, lower indemnity and high planting cost of mandarin orange. Farmers emphasized these three points when filling out the questionnaire. In Table-3, it is clearly find that the planting cost of mandarin orange is relative high because of both low net income and cheap wholesales price of mandarin orange. For example, in 2013, the temperature in winter reached -8°C and caused frost. In 2013, the income of mandarin orange is about 2,400 CNY /mu and the total cost of planting mandarin orange is about 1,557.23 CNY/mu based on farmers' memories. In addition, premium of LTMOI at that time is 72 CNY /mu. Therefore, the payout at strike level of -8°C is obviously not enough for farmers. On the other hand, the frost will directly lead to large-scare death of the mandarin trees, and farmers should repurchase seedlings to plant the mandarin tress. This will take at least 3 years-4 years for mandarin orange tree to bear fruit. Except that farmers have to pay high cost of mandarin orange production during this period, farmers cannot earn income from mandarin orange. According to the analysis above, the total economic loss of mandarin with higher planting cost even can't be made up for the maximum payouts of 2,000 CNY/mu.

Government support plays a key role in agricultural insurance, especially when concerning premiums on agricultural insurance subsidies. The expensive premium of LTMOI is closely related to smaller government subsidy. Government directly subsidizes premium for PICC of Jiangxi Branch, but with only 40% subsidy ratio. Table-7 is agricultural insurance premium rate table of PICC in Jiangxi Province. From Table-7, it is clearly find that compared with premium and subsidy ratio of other crop insurance in Jiangxi Province, the price of LTMOI is more expensive and government subsidy is relative low. Regarding high planting cost and cheap wholesales price of mandarin orange, farmers don't want to spend more money on LTMOI with lower indemnity.

Another main reason for farmers not willing to buy this insurance is strike level and effect of low temperature. As climate warms, drought and precipitation becomes main weather risk for mandarin orange, so the daily minimum temperature threshold is difficult to reach these two strike levels of -1 °C and -4 °C. Furthermore, because of

**Table 7.** The government subsidy for crops insurance in Jiangxi Province

Crop	Payout	Premium Rate	Subsidy ratio	Premium for famers
rice	400 CNY /mu	5%	75%	5 CNY /mu
rape	150 CNY /mu	5%	70%	2.25 CNY /mu
peanut	300 CNY /mu	5%	70%	4.5 CNY /mu

Source: the subsidy is provided by government of Nanfeng County

basis risk, some insured farmers cannot get the payout even if strike level matches the low temperature risk of mandarin orange. Therefore, it is difficult to attract the farmers who had purchased this insurance to purchase it again and the farmers who insured at the time of survey regret purchasing LTIMOI, which is explained by fifth configuration. In addition, farmers more care about that if they can receive the payout regardless of whether the strike level or effect of temperature is appropriate or not, so both strike level and effect of low temperature becomes meaningless, as indicated by 'absence' or either present or absent in the configurations.

Claim processing efficiency is one of the advantages of weather index insurance. The LTIMOI contract states it will only take about one month for farmers to accept payout, but respondents felt that actually the claim process is complicated. At claim stage, not only do insured farmers need to provide various documents about their information of planting mandarin orange, but insurance company also have to check the number of acres of mandarin orange trees of insured farmers again. However, for farmers, they will more focus on whether payout can be paid rather than claim process efficiency. The farmers reported in the interview that as long as they can get pay-out, they can bear delay claim process. This is also why that among the configurations, claim process efficiency is expressed as 'absence' and 'either present or absent'.

Among the five configurations, the fifth configuration has highest values of consistency score of 1. However, from the perspective of investigation, the fourth combination is more in line with reality, which can be seen as the most typical combination to explain the reason of low take up of LTIMOI these years in Nanfeng County.

## 5. Conclusion and recommendations

The primary objective of this study is to assess farmers' willingness to pay for Low Temperature Index-based Mandarin Orange Insurance and find out the problem in implementing this insurance product. We hope the key findings can promote the development of weather index insurance in Jiangxi Province and other regions in China. The result of fsQCA indicates a very low take-up for LTIMOI among farmers in Nanfeng County, Jiangxi Province. This can be contributed to three reasons. One reason is that in Nanfeng County, most of mandarin orange planting farmers are small-scared farmers, so under pressure of higher planting cost and lower wholesales price of mandarin, the high premium and low payout of LTIMOI as well as the changing weather risk are not sufficiently tailored to the needs and preferences of mandarin orange planting farmers. The other two reasons are that lacking of trust of insurance company and farmers cannot get strong support from government. The study puts forward to some recommendation from perspectives of contractual design and enhancing government support to help toward widespread insurance uptake among farmers.

In response to changing weather risk, firstly, insurance company should add the designing of drought index and rainfall index in the insurance terms or design different weather index based on different weather risks in the mandarin orange's four stages of germination, growth, maturity and picking. Secondly, insurance company can set three different premium levels based on farmers' own land cultivated, the smaller the planting areas, the less premium are paid. In order to reduce basis risk in designing weather index, if the farmer who suffered loss without receiving compensation and they still want to continue buying insurance next year, insurance company can reduce a percentage of premium rate for them.

For solving the lacking of trust between insurance company and farmers, this problem, firstly, insurance salesman should improve their professional knowledge and business level and find ways to transparently and openly explain the insurance products to famers. Then, Insurance companies should promptly collect feedback from insured farmers, and incorporate valuable opinions into future insurance product design. On the other hand, farmers should promptly report relevant information on tangerine cultivation to insurance companies.

In China, weather index insurance program will not be improved significantly without strong government support. In order to reduce the basis risk in designing weather index insurance product, firstly, government should strengthen the infrastructure construction of rural weather meteorological stations to improve the meteorological data accuracy. Secondly, Jiangxi government should increase the proportion of provincial financial subsidies in Jiangxi Province to 30%, or actively apply for financial subsidies from the central government for LTIMOI. Furthermore, in order to reduce disputes between insured farmers and insurance company, country-level government can establish communication intermediary between insurance parties.

Finally, establishing a three-party evaluation mechanism under the leadership of the China Insurance Regulatory to investigate and evaluate the financial data of insurance companies and farmers, respectively, which improve the risk protection ability of weather index insurance.

This paper points out the factors that influence the farmers' willingness to purchase LTIMOI of adopting surveyed data in fsQCA analysis, this study is not without limitations. Several limitations of this study to the need for future study. Firstly, the survey of this paper was only conducted in Jiangxi Province, the findings may be are not generalizable to other regions, especially developed regions in China. For this reason, further research will expand to other pilots in developed regions of China. Secondly, another limitation that comes with a small sample size of 110, which leads to smaller value of unique coverage in the fsQCA result. Therefore, the further work will increase with a higher sample size.

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# Strategies for Managing Shocking Global Crises in a Disruptive Environment: Proposal for a Intelligence Management Model

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**Abstract.** The high global vulnerability revealed by the current pandemic confirms the existence of a very threatening and disruptive environment. The development of new strategies is needed in response to the new shocking global disruptive crisis, analysing the use of new methodologies and digital tools for their early detection and prospective planning. This will allow the development of more proactive, effective, and efficient response plans, with minimal risks. The work considers the convenience of standardized use and optimisation of social welfare functions that integrate social, economic, and ecological variables and indicators, around the achievement of 17 Sustainable Development Goals of the UN 2030 Agenda, and 169 objectives associated with them.

**Keywords.** Shocking Crisis, Disruptive Environment, Strategic Anticipation, Prospective Planning, Social Welfare Functions, Sustainability.

## 1 Introduction

The current global pandemic has revealed a high international vulnerability to this type of threat and the inability of many nations to respond effectively to environmental uncertainty [1]. It seems clear that this pandemic will involve a profound change in lifestyles and a crisis in traditional economic systems, with a structural change that will lead us to a new global situation. This progressive increase in risk situations associated with infectious diseases could be the result of a rapid global change that is altering the relationship between humans and our environment [2]. In our opinion, the response from governments in many countries and from civil society has been delayed, improvised, ineffective and insufficient. But these threatening triggers are also present in other equally devastating phenomena: climate action failure, extreme weather, water crisis, natural disasters, human-made environmental disasters, cyberattacks, global governance failure, biodiversity loss, involuntary migration, social instability, etc. [3].

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In addition to reducing the vulnerability of the population through preventive actions and the management of sector-specific policies against each threat, it is necessary to develop multidisciplinary and multisectoral action systems for early detection and strategic anticipation, response planning in terms of resilient perspectives [4], both social, economic and environmental, as well as strategic crisis and post-crisis management, ensuring coordination between all the agencies involved, the necessary public-private collaboration and the necessary international cooperation [5].

Generalizing to other shocking global crises that may arise, it seems advisable to undertake in depth a restructuring of the methodology to manage them. To avoid surprises and improvisations, as well as deviant and insufficient responses, it is necessary to develop digital systems for strategic anticipation and prospective planning, in a real time strategy, facilitating early detection and the most effective and efficient response with minimal risk [6]. The objective of this work is to study the application of these new strategies based on the optimisation of the social welfare functions that are determined, and that integrate the most significant variables of the social, economic and ecological dimensions of the sustainable development goals of the UN 2030 Agenda.

The research has been developed under an exploratory and explanatory research methodology, to understand the problem posed, and the work has been structured in three sections. First, there is a Literature Review section on new strategic methodologies applicable in a disruptive environment. Second, the Methods section discusses the use of social welfare functions to support the impactful global crisis management strategy, building on the outline of the Sustainable Development Goals. Finally, the Results and Discussion section studies an optimisation model of social welfare functions to support global crisis management impacting, and proposes a model of a general action scheme that is considered to improve the models that are being used, contextualizing the importance of the new approach.

## 2 Literature Review

In recent years there have been very intense and rapid changes in a highly disruptive global environment, whose generating aspects act with total uncertainty and without adjusting to a previous historical pattern [7]. It is a new and important characteristic of today's world that very significantly conditions the definition of strategic plans. The possible shocking triggers already mentioned, capable of acting globally, are very much alive today. In this way, the environment in which the public sector, the private business sector and civil society operate is very different from usual, and presents new threats, risks and opportunities, against which it is necessary to react in advance [8].

Strategic anticipation is the ability to explore and monitor the future, allowing decision makers to protect their interests, seek and take advantage of opportunities, and ensure the achievement of their goals and objectives [9]. Deeply related to strategic anticipation is the concept of prospective, which is the systematic, multidisciplinary and participatory process to gather knowledge about the future and build medium and long-term visions, with the aim of informing the decisions that will be made in the present [10]. Among the purposes of prospective planning, it should be highlighted that of generating alternative visions of desired futures, that of providing impulses for action, that of promoting relevant information under a far-reaching approach, that of creating explicit alternative circumstances of possible futures, and to establish values and decision rules to achieve the best possible future [11].

On the other hand, strategic intelligence has evolved towards a polysemic concept [12] that is obtained from the analysis and integration of very varied information, which offers key conclusions about a problem, within its framework of relation with other existing problems. It consists of the use of methodologies and techniques that allow reducing the uncertainty that affects strategic decision making. The organizational utility of strategic intelligence derives from its ability to transform and assign information to those responsible for strategic decisions [9], facilitating the early detection of opportunities, threats and risks in the disruptive environment [13] and improving performance and success [14]. Many authors have criticized the strategic planning technique because they consider that it should be alternatively continuous instead of at certain intervals [15], and thus evolve towards a prospective planning that facilitates a more comprehensive perspective of the organization [16]. Achieving the ability to penetrate the future requires a change in the strategic attitude, abandoning the reactive attitude and developing a proactive, anticipatory, and preventive attitude.

To apply all these new strategies, it is necessary to have methodologies that allow knowing the economic and social impact of each project or initiative. The Cost-Benefit Analysis (CBA) [17] [18] estimates and adds the equivalent monetary value of the benefits and costs for the community of public, private, and public-private projects. To reach a conclusion about its suitability, all aspects of the project, positive and negative, must be expressed in terms of a common unit, which means that all financial and social benefits and costs must be measured in terms of their equivalent value, a through the estimation of "income and opportunity costs". The equivalent monetary value is based on information derived from consumer and producer market choices, analysing historical data and future estimates of the demand and supply of goods and services affected by the project, updated through a discount rate to be integrated.

Finally, according to the Bergson-Samuelson approach, a social welfare function [19] [20] is a qualitative mathematical construction that considers the welfare of a given set of individual preferences, assigning values of social utility to possible reasonable alternative states of feasible associations of its economic system and associating a social preference to each possible configuration of individual preferences. It represents the possible patterns of collective choice and the alternative social states of allocation, trying to achieve the optimal allocation of resources based on the preferences of the individuals of that society with respect to collective decisions.

### 3 Methods

Collective decision models, currently linked to interactive models of democracy [21], try to obtain criteria for the aggregation of individual preferences in social preferences. Analytically, the function of utility levels is obtained from the problem of maximising the social welfare function  $W_{Social}$ , which is qualitative, defined by the integration and interaction of individual utilities  $U_i$ ,  $i$  from 1 to the  $n$  members of society:

$$\begin{aligned} & \text{Maximise } W_{Social}(U_1, U_2, \dots, U_n) \text{ subject to restrictions} \\ & \text{minimum individual utility, feasibility of allocations, and availability of resources.} \end{aligned}$$

In 2015 the UN established the Sustainable Development Goals (SDGs) within 2030 Agenda. Since then, sustainability has become an important aspect of management [22], which requires that the public and private sectors implicitly carry out the critical evaluation of their activities in economic, social and environmental terms [23], including responsibility and the ethics of social behaviour as well as the new requirements of

citizens in the welfare economy. The SDGs, as a plan for global development, demand the interconnection of all social sectors as key development actors, and an unprecedented level of cooperation and collaboration between civil society, business, government, NGOs, foundations, and others for their achievement. Partnership and collaboration between the social sectors have become an essential paradigm of sustainable development [24], perhaps in response to the limitations of traditional methods of development led by States.

On the other hand, scenario planning is a tool that involves generating a series of scenarios described in depth, each of which talks about a possible different future for society, and considers how each different future could influence decision-making of global crisis management [25]. The focus of the strategy is on decision making and assumes that the future that will follow will be the result of decisions made in the present. It is therefore a sequential linear approach, but it assumes that in complex situations the future is unpredictable, changes rapidly, and that decision-making is strengthened by taking a more open and flexible approach to the future.

Integration into a strategic intelligence management joint model that uses maximised social utility functions and sustainable development goals, variables, and indicators, is considered an excellent basis for assuming prospective planning of response scenarios to potential shocking global crisis.

#### 4 Results and Discussions

Before proposing such a model, it is necessary to assume a systemic conception of sustainability and sustainable development [26], and the deployment of the 17 SDGs and 169 objectives associated with them in measurable and integral composite indicators [27]. Then, the strategic intelligence management model would be based on the maximisation of the utility index functions that would use the quantitative (and not qualitative) variables of the deployment of the SDGs:

$$\text{Max}\{W_S(U_1, U_2, \dots, U_n)\} \approx \text{Max}\{U_S\} = \text{Max}\left\{\sum_{i=1}^n U_i\right\} = \text{Max}\left\{\sum_{j=1}^{169} p_j * f(SDG)_j\right\}$$

where  $W_S$  is a qualitative social welfare function,  $U_S$  is its quantitative function,

and  $f(SDG)$  is a function of the composite indications of the deployment of each objective.

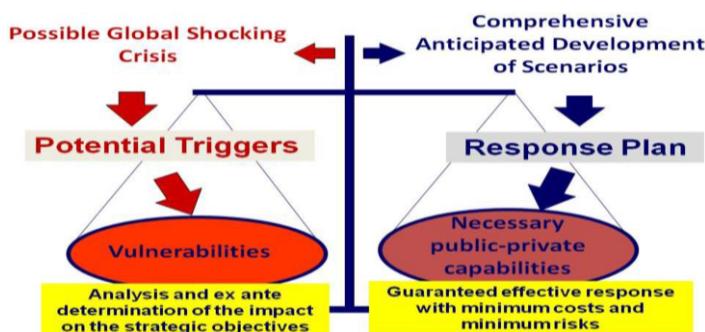
This optimisation is subject to the following restrictions:

$$U_i \geq K \text{ (minimal quality of life restriction)}$$

$$\text{Max}\left\{\sum_{j=1}^{169} p_j * f(SDG)_j\right\} \text{ involves the resource allocation, which must be feasible and adjusted to the available resources.}$$

The joint strategic intelligence management model must permanently track the indicators that comprehensively explain the behaviour of possible triggers that generate vulnerability. As you can see in Fig. 1, the potential impact of the state and the evolution of the different crisis triggers and the potential impact on the established strategic objectives (SDG) must be analysed and determined ex ante, evaluating direct preferences and behaviour people (CBA). In all cases in which there is a possible shocking crisis, nuanced by the estimated level of probability of occurrence, the exhaustive generation of all possible prospective scenarios would proceed, with the help of big data, business

analysis, artificial intelligence and simulation systems. Each scenario will involve the determination of a specific strategic response plan that will identify the public-private capacities that are necessary to guarantee an effective response, depending on the maximised function of social utility index, and generating the maximum difference between benefits and social costs, with minimal risk of error. So, action strategies and capacity building for strategic anticipation will depend on the dynamic balance between the comprehensive social benefits of the consequences of each possible shocking global crisis, and the comprehensive social cost of generating these capabilities. At the same time, direct action plans and the deployment of such capabilities must be developed, making it possible to turn the most desirable scenarios into those most likely to become reality. It is considered that the proposed model improves the models that are currently being used which do not guarantee the maximisation of social utility, considering as a line for future research its application to a real case, as well as its adjustment and validation.



**Fig. 1.** Scenario planning: Generating alternative response plans [5]

## 5 Conclusions

The management of shocking global crises produced as a consequence of the current highly disruptive environment, requires new strategies of strategic anticipation, prospective planning and strategic intelligence that guide the application of digital technologies and can develop proactive, effective and efficient response plans, facing the currently used traditional management models which do not allow obtaining an adequate performance from digital technologies. International cooperation and public-private collaboration are essential and require a global standardization of actions, for which management models based on maximising social welfare functions on the SDGs and the use of CBA are useful.

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# An Innovative Application of Big Data in Healthcare: Driving Factors, Operation Mechanism and Development Model

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**Abstract.** This paper aims to build a conceptual framework for the innovative application in big data in healthcare. Method: Diamond Model and PEST Model were used to analyze the key driving factors of big data in healthcare through external and endogenous driving factors. Based on this, the operation mechanism and possible development model of big data in healthcare were analyzed by using the diffusion theory of policy innovation. Results: The key factors of innovation and application of big data in healthcare are divided into external and endogenous driving factors. The driving mechanism is defined as "learning, compulsion, competition, imitation and inducement". The conceivable development model is based on big data value innovation and the motivation of different stakeholders. Conclusion: Through the logical analysis of value innovation, the internal relationship among the relevant factors, driving forces and interaction of big data in healthcare application is established, and finally a theoretical analysis framework for innovative application of big data in healthcare is presented.

**Keywords.** Big data in healthcare, innovation application, driving factors, operation mechanism, development model

## 1. Introduction

The development and application of big data in healthcare will enable to increase the supply of health and medical resources, reduce medical costs, improve the quality and efficiency of medical services, and have a important impact on social and economic development and public living standards[1]. At present, big data in healthcare has been gradually applied in clinical medicine, public health, medical insurance and other fields, providing important support for decision-making to medical staff, patients and insured[2]. The purpose of this paper is to build a theoretical framework for innovative application of big data in healthcare. With data value as the main line, the external and endogenous drivers of big data in healthcare application are analyzed from the front end. Whereas, the operation mechanism of big data in healthcare application as the core, the back end focuses on the development mode of application, forming a healthy

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complete chain of big data in healthcare application analysis. This innovative application of big data in healthcare provides essential theoretical support[3].

## 2. Method

This study mainly applies Diamond model and PEST model to analyze the key drivers of big data in healthcare through external and endogenous drivers. Based on this, it uses the theory of policy innovation diffusion to analyze its operation mechanism and development mode.

### 2.1. *Diamond model*

The analysis factors of diamond model include micro forces like production, demand, industry strategy and supporting industry[4]. By comparing the above four aspects of big data in healthcare application, this study analyzes and summarizes the main influencing factors of two major bodies (public sector and market forces) of health big data.

### 2.2. *PEST analysis*

PEST analysis refers to the macro factors affecting the development of an industry from four aspects of politics, economy, technology and society. By using PEST to analyze the big data in healthcare, we can better grasp the macro environment and the future development of big data in healthcare.

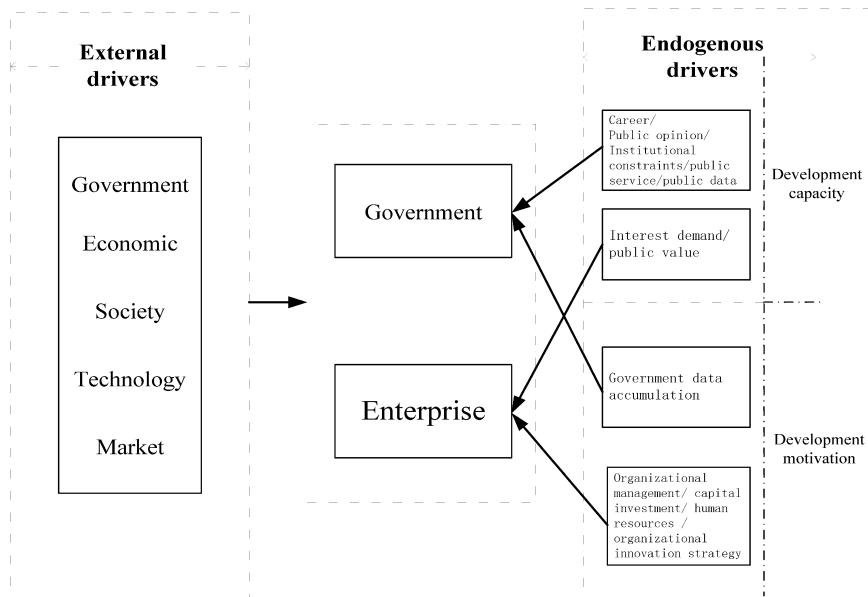
### 2.3. *Diffusion theory of policy innovation*

The diffusion theory of policy innovation expounds the source of public policy by analyzing the influence of external factors on public policy making. This study examines the operation mechanism of big data in healthcare application by analyzing the learning, competition, imitation and enforcement mechanisms in the process of big data in healthcare application innovation[5][6].

## 3. Results and Analysis

### 3.1. *Key drivers of big data in healthcare innovation application*

According to the Diamond model and PEST analysis, the key driving factors of big data in healthcare application are divided into external and endogenous driving factors[7]. The external factors mainly include government, economic, social, technical and market factors. The endogenous drivers include development motivation and development capacity and are illustrated in Figure 1.



**Figure 1.**Key drivers for application of big data in healthcare.

- **External drivers**

Government factor means that the government regulates and guides the resources, technologies and applications of big data in healthcare through various legislations and regulations, policies, standards and other tools[8]. Economic factors are the macroeconomic conditions of a country or a region, such as economic development level, economic structure, residents' income, consumption structure, etc. The impact of social factors on big data in healthcare is more reflected in literacy, employment, community safety, and moral constraints. Technology factor is the main factor and important support for the application and development of big data in healthcare. Technology innovation can promote the core competitiveness of the enterprises, and provide a realistic basis for the development and growth of big data in healthcare industry[9]. On the other hand, market factors like the number of consumers, market size, market structure and market demand, which affect the application direction and industrial scale of big data in healthcare to a certain extent[10].

- **Endogenous drivers**

The endogenous drivers refer to various influencing factors and conditions arising within the fields of big data in healthcare and closely affect its operation activities. The logic behind the development motivation, capacity of the public sector and market forces is as follows[11].

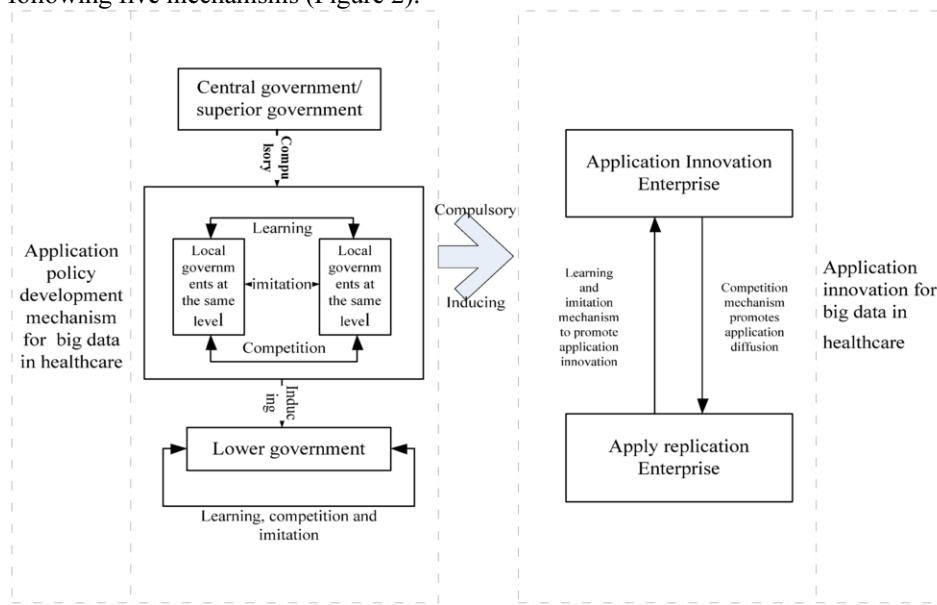
The internal and external stakeholders and environmental factors of the public sector will jointly shape the motivation and ability of the public sector to apply health big data. From the perspective of motivation, what are the main leaders' and department leaders' understanding of big data application? It is the key factor that affects the application of big data in healthcare in the public sector. The main factors include career promotion, public opinion promotion, institutional constraints, public

service motivation and public data promotion[12]. From the characteristics of big data in healthcare, the development capacity of the public sector mainly includes the accumulation of government data.

The motive of market power development is interest demand and public value. The main body of market power's development ability in the application of big data in health care includes four aspects: organization and management mode, capital investment scale, human resources and innovation strategy of interest body[13]. Stakeholder organization and management mode refers to the responsibility structure and management mode based on the specific rules and procedures in order to effectively allocate various resources within the stakeholders (i.e. public sector and market forces). Capital investment scale especially, for big data in healthcare has the high-tech characteristics of emerging industries, which means that it needs a certain scale of capital-intensive R & D activities to support. Human capital is the most predominant factor, since the big data in healthcare industry is a high-tech knowledge intensive industry and its development is based on the accumulation and assimilation of technology and knowledge[14]. In addition, the stakeholder innovation strategy is to improved based on the environmental changes in order to leverage their own advantages in the competitions.

### 3.2. Operation mechanism of big data in healthcare innovation application

The aforesaid analysis of the key drivers, the external drivers and endogenous factors of different stakeholders have been clarified. However, the mechanism by which these drivers have an effect on the innovative application of big data in healthcare is not yet clear. Based on the four mechanisms of "learning, competition, imitation, and compulsory" in the theory of policy innovation diffusion[15], the driving mechanism for the innovative application of big data in healthcare is defined in the following five mechanisms (Figure 2).



**Figure 2.** Operation mechanism of application development for big data in healthcare.

- Learning mechanism

Learning mechanism is a process of information obtaining, interpretation and usage, which explores new solutions to problems through keeping trying[16]. From the government's point of view, learning from the experience of other places can change the thinking mode of decision-makers, so as to provide new and feasible ways or programs to solve their own problems. From the perspective of the enterprises, the importance of learning mechanism is to provide information support for enterprise decision-making, so as to achieve the goal of maximizing their own interests[17]. In the process of innovative application of big data in health care, innovation pioneers can promote the establishment of learning mechanism, and the benefits obtained through learning and innovation can reduce the concerns of relatively conservative people, thus reducing the resistance to reform.

- Compulsory mechanism

At the government level, compulsory mechanism refers to a process in which one actor try to impose its approved policy scheme on another[18]. For example, it directly promotes the innovative implementation of big data in healthcare through administrative orders, so as to improve the possibility of its promotion and application. Therefore, like other policy innovation diffusion, innovation of big data in healthcare often follow the top-down policy implementation path. Power inequality is an important feature of compulsory mechanism[19]. The actors with greater power will affect the decision-making of the relatively weak one. At the enterprise level, the compulsory mechanism comes from market competition. Enterprises must develop new products to meet market demand, or improve management and technical level to reduce costs, so as to improve their own efficiency and competitiveness. And the innovation of these products, management and technologies will promote other backward enterprises to enter the process of compulsory innovation. The compulsory mechanism also further enhances the interaction between the government and the enterprises. The government can push the enterprises to carry out the application and development of the corresponding big data in healthcare through the government documents and other laws. However, the enterprises actions will not fully reflect the original intention of the government policies, but only choose their own interests, leading deviation of government policy implementation or inefficiency of market[20]. The interaction between government and enterprises can also be achieved through inducement mechanism. The details are discussed below.

- Competition mechanism

From the perspective of the government, the competition mechanism of big data in healthcare application refers to the adaptive pressure between different governments in the competition of political promotion resources and economic scale growth. Therefore, it is necessary to compete for more powerful resources through policy adjustment in the new field of big data in healthcare[21]. Under this mechanism, all regions need to maximize their own interests to carry out policy competition, such as talent introduction, financial revenue and so on. If one region takes the lead in introducing new policies in the application of big data in healthcare, it will get more resources in the development. In order to reduce its own loss in the competition, another region will take similar strategic actions, such as adopting the former's new policies or introducing policies with more potential development. From the perspective of enterprises, the driving force of innovation diffusion in health care big data application comes from the pressure of innovative application, that is, non innovative application enterprises

choose innovative application to avoid being eliminated in market competition; application innovation diffusion is also driven by traction force, that is, innovative enterprises choose initiative promotion and application in order to maximize the profit of innovative application. To sum up, both the government and the enterprise will adopt different measures to promote or limit the diffusion of health and medical big data application innovation according to the principle of maximizing interests[22].

- Imitation mechanism

The imitation mechanism involved in the classical theory of the diffusion of policy innovation is more about the actors' copying and applying or simply modifying to increase the legitimacy of policy choices and the availability of benefits. On the one hand, for the government, most regions simply apply the new policies without combining their actual conditions and giving full play to their advantages. For example, while developing big data in healthcare, most regions will promote the construction of big data industrial parks, without fully considering their own resource endowment. From the enterprises point of view, enterprises can quickly get a share of the market by simply imitating innovative applications, which may have considerable profits in the early stage of operation[23]. However, the threshold of such simple imitation innovation is low, and the subsequent market competition will lead to short profit cycle, and the final price competition will also make the profit return to normal level, which can not fundamentally changing the profit model of enterprises.

- Inducing mechanism

From the government perspective, inducing mechanism refers to that the innovative application projects of big data in healthcare of lower level government or neighboring government have achieved remarkable results, thus guiding and promoting the higher level government or the neighboring government to make innovative decisions. For the enterprises, the government can also provide support in the application and innovation of health care big data through various forms such as incentives, subsidy, and other financial support. By identifying conducive development conditions created by the government, enterprises can judge whether they are in line with the development strategy of the enterprise or the impact on the future profits of the enterprise, and choose their own policy, so as to promote the development of big data in healthcare application[24].

### *3.3. The development mode: innovation application of big data in healthcare*

Based on the analysis of driving factors and operation mechanism, this paper analyzes the application of big data in health care with the core logic of value discovery, value creation and value realization, and summarizes the possible development mode of big data in health care[25].

- Possible development model of value innovation based on big data in healthcare

In public management activities and market economy activities, the development model of big data in healthcare includes value discovery, value creation and value realization[26]. Value discovery refers to discovering the value information of market demand through the changes of political, economic and social factors. Value creation refers to the change of development mode caused by the change of internal environment, which mainly refers to the change of organizational structure, cost,

process, workflow, working mode, working partnership and other factors. Value realization refers to the change of target customers and the innovation of means, which mainly includes changes in customer relationship, distribution channel and revenue model. According to the above analysis, the possible development modes of big data application in health care can be divided into value proposition innovation mode, key business and process innovation mode, value network reconstruction mode, etc[27].

Value proposition innovation model. "Big data" can provide accurate value proposition to government departments, medical institutions or enterprises due to its infinite potential close to everyone's health level or medical treatment mode, that is, clinical application innovation based on health and medical big data. It has the following characteristics: first, it has an insight into the real needs of human health. Over a long time, medical institutions use limited data or experience for diagnosis and treatment activities[28]. However, the real health needs of individuals are difficult to identify due to their complexity, diversity and variability, which require the empowerment of big data. The second is the real-time, accurate and dynamic positioning of diagnosis and treatment. The real-time personalization of big data in health care can quickly collect, correlate and analyze the data with scattered sources and various formats, which helps medical institutions dynamically capture the real health needs of individuals and accurately delineate the health level of the population. Through big data empowerment, the human health status is accurately subdivided and different diagnosis and treatment schemes are implemented. For example, through the analysis of personal genetic data and molecular data, it is helpful to carry out personalized medicine treatment and boost the reform and development of the medical industry[29].

Value creation and transmission innovation mode. Big data in healthcare is not only the basic tool for application, but also the basic condition for innovation. The innovation mode of value creation and transmission is based on big data in healthcare, which is the key business and process of health care activities innovation and empowerment, namely the "big data" process of health and medical activities[30]. According to the scope of its transformation and influence, it can be divided into: reconstructing medical data information flow through health care big data technology, realizing business process innovation and reengineering; taking health and medical data flow as the core, realizing the deep integration and reform of the business model of medical institutions; increasing the new driving force of big data in health and medical application innovation, and realizing new value exploration And path change, from the big data thinking mode, optimize the existing process, and put forward new methods and ideas to solve the problem[31]. To sum up, the key business and process innovation mode is guided by the actual needs of medical services, integrating the application of big data in health care, focusing on solving the key tasks of public hospital reform, family contract service system, hierarchical diagnosis and treatment, the key and difficult problems in the field of health and mainly through optimizing the health management service process, and promoting the refinement in supervision and decision-making.

Value network reconstruction mode. The innovative application big data in healthcare has greatly reduces the cost and risk of the government, medical institutions, relevant enterprises and the public to own and use other external resources, sharing resources and overflow resources, and provides a technical support for the development and the dissemination of new value[32][33]. The process of value network reconstruction is a process of interaction between multiple participants and multiple

value chains, which is oriented by the value creation of leading products or original target customers. Stakeholders can also integrate into other value chains and other stakeholders through the characteristics of value communication[34]. The innovative application mode of big data in healthcare can be one or more innovative modes[35]. For example, local governments explore the innovation of medical service mode through establishment of internet hospitals and smart hospitals.

- The possible development model based on the motivation of different stakeholders

The development mode of big data application in healthcare is mainly composed of external and endogenous drivers. Among them, the relationship between the government, society and market among the external drivers is the dominant factor that determines the industrial development model of big data in healthcare. The differences in the power and resources possessed by the government, society, and market within the industry determine the different development models, which in turn lead to the different sources of power, influencing factors, and combinations of innovative applications in the industry. According to the main source of innovation power, the development model of innovative application of big data in healthcare can be divided into four types: government-led, industry-driven, socially-initiated, and mixed development[36].

#### 4. Conclusion

This paper analyzes the key driving factors, operation mechanism and possible development mode of health care big data based on the core logic of value discovery, value creation and value realization. On the basis of multiple theories, aiming at the two interest subjects of government departments and enterprises, the paper organically integrates the key driving factors and operation mechanism, and combs out the possible development mode of application through the analysis of value innovation, and establishes the internal relationship among the application related factors, driving forces and interactions of health care big data, finally forming an internal logical connection as depicted in Figure 3.

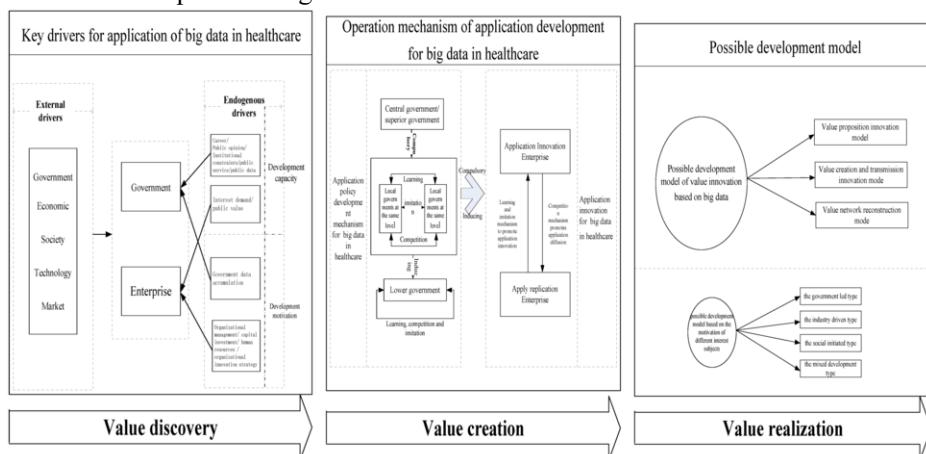


Figure 3.Theoretical analysis frame of big data innovation application in health care.

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# Using Bibliometric Indicators from Patent Portfolio Valuation as Value Factor for Generating Smart Beta and Index Products

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**Abstract.** This paper goal is to present the results the use of patent valuation indicators as alternative data which can generate a value factor which is suitable to design financial products. Based on different patent value indicators which address the areas “assignee”, “technology” and “market” an “IP portfolio index” was designed and backtested with real market data. The outperformance of the IP portfolio index is shown in the current paper.

**Keywords.** patent valuation, bibliometric data, stock picking, IP portfolio index, smart beta, factor-investing, alternative data

## 1. Introduction

Alternative data (proprietary datasets) in different areas like geo-location, credit card, social/sentiment or web traffic became very popular over the last years at financial institutions promising additional insights beside business data.

The financial asset management institutions like discretionary, quantitative or hedgefunds develop own indexes which should outperform in terms of absolute return on investment with low maximum drawdown (a maximum drawdown (MDD) is the maximum loss of a portfolio. The MDD indicates the downside risk of a trading strategy) compared to an underlying (similar) index. These so called ‘smart beta products’ (applying different metrics/factors for signal-creating) use alternative index construction which is rule-based and including different factors.

Patent data became very popular over the past years because of the currently high quality of the data delivered by the most national patent offices and the possibility to use patent metrics as an indicator to measure the innovation developed by companies [1,2,3,4,5,6,7,8].

In literature have been created as well some “patent indexes” based on different patent metrics. Some of them are described in the study of Michele Grimaldi and Livio

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Cricelli [9]. In this study an own “patent value index” is described based on different metrics.

The main weakness of the current existing patent indexes is beside of the lack of high quality data that the meaningfulness of the outcome and the commercial exploitation is doubtful.

## 2. Aim of the Study

The aim of the study is to scientifically prove that patent indicators derived from different metrics have a real market impact especially for the financial sector.

This paper shows that patent value indicators build out of bibliometric data are suitable to determine equities which will outperform on a long-term base and can be used as reliable factor to develop smart beta products based on patent related indicators.

The contribution of the authors in this work is to determine patent indicators which have a scientific prove and to apply them in out-of-sample tests on different stock indices in order to determine a outperformance of equities which are selected with these metrics.

The main theory for using patent indicators is, that the development of the patent portfolio of a company is an early trend indicator and contemporary representing the present status of a company’s research- and development output.

The amount and quality of granted and applied patents are an early stage and trend indicator, because first there is a serious time lag between application and grant of a patent which depends on the patent office, the patent quality itself and the technological sector and is stated to 1-10 years [10]. Secondly patents can be found after several years of their filing in products of the applicant.

The patenting activity of a company represents as well the current status of a company in terms of revenues and profits, because filing and counter fighting needs available resources in terms of money and human power. Further the development of patents needs a high-class research and development department, which generates innovations, otherwise no patents will be granted. Last but not least, a company which is filing patents with a high quality believes in its own technology and future growth, and is not only optimizing the corporate structure for cost-savings.

These points make patent analysis for fundamental company rating so interesting. Studies have shown that there is a correlation between stock value and patent development [11,12,13].

The current paper endorses the basic theory, that measurement of patent quality is a suitable factor for selecting equities and generating indexes for investment purposes.

## 3. Data Sources

For this study different data sources have been used which are described as follows:

### 3.1 Business data

The business data have been delivered from Moodys product “Orbis” which is Bureau van Dijk's flagship company database [14]. It contains information on companies

across the world and focuses on private company information. It has information on around 300 million companies from all countries. The main information which was exported from the database have been:

- Company identifier (ISIN)
- Total assets
- Amount on employees
- Corporate tree with subsidiaries >51% share
- Stock quotes of the equities (closing prices)
- List of constituents for backtested index

The sample size of companies who have patents is:

- 1,055,090 active companies worldwide
- 21,716 stock market listed with patents
- 11,584 stock market delisted with patents

### *3.2 Patent data*

The used database for patent data was “Patstat” [15] which is a global database containing bibliographical data relating to more than 100 million patent documents from industrialised and developing countries. It also includes the legal event data from more than 40 patent authorities contained in the EPO worldwide legal event data.

### *3.3 Economic data*

The economic data used for this study is the GDP from each country. This was downloaded from the Worldbank Open Data [16].

## **4. Proposed System for the Main Indicators**

Based on different possible indicators, the proposed main indicators determining patent portfolio quality are:

1. Assignee impact  $[Ai]$  = ratio alive patent families/employees and total assets of the assignee
2. Technology Impact  $[Ti]$  = Number of citing patents
3. Market impact  $[Mi]$  = amount of family members and GDP of the countries where the patent family members are alive (= patent country distribution)

The indicators are determined like follows:

### *4.1 Assignee Impact $[Ai]$*

The assignee itself seems to have an impact for the value of a patent because he needs high resources to get the patents in force, to block competitors and to sew infringements. One metric to determine the commercial strength of an assignee is the amount on “total assets”. Further the more granted patents a research and development department is producing, the higher the quality of the patents due to standardised processes and intellectual knowledge in patenting.

The Assignee impact is defined to:

$$[Ai] = \frac{\text{Amount on alive patents}}{\text{Amount on employees}} * \frac{\text{Total assets}}{\text{Maximum total assets}} \quad (1)$$

Both sub-indicators are equalweighted.

#### 4.2 Technology Impact [Ti]

There are 2 different types of citation: forward and backward citations. Future citations received by a patent (forward citations) are more important than the backward citations, because in the case of forward citation the main indication is, that an innovation has contributed to the development of subsequent inventions. For this reason, citations have been used in several studies as a measure of the value of an invention [5, 17, 18]. The main thesis is, that the more often a patent is quoted as prior art during examinations of subsequent patent examinations, the more fundamental its technological contribution to the field, the higher the quality [19, 20].

Backward citations are used to determine the inventory step of the innovation and because this is connected with the patent applying process of the attorney it can't be used as good indicator: some attorneys are using a huge amount of backward citations with the aim to show the examiner that the applied patent is very innovative, other attorneys do not use this very intensively. Also the application process in different countries leads to different amounts of backward citations.

The examiners in the Patent offices have a certain amount of patents they always use for citations (because of time reduction for the examination process) – this behaviour from the practical point of view can have influences. This topic was examined by Criscuolo and Verspagen [20] and Juan Alcácer and Michelle Gittelman [21].

Further the cited documents can be also used as an indicator. Usually there are other patents or utility models cited but also NPL (Non-Patent-Literature) [22]. The main conclusion is, that the closer a patent application is to "fundamental research", as reflected by the non-patent references, the higher its technological quality. NPL is also used like backward citation to show the examiner that the state of the art has been approved before applying.

The forward citation is also a main indicator for the litigation process. In the work of Jean O. Lanjouw and Mark Schankerman [23] it is shown that there is a direct impact between citation and litigation.

The current Technology impact is defined as follows: the amount on foreign citations was divided through the amount on alive patents. The normalization was performed under the backward citation index, average per economy (country) [24]. Self-citations (even intra-corporate from subsidiaries) and references to non-patent literature have been excluded from the count. Approximately 11 percent of all citations in the sample from Jaffe and Tratenberg, 2003 are self-citations. To determine this indicator properly the corporate tree from the company must be available [25].

The technology impact [Ti] is defined to:

$$[Ti] = \frac{\text{amount on foreign citations (normalized)}}{\text{amount on alive patents}} \quad (2)$$

#### 4.3 Market impact [Mi]

A number of authors have argued out that information on family size may be particularly well suited as an indicator of the value of patent rights. The studies by Putnam and Lanjouw et al. [26] have shown that the size of a patent family, measured

as the number of jurisdictions in which a patent grant has been sought are highly correlated. To measure the potential power of a “family size”, it is recommended to obtain the number of nations in which protection for a particular invention was sought from Derwent’s World Patent Index (WPI) database.

The study from Adam B. Jaffe, Gáetan de Rassenfosse [27] shows, that there exists as well a bias for the priority application. The size of a patent family is an indicator for the market impact that the technology described in the patent may have. The assumption is, that the higher the applicants willingness to pay for a large territory protection, the higher the patents value.

There exist some studies [28] showing that triadic patents (patent family applied and/or granted in Europe, Asia and USA) having a higher value than only filed in single countries, but due own experience of the author in several valuation projects the value of a patent depends much more on the certain economy where the patent is filed. The market impact is therefore defined to the share of the IPC class (distinct 4 digit IPC subclasses) in the certain country where the patent family is filed, expressing the importance of the technology area in the certain country. The shares for each sub-class are exemplarily shown in a study from InTraCoM [29].

The market impact is further directly correlated with the economic size of the country (expressed in GDP), the importance of the certain technology in that country (expressed in share of the IPC class in the country) and the legal status of the patent family (application, grant or utility model).

The Market impact [Mi] is defined to:

$$[Mi] = \sum_1^n \frac{\text{amount patents in the IPC class in the country}}{\text{total amount of patents in the IPC class}} * \frac{\text{GPR of the country}}{\text{Global GDP}} * Co \quad (3)$$

Co = factor for legal status of the patent family member defined to

Granted patent = 100%

Applied patent = 20 %

Utility model = 10%

#### 4.4 Composite Index

The calculation of the total patent quality [TPQ] in %, is based on the equal weighted indicators Ai, Ti, Mi, to:

$$TPQ = Ai * Ti * Mi$$

### 5. Data Samples

The IP portfolio index was generated and backtested based on the available indices in the market. Because the constituents (listed and delisted equities) of the index change every year, the backtest is performed static and dynamic. The static tests were designed in that way, that the current constituents have been selected and remained for the past 10 years in the patent value index, and not replaced with the new ones. This is a small failure in the direct benchmarking of the IP portfolio index with the current indices, but there is no other possibility on how to handle this issue for benchmarking on a long

time period ( $> 10$  years). A second, dynamic backtest was performed too, but for a shorter period, for 4 years. The dynamic tests take into account the change of constituents and there is as well some turnover in the designed IP portfolio index.

The composition of the indexes and other related data like closing prices have been received from Orbis IP database [14].

Some data samples are given in the following tables in order to give an impression about the patent indicators, the sectors and equities used. Table 1 shows data samples are for the STOXX600 index:

**Table 1.** Data samples of patent metrics for a sample set of companies from STOXX600

No.	Company name	1	2	3	4	5	6	7
1.	ABB	CH	Industrial	15.937	73,6	91,1	79,3	50,4
2.	BASF SE	DE	Chemicals	50.771	75,8	95,1	57	75,3
3.	Daimler AG	DE	Automotive	11.684	79,0	98	68,6	70,5
4.	Electrolux	SE	Household	4.895	74,0	94,7	78,3	49
5.	Fresenius Medical	DE	Medical equipment	4.879	67,7	89,9	74,3	39
6.	Infineon	DE	Semiconductors	28.964	77,7	90,1	73,2	69,7
7.	Nestle	CH	Consumer	16.760	75,9	97,4	72,6	57,8
8.	Nokia	FI	Communication services	60.229	91,5	95,5	82,6	96,5
9.	SAP	DE	Information technology	9.556	74,2	77	96,5	49,2
10.	Vestas	DK	Energy	60.229	88,5	95,5	82,6	87,4

1 Country code

2 Sector

3 Number of live publications

4 Total patent quality in %

5 Technical impact

6 Market impact

7 Assignee impact

The data samples are selected from different technology sectors and having as well different metrics, for example amount on alive patents or the key indicators.

The selected equities have as well different economic numbers like the following table shows.

**Table 2.** Data samples of financial metrics for a sample set of companies from STOXX600

No.	Company name	1	2	3	4	5	6	7
1.	ABB	CH	CH001222 1716	24	16	17	144	41
2.	BASF SE	DE	DE000BA SF111	99	57	60	117	86
3.	Daimler AG	DE	DE000710 0000	76	45	46	298	302
4.	Electrolux	SE	SE000010 3814	28	15	18	48	10
5.	Fresenius Medical	DE	DE000578 5802	94	56	56	120	32
6.	Infineon	DE	DE000623 1004	26	18	20	41	13

7.	Nestle	CH	CH003886 3350	77	65	71	291	117
8.	Nokia	FI	FI0009000 681	5	4	5	98	39
9.	SAP	DE	DE000716 4600	108	81	87	100	60
10.	Vestas	DK	DK001026 8606	71	51	66	25	14

1 Country code

2 ISIN number

3 Market price – high, EUR, year 2018

4 Market price - low, EUR, year 2018

5 Market price - year end, EUR, year 2018

6 Number of employees in 1,000

7 Total assets, b€

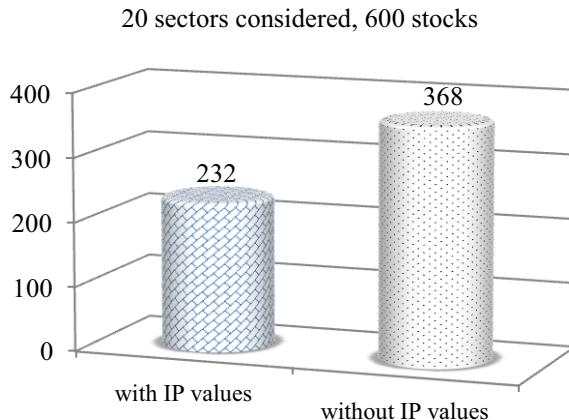
The Stoxx600 Index contains in general 20 sectors. The sectors considered for the IP portfolio index are:

1. Automobiles & Parts
2. Basic Resources Services (Basic resources)
3. Chemicals
4. Construction Materials
5. Food & Beverages
6. Industrial Goods
7. Media
8. Medical Engineering (Healthcare)
9. Oil Services, Green Energy (Oil&Gas)
10. Personal & Household Goods
11. Retail
12. Technology
13. Travel & Leisure

The sectors not considered (due low IP activity and importance) are:

1. Banks
2. Basic Resources (producers)
3. Financial Services
4. Healthcare (producers)
5. Insurance
6. Oil & Gas (producers)
7. Real Estate
8. Real Estate Cap
9. Telecommunications
10. Utilities

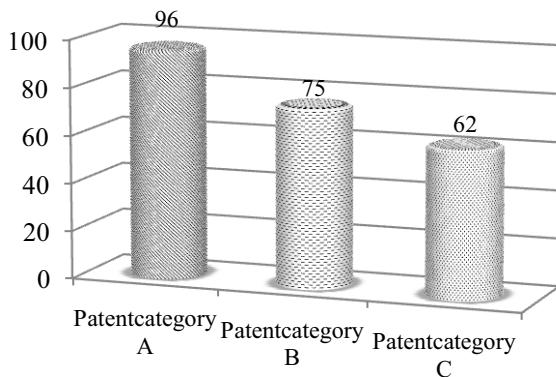
In the Stoxx600 232 companies were identified having a reasonable amount on patents:



**Figure 1** Amount on equities with high quality patents in Stoxx 600 index

In these sectors the equities with highest IP relevance were selected:

#### IP categories (A highest IP relevance)



**Figure 2.** Categories within the IP value index

The selected equities in the Patentcategory A in the IP portfolio listed in table 3.

**Table 3.** Top equities with highest patent portfolio quality in Stoxx600 index

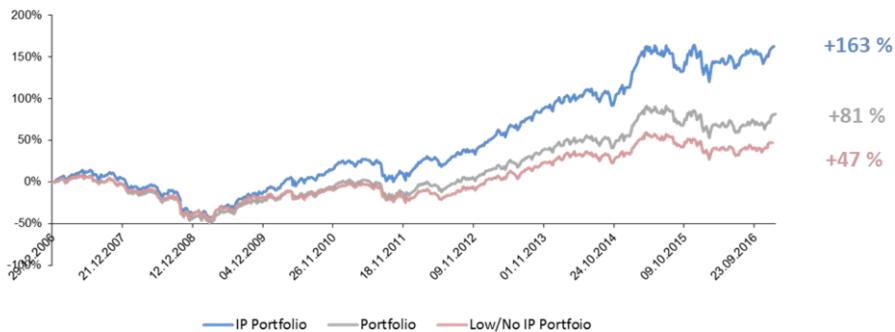
- |                                  |                         |                           |
|----------------------------------|-------------------------|---------------------------|
| 1. ABB Ltd.                      | 13. BASF SE             | 25. Deutsche Lufthansa    |
| 2. Actelion Ltd.                 | 14. Bayer AG            | 26. Diageo plc            |
| 3. Air Liquide SA                | 15. Beiersdorf AG       | 27. Electrolux AB         |
| 4. Akzo Nobel N.V.               | 16. BT Group plc        | 28. Elekta AB             |
| 5. Alcatel-Lucent SA             | 17. Carlsberg A/S       | 29. Essilor International |
| 6. Alstom SA                     | 18. CGG                 | 30. FLSmidth & Co.        |
| 7. Arkema SA                     | 19. Clariant AG         | 31. Fortum Oyj            |
| 8. ARM Holdings plc              | 20. Compagnie de Saint- | 32. Fresenius Medical     |
| 9. ASML Holding NV               | Gobain SA               | 33. Fresenius SE & Co.    |
| 10. ASSA ABLOY AB                | 21. Michelin SCA        | 34. GEA Group             |
| 11. Associated British Foods plc | 22. Continental AG      | 35. Gemalto N.V.          |
| 12. Atlas Copco AB               | 23. Daimler AG          | 36. Getinge AB            |
|                                  | 24. Danone SA           | 37. Givaudan SA           |

- |   |                                       |                              |
|---|---------------------------------------|------------------------------|
| 38. GKN plc                             | 59. Petroleum Geo-Services ASA        | 78. Smiths Group Plc         |
| 39. Grifols, S.A.                       | 60. Porsche Automobil Holding SE Pref | 79. Solvay SA                |
| 40. Henkel AG & Co.                     | 61. Prysmian S.p.A.                   | 80. Sonova Holding AG        |
| 41. Hexagon AB                          | 62. Reckitt Benckiser Group plc       | 81. STMicroelectronics NV    |
| 42. Infineon                            | 63. Rolls-Royce Holdings plc          | 82. SUEZ SA                  |
| 43. International Consolidated Airlines | 64. Royal DSM NV                      | 83. Swatch Group Ltd.        |
| 44. Investor AB                         | 65. Royal KPN NV                      | Bearer                       |
| 45. Johnson Matthey                     | 66. Royal Philips NV                  | 84. Syngenta AG              |
| 46. Kone Oyj                            | 67. Safran SA                         | 85. Tate & Lyle PLC          |
| 47. LANXESS AG                          | 68. Salzgitter AG                     | 86. Technip SA               |
| 48. Legrand SA                          | 69. Sandvik AB                        | 87. Telecom Italia           |
| 49. LM Ericsson Telefon AB              | 70. SAP SE                            | 88. Telia Company AB         |
| 50. Lonza Group AG                      | 71. SBM Offshore NV                   | 89. UCB S.A.                 |
| 51. L'Oreal SA                          | 72. Schneider Electric                | 90. Umicore                  |
| 52. Metso Oyj                           | 73. SES SA FDR                        | 91. Unilever NV Cert. of shs |
| 53. Nestle S.A.                         | 74. Siemens AG                        | 92. Unilever PLC             |
| 54. Nokia Oyj                           | 75. SKF AB                            | 93. Veolia Environnement     |
| 55. Novo Nordisk A/S                    | 76. Sky plc                           | SA                           |
| 56. Novozymes A/S                       | 77. Smith & Nephew                    | 94. Vestas Wind Systems      |
| 57. Orange SA                           |                                       | A/S                          |
| 58. Outotec Oyj                         |                                       | 95. Vivendi SA               |
|   |                                       | 96. Wartsila Oyj Abp         |

## 6. Results

### 6.1 Backtests on STOXX600

The performance of the IP portfolio Index containing the selected 232 equities with high IP quality shows a significant outperformance in opposition to the equal-weighted Stoxx 600 Index, and to the index of No IP Stoxx 600:



**Figure 3** Performance of the static IP portfolio Index for Stoxx600

#### Portfolio construction:

The Stoxx Europe 600 Index is separated in IP and Low/No IP stocks per 30.06.2016. Static, equal weighted portfolios of 232 IP stocks (“IP Stoxx Europe 600”) vs 368 Low/No IP stocks (“Low/No IP Stoxx Europe 600”) with yearly adjustment per 31.07; Benchmark is equal weighted Stoxx Europe 600 Portfolio (“Stoxx Europe 600”; 600 stocks); degree of investment = 100%; no risk management; no fees; ex dividend; all stock prices are calculated in EUR

Some performance indicators for the IP portfolio index is shown at following table:

**Table 4.** Key performance indicators of static IP portfolio Index Stoxx600

	Sharpe Ratio	Sortino Ratio	Avg 1 Y Return	Avg 1 Y Volatility	MAX DD
Patent portfolio index Stoxx600	0.54	0.87	10.2%	14.4%	-43.3%
Stoxx 600	0.42	0.39	6.1%	14.2%	-44.9%
No IP Stoxx 600	0.32	0.18	4.0%	14.6%	-42.3%

The Sharpe Ratio is used to help investors understand the return of an investment compared to its risk. Generally, the greater the value of the Sharpe ratio, the more attractive the risk-adjusted return. The sharpe ratio is calculated to:

$$\text{Sharpe Ratio} = \frac{R_p - R_f}{\sigma_p} \quad (4)$$

Where:

R<sub>p</sub> = return of the portfolio

R<sub>f</sub> = risk-free rate

σ<sub>p</sub> = standard deviation of the portfolio's excess return

The Sortino ratio is a variation of the Sharpe ratio that differentiates harmful volatility from total overall volatility by using the asset's standard deviation of negative portfolio returns, called downside deviation, instead of the total standard deviation of portfolio returns (Investopedia). The Sortino ratio is a useful way for investors to evaluate an investment's return for a given level of bad risk and is defined to:

$$\text{Sortino Ratio} = \frac{R_p - r_f}{\sigma_d}$$

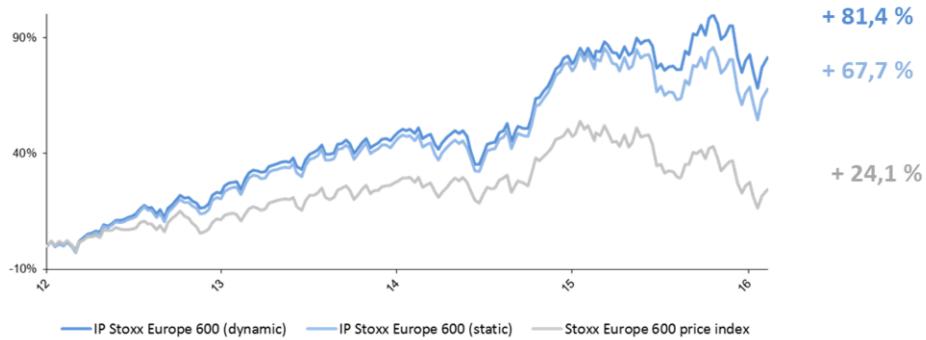
Where:

R<sub>p</sub> = actual or expected return of the portfolio

r<sub>f</sub> = risk-free rate

σ<sub>d</sub> = standard deviation of the portfolio's downside

All key performance indicators show a better quality of the IP portfolio index. Especially the correlation of significantly increasing the return with a very slight change of maximum drawdown (Max DD) and volatility makes the IP portfolio index very attractive. The downside risk (Sortino ratio) is as well much better than the index. This backtest was performed with a static portfolio of selected equities. This means, that the constituents of the IP portfolio index did not change, which does not meet the reality. Therefore a dynamic index was backtested too, where every year the new composed Stoxx 600 was analysed. The performance is shown in the figure 4.



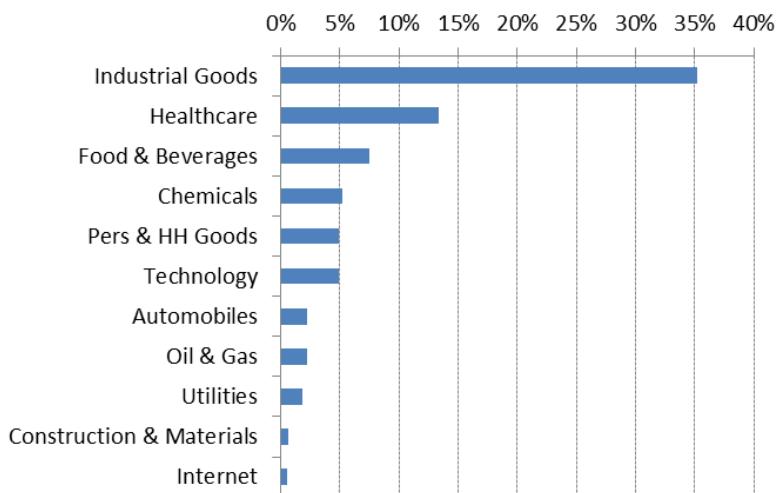
**Figure 4.** Performance of the dynamic IP portfolio Index for Stoxx600

#### *Portfolio construction:*

Stoxx Europe 600 Index Portfolio is separated in IP and Low/No IP stocks per 30.06.2016. Static, equal weighted portfolios of 232 IP stocks (“IP Portfolio”) vs. 368 Low/No IP stocks (“Low/No IP Portfolio”) with yearly adjustment per 31.07; Benchmark is equal weighted Stoxx Europe 600 Portfolio (“Portfolio”; 600 stocks); degree of investment = 100%; no risk management; no fees; ex dividend; all stock prices are calculated in EUR.

#### *Sector performance:*

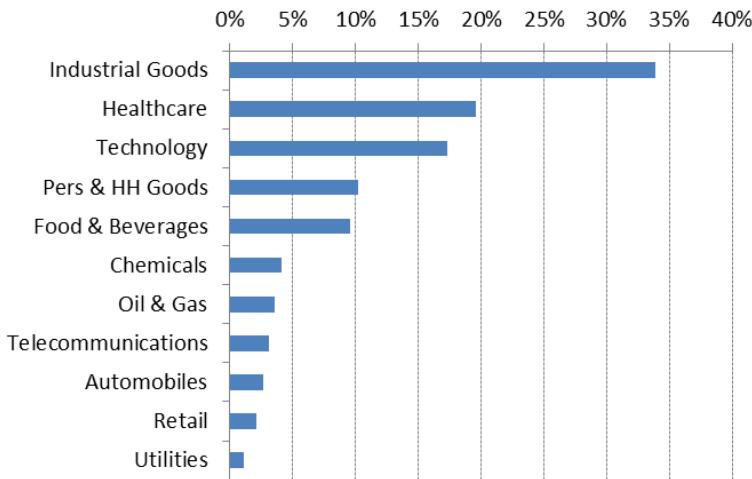
The selected sectors for designing the IP Stoxx index intended to show the market neutrality of the composed index. This means that the index should provide positive returns completely independent of the market conditions. Compared to the STOXX Europe 600 Index the main performance driver are the Sectors Industrial Goods, Healthcare, Food & Beverages, Chemicals, Pers. & HH Goods and Technology.



**Figure 5.** Sector performance of the Stoxx600 Index

Compared with equal sector weightings to STOXX Europe 600 Index the main performance driver are the Sectors Industrial Goods, Healthcare, Technology, Pers. &

HH. Goods, Food & Beverages, Chemicals, Oil & Gas and Telecommunications. In these sectors the influence of the IP Relevance on outperformance is very high.

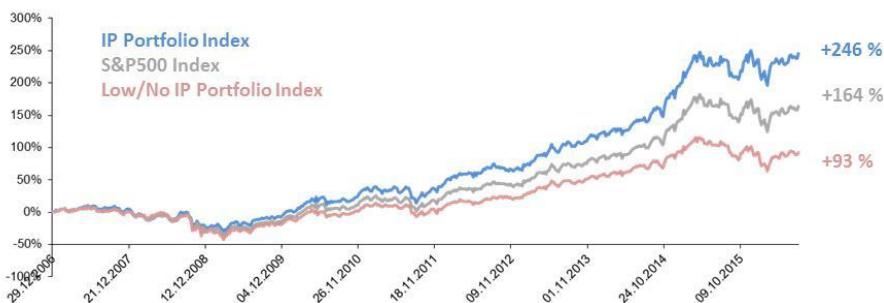


**Figure 6.** Sector performance of the IP portfolio STOXX600 vs. Stoxx600 Index

Different other indices were backtested, under same conditions like the Stoxx600 which is showed more detailed in this paper. The results for the other indices are the following:

## 6.2 Backtests on S&P500

Backtests on S&P500 show similar results to the STOXX600 index.

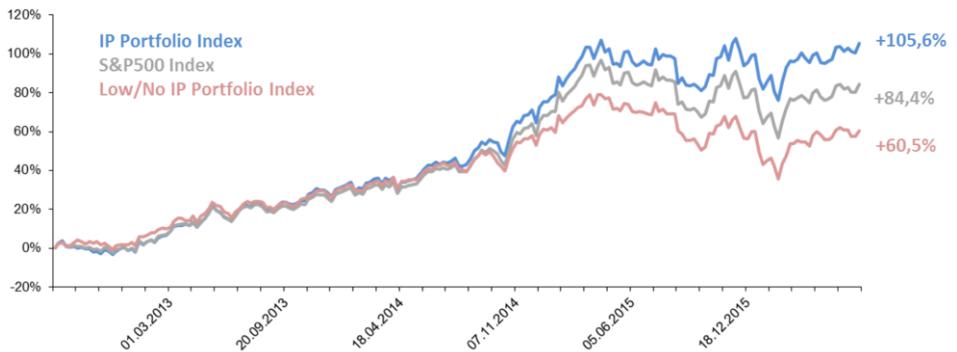


**Figure 7.** Performance of the static IP portfolio Index for S&P 500

Static, equal weighted portfolios of 238 IP stocks (“IP Portfolio”) vs. 248 Low/No IP stocks (“Low/No IP Portfolio”) with yearly adjustment per 31.07. All stock prices are calculated in local currency.

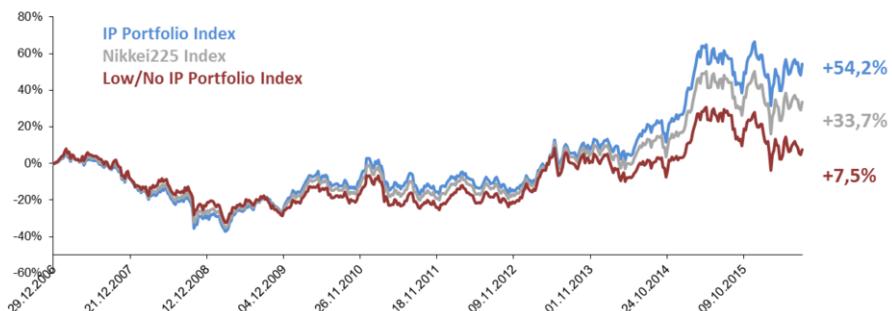
**Table 5:** key performance indicators of static IP portfolio Index S&P500

	Sharpe Ratio	Sortino Ratio	Return	Avg 1 Y Volatility	MAX DD
<b>IP Portfolio Index S&amp;P 500</b>	<b>0.77</b>	<b>1.28</b>	<b>14.4%</b>	<b>12.8%</b>	<b>-30.7%</b>
S&P 500	0.66	1.24	11.2%	12.6%	-33.8%
Low/No IP S&P 500	0.48	0.68	7.5%	12.7%	-41.9%

**Figure 8.** Performance of the dynamic IP portfolio Index for S&P 500

For the IP portfolio S&P index the main improvement is the return. The other factors like MaxDD, Sortino- or Sharpe ratio remain similar but much better than the equities with no or low IP.

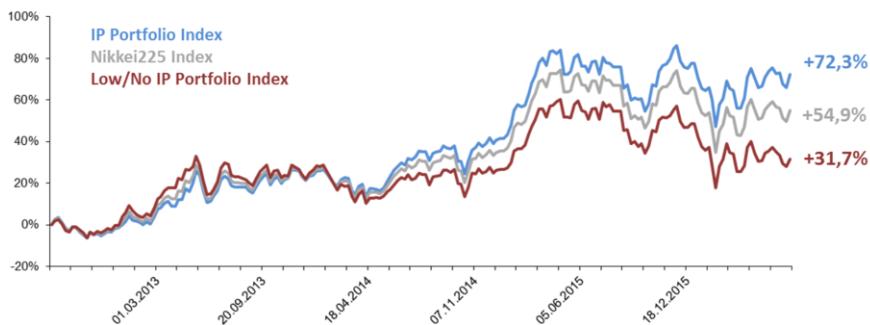
### 6.3 Backtests on Nikkei 225

**Figure 9.** Performance of the static IP portfolio Index for Nickei225

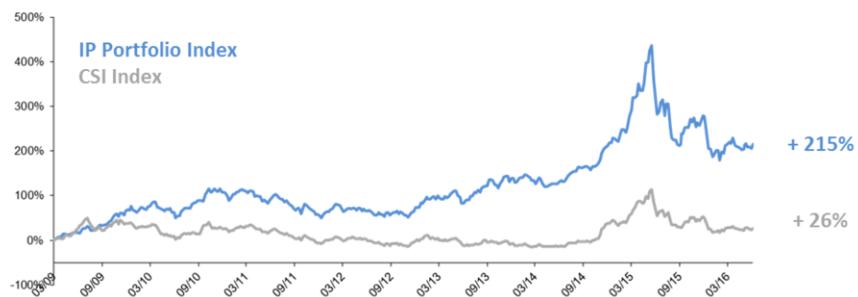
Static, equal weighted portfolios of 132 IP stocks (“IP Portfolio”) vs 93 Low/No IP stocks (“Low/No IP Portfolio”) with yearly adjustment per 31.07. All stock prices are calculated in local currency.

**Table 6:** Key performance indicators of static IP portfolio Index Nikkei225

	Avg. Return (9Y)	Avg Volatility (9Y)	Sharpe Ratio	Sortino Ratio
IP Nikkei 225 Index	5.3%	14.9%	0.46	0.17
Nikkei 225 Index	4.0%	14.9%	0.42	0.10
Low/No IP Nikkei 225 Index	2.2%	15.3%	0.30	0.01

**Figure 10.** Performance of the dynamic IP portfolio Index for Nickei225

#### 6.4 Backtests on CSI300

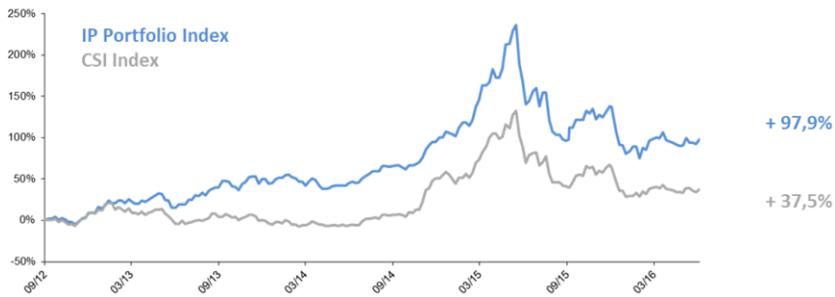
**Figure 11.** Performance of the static IP portfolio Index for CSI300

Static, equal weighted portfolio of 40 IP stocks with half-yearly adjustment (“IP CSI 300 Portfolio”) vs. 260 Low/No IP stocks in CSI 300 Index per 30/06/2016. All stock prices are calculated in local currency.

For the Nikkei index the findings are the same like for the S&P index.

**Table 7.** Key performance indicators of static IP portfolio Index CSI 300

	Sharpe Ratio	Sortino Ratio	Avg. Return (6Y)	Avg. 1 Y Volatility (6Y)	MAX DD
IP Portfolio Index	0.75	7.0	14.7%	18.6%	-47.9%
CSI 300 Index	0.16	0.85	1.6%	24.8%	-44.8%

**Figure 12.** Performance of the dynamic IP portfolio Index for CSI300

For the IP portfolio CSI index the main improvement is the massive increase of return and much better Sortino ratio. The max DD increased slightly.

Summary of the most important key performance indicators:

**Table 8.** Summary of most important key performance indicators of the IP portfolio index

Index	1	2	3	4	5	6	7
Stoxx600	232	368	39%	11	7	4.5	157%
CSI300	40	260	13%	14.7	1.6	-	919%
Nickei225	132	93	59%	5.3	4	2.2	133%
S&P500	238	248	49%	14.4	11.2	7.5	129%

1 Amount on patent equities in index

2 Amount on No or Low patent equities in index

3 Share of IP equities

4 Average return of the IP portfolio

5 Average return of the equal weighted index

6 Average return of the no IP portfolio

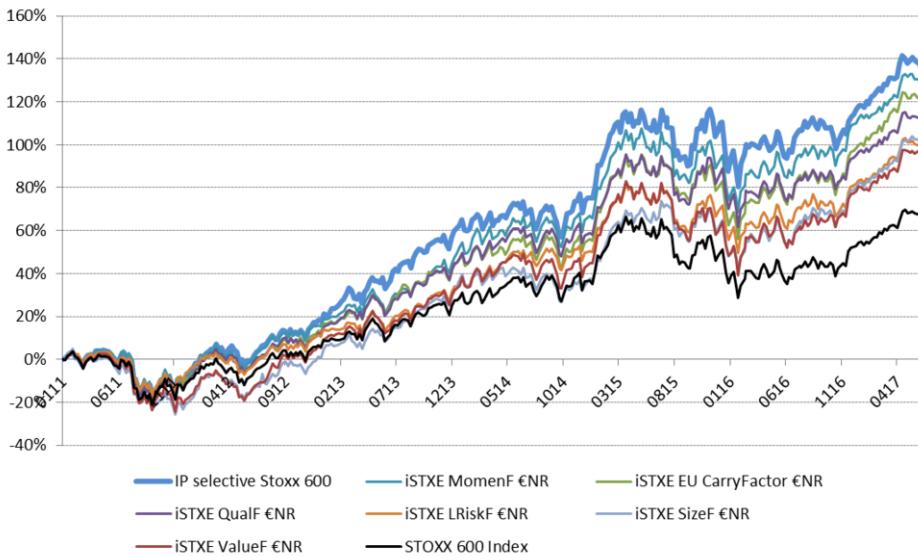
7 Outperformance IP portfolio

### 6.5 Correlations and sector Bias

A main question which occurs when a new factor is designed and applied to indices is if the factor has a certain attribute bias? Attribute bias describes the fact that equities that are chosen using one predictive model or technique tend to have similar

fundamental characteristics. For the patent factor it is obvious that there could be a bias in technology equities, because those are having the most patents. The current analysis showed that different other sectors like “household” or “food and beverages”, which are not classified as “hightech” are outperforming as well.

A look-ahead-bias does not exist because the data were produced at point of time. The next important question is if the factor correlates with any other existing factor? Backtests on the factors value, momentum and others are not correlated like the figure 13 shows.



**Figure 13.** Comparison of value factors Stoxx 600 versus IP portfolio Index

The selected value factors for comparison are:

Code	Factor	Description
IP selective Stoxx Europe 600	IP factor	stocks that have high IP Relevance
iSTXE MomenF €NR	Momentum	stocks with exceptional historical price movements
iSTXE EU CarryFactor €NR	Carry	stocks with high carry based on earnings and dividends
iSTXE QualF €NR	Quality	stocks with solid financial background based on debt coverage, earnings and other
iSTXE LRiskF €NR	Low Risk	stocks with risk / vola levels below average
iSTXE SizeF €NR	Size	stocks with low market capitalization / enterprise value
iSTXE ValueF €NR	Value	stocks that are cheap based on cash flow and earnings per share

The above test was performed by applying the factor to the index and generating the return. The result of the comparison is, that there is no factor existing, which has the same overlay. Therefore the calculated IP factor is uncorrelated to the above used value factors.

One could also guess that the amount on patents or research-and development expenditure is correlated. This was analysed in older studies and can be denied [30, 31].

## 7. Conclusions

The current work shows that using patent metrics for defining and applying indicators for stock picking is an appropriate method to develop a new factor which can generate alpha in a designed index. The main requirement to use the IP portfolio Index factor for

improving financial products is, that in the selection must be a reasonable amount on equities which operate in a technology field. The backtests do not show correlations for an optimum of the share of IP equities in an index neither focus on a certain world-region or a technology sector.

The basic theory that equities with a high qualitative patent portfolio perform better than those without is proved in the current study because the main global indices like Stoxx600, S&P, Nikkei and CSI showed an outperformance in a backtest period of 10 years.

Further research in this area will be done in the area of a higher granulation of the patent quality in defining more than 3 indicators. The basic selection for the equities was to identify equities with good patent portfolio, the possibility of identifying exit signals was not evaluated in this work. Other research topics are to develop real trading models with mixing up different other quantitative factors or hedging strategies like long-short strategies.

One other research area is in the field of corporate bonds, in order to develop smart beta products.

## 8. Acknowledgement

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# Supply Chain Finance for Targeted Poverty Alleviation: A Case Study of Suning

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**Abstract.** The sudden emergence of ‘COVID-19’ in 2020 has tightened traffic control in various places, which has posed a huge challenge to the agricultural product supply chain. This research introduces the perspective of supply chain finance, uses in-depth case study methods, and takes Suning’s agricultural supply chain finance as an example to discuss how e-commerce companies relying on big data adopt agricultural supply chain finance practices to promote accurate poverty alleviation. By analyzing Suning’s four agricultural supply chain financial operation models, we find that the internal and external stakeholders of the enterprise are the driving factors for enterprises to adopt agricultural supply chain finance, and the adoption of agricultural supply chain finance measures has brought economic benefits and social benefits to enterprises benefit. Advanced big data tools, fintech and cooperation with other partners are necessary to adopt agricultural supply chain financial measures.

**Keywords.** Agricultural Finance; Targeted Poverty Alleviation; Supply Chain Finance; China; Suning; Case Study

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## 1. Introduction

Recently, concern about Targeted Poverty Alleviation and Financial poverty alleviation has risen in academia and industry. Resolving the current huge financing gap of poverty alleviation requires the participation of financial institutions at all levels, and the use of modern big data technology to launch innovative financial products, thereby improving the efficiency of poverty management. As a new financial model of “industry + finance”, supply chain finance meets the innovative and diverse requirements of financial poverty alleviation [1]. Although the development of supply chain finance is an inherent requirement of “targeted poverty alleviation”, information about how companies implement supply chain finance practices to help “targeted poverty alleviation” is still limited. This study takes Suning as an example and show how innovative measures of supply chain finance are used in the field of “Targeted Poverty Alleviation”.

Despite increasing attention and efforts from scholar to the development of financial poverty alleviation and targeted poverty alleviation, the link between agricultural supply chain finance and targeted poverty alleviation has been neglected.

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Inclusive finance can increase the income of poor farmers by releasing the rural credit constraint mechanism [2]. Some studies believe that the development of rural inclusive finance can further promote economic development and the optimization of broad income distribution, and indirectly achieve the results of income growth and poverty alleviation through the “trickle-down effect” [3]. However, for the internal connection between agricultural supply chain finance and targeted poverty alleviation, in particular, there are relatively few financial supply chain finance tools for e-commerce enterprises supported based on big data platforms.

In recent years, E-commerce giants represented by Alibaba, JD.com and Suning have actively explored rural supply chain financial services and developed various types of financial products to ease the financing constraints of upstream and downstream agricultural enterprises [4]. With the help of its advanced big data technology, E-commerce companies have built financial targeted poverty alleviation platforms to achieve accurate identification of poor households, thereby realizing effective allocation and dynamic supervision of financial poverty alleviation resources. However, there are still little researches on Suning’s agricultural supply chain financial practices. The purpose of this paper is to study how Suning’s agricultural supply chain financial solutions can help target poverty alleviation, and apply exploratory single case study methods to solve the following problems:

Question 1: What specific agricultural supply chain finance solutions does Suning use to help targeted poverty alleviation?

Question 2: What are the driving factors affecting Suning’s adoption of agricultural supply finance initiatives?

Question 3: How do these agricultural supply chain financial initiatives work?

## 2. Literature review

### 2.1. Agricultural supply chain finance and targeted poverty alleviation

The supply chain finance has a natural adaptability to solve such financing problems. Agricultural supply chain finance is also called agricultural industry chain finance, which is essential to explore the issue of financing and rational use of capital from the perspective of agriculture [5]. At present, scholars have conducted in-depth research on agricultural supply chain finance from different perspectives, and have achieved certain achievements.

The agricultural supply chain financial model can be divided into the operating mechanism of upstream suppliers, agricultural product processing enterprises and downstream distributors suitable for agriculture based on different links of the supply chain. The supply chain finance products for the upstream suppliers of the agricultural supply chain are mainly to solve the problem of shortage of funds for upstream farmers [6], including order financing, account receivable financing and warehouse financing, which are suitable for the supply of downstream agricultural distributors [7]. With the vigorous development of artificial intelligence, blockchain, cloud computing and big data, supply chain finance has also ushered in a new stage of fintech promotion, which is reflected in the agricultural supply chain finance field as the main body leading supply chain financial activities no longer limited to agricultural core enterprises, e-commerce platform dominance has become a new model [8].

In the context of China's vigorous development of inclusive finance, the combination of agricultural supply chain finance and targeted poverty alleviation has deepened the reform of financial services in rural areas. Many studies show the relationship between inclusive financial development and poverty alleviation. Zhu Yiming and others showed that inclusive financial development can effectively reduce poverty by promoting economic growth, but this effect is the heterogeneity of different income groups [9]. Zhang Yan and Wang Xiaozhi believe that in order to ensure the realization of the overall goal of poverty reduction, it is necessary to formulate an overall plan for poverty reduction by e-commerce [10], strengthen infrastructure construction, promote poverty alleviation by e-commerce, and improve the accuracy of targeted poverty reduction.

The rise of big data and financial technology has provided scholars with new research ideas. Yan Fei and others conducted research on financial targeted poverty alleviation from the perspective of big data, and proposed that the use of big data can more effectively explore the root causes of poverty and effectively share financial precision poverty alleviation information[11]. Dong Yufeng and others believe that the key to breaking through the practical difficulties of traditional financial poverty alleviation lies in leveraging the advantages of digital technology to improve risk controllability [12]. The link between big data technology and financial poverty alleviation is gradually becoming a new research trend, Strengthening the application of big data technology has a significant improvement effect in optimizing the digital financial service environment in poor areas.

In recent years, the field of agricultural finance research has continued to develop, especially in developing countries. Although agricultural finance has been studied for decades, the focus is mainly on factors related to its implementation and the importance of economic development or social welfare. Few studies involve technical, economic and social aspects of agricultural finance. Therefore, agricultural finance should be investigated from a complex perspective.

## 2.2. Stakeholders

Stakeholders are defined as “any group or individual that can influence or be affected by the achievement of organizational goals” [13]. Stakeholder theory arises from how managers can more effectively solve the problems of key stakeholder groups. Managers think of stakeholders based on their views and therefore act as critical interpreters of stakeholder influence [14]. After evaluating which stakeholders are significant, the stakeholder’s management concept then determines how the company’s strategy will be affected.

Internal stakeholders, including investors and employees, are key allies in the success or failure of any company’s strategy. Employees (all kinds) who support the company's environmental goals are more likely to find a job in it and (once there) continue to be employed [15]. They may also express satisfaction or dissatisfaction through direct discussions with company executives or company boards. The dissatisfaction of management and non-management employees can be expressed by terminating employment. External stakeholders include social stakeholders and regulators [16]. The increasing influence of social stakeholders is one of the important considerations in the company’s strategic decision-making [17]. These stakeholders have the ability to mobilize public opinion to support or oppose the company. Social

stakeholders often use indirect methods to influence company behavior because they lack direct economic interests in the organization.

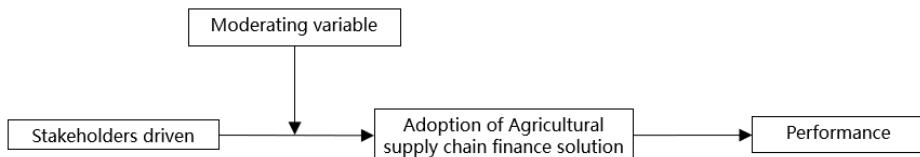
In this study, when analyzing the motivation of Suning's implementation of the agricultural supply chain financial solution, based on the theoretical background of stakeholders, it explored the external and internal stakeholders' role in promoting Suning.

### 3. Research Methodology

Given the exploratory nature of this method, in-depth case study is adopted to investigate the agricultural finance practice of a company and its relationship with targeted poverty alleviation. A case study focuses on the "what" and "how" questions. The in-depth case study is applicable to explore causality and mechanism. In addition, on the basis of a single case study, we need to find the framework of the financial supply chain financial practice of the e-commerce core enterprise, and then test it through multiple case studies.

#### 3.1. Research Framework

A case study initially considers the research questions and framework, so we design a research framework (see Figure 1) to answer our research questions. The adoption of a certain agricultural financial solution is driven by different stakeholders, and the implementation of the agricultural supply chain financial solution requires a guarantee method, which can be regarded as a regulatory variable.



**Figure 1.** Research Framework.

#### 3.2. Case Selection

Suning was established in 1990, and after more than 20 years it has developed into a well-deserved giant in China's chain retail industry. In 2004, Suning (stock code 002024) Group Co., Ltd. was listed on the Shenzhen Stock Exchange, becoming the first home appliance chain enterprise to be listed on the IPO in China. Suning ranked first among the top 100 Chinese chains from 2009 to 2012. Since 2009, the traditional retail industry has been violently impacted by e-commerce, which forced Suning to complete the industrial transformation and upgrade [18]. With its broad and deep offline market foundation, Suning has created a unique ecosystem of "O2O".

In recent years, some leading businesses have successively developed agricultural financial services in China. Among these platforms, Suning has a strong representative for the following reasons. First of all, Suning Finance, as a financial company of Suning, has been sticking to the O2O strategy since its establishment, creating a complete closed-loop financial ecosystem [19], Suning Finance achieved a transaction

scale of over one trillion in 2018, with more than 70 million active members. Secondly, Suning's supply chain financial business relies on Suning E-Commerce platform, accumulating massive customer resources of small, medium and micro enterprises, and deeply integrating with the real industry to create supply chain financial products that serve a variety of financing objects. In addition, Suning has been actively exploring the agricultural finance model and implementing the core of "inclusive finance". In May 2016, the Ministry of Rural Finance was specially established to build a closed-loop agricultural product supply chain of "finance + e-commerce + agricultural production". Suning's big data platform and advanced technical means accurately identify the targets of poverty alleviation, accurately predict the amount of poverty alleviation, and use financial means to achieve precise poverty alleviation.

### *3.3. Data Collection*

This case study starts with data collection and selects a combination of second-hand data and first-hand data collection. Among them, the first-hand information includes: (1) Face-to-face interviews with senior managers and front-line employees of Suning finance department. The interviews were recorded throughout the interview, and the interview materials were confirmed and updated through WeChat, email and other channels. (2) The research team went to the Suning headquarters to conduct a field survey, conducted random interviews and experienced Suning's supply chain financial product services. The collection of second-hand materials includes: (1) Use "Suning", "Suning Agricultural Finance", "Suning Targeted Poverty Alleviation", and "Suning Supply Chain Finance" as keywords to search for relevant documents published in CSSCI and core journals from 2009 to 2019; (2) Through Suning's official website, Suning Financial Research Institute, Suning's official WeChat public account, and other Suning internal channels; (3) Obtain Suning's 2009-2019 financial report and social responsibility report through Guotai'an database and wind database.

### *3.4. Coding and Data Analysis*

The data analysis method of this study is data coding and classification, and then to demonstrate the research issues raised. For first-hand materials, interview tapes are transcribed into text materials for easy coding. According to the main issues of the research—the driving factors, specific measures, and benefits of agricultural supply chain financial practices, we analyze the first-hand and second-hand data. Among the driving factors and benefits, we follow the theoretical framework of stakeholders, according to government, investors, customers, employees, and external supervisors are classified.

In order to ensure the reliability of the coding, we adopted the independent coding by the researchers, and then checked it, and finally obtained the data coding of the explanation source that is necessary for the research framework. In order to ensure the reliability of the coding, we adopted the independent coding by the researchers, and then checked it, and finally obtained the data coding of the explanation source that is necessary for the research framework. The specific process is as follows: First, two members of the research team respectively code a second-hand data; Second, the two members discuss and check the content of the differences in the encoded entries in the independent encoding process, and strive to reach agreement opinion; Finally, the other two members of the data research team of the research team will review the coding

results of the second round. If there are still differences in this round, the coding analysis of the differences will be discarded. Finally, in order to ensure that the obtained concepts are highly consistent with the corresponding descriptions, the research team sent the data and preliminary conclusions to Suning, and the final confirmation was made only after confirmation by relevant departments. Table 1 shows the encoding results.

**Table 1.** Examples of codes

Category	Code	Original Quotes
External Stakeholders	Government	“We will take targeted poverty alleviation as the main line to achieve financial poverty alleviation + e-commerce poverty alleviation + industrial poverty alleviation and technology poverty alleviation.”
	Farmers	“President Xi has repeatedly emphasized that people’s longing for a better life is our goal of struggle.”
Internal Stakeholders	Shareholders	“Suning should promote the integration of online and offline to deepen rural and remote areas, practice social responsibility.”
	Employees	“The weakening of the Internet dividend has transformed the competitive landscape of major e-commerce businesses from online to offline. Financial poverty alleviation is an important measure to maintain the competitive advantages of enterprises.”
Performance Society	Promote government “Targeted Poverty Alleviation”	“Suning won the ‘2017 China’s Listed Companies’ Targeted Poverty Alleviation Innovation Case” and became the only winner in the retail industry in this award.”
	Conducive to farmers’ stable production and sustainable operation	“Suning Finance will give full play to its resource advantages, rely on advanced financial technology and rich financial products, provide comprehensive inclusive financial services for the general public and small and medium-sized enterprises in Yichun City, use financial means to promote targeted poverty alleviation, and help the economy of Yichun City. Further development and comprehensive improvement of the quality of life of local citizens.”
Performance Economy	Improve corporate social image and social responsibility disclosure	It is reported that Suning Public Welfare has donated more than 1.1 billion yuan in total over the past 27 years. There are also a large number of materials used for public welfare charities. Suning Public Welfare’s love image and social responsibility have been fully demonstrated.
	Business expansion and innovation	“After the traditional retailers were shocked and withered by online opponents, Suning returned to the market with a high-profile attitude, to achieve the goal of covering the entire scene online and offline, from cities to counties.”
	Financial nurturing retail business	“Smart retail is rebuilding people, goods and field, but also urgently needs matching financial services. At present, new finance has begun to penetrate into the scene, which has played a catalytic role in the integration of online and offline.”

Improve enterprise business ecological closed loop

On the financial track, Suning Finance has fully tapped the resources of the Suning Ecosystem, continuously increasing its penetration rate, and achieving coordinated development. From payment to consumer loans, to extended warranty services, to corporate loan services, Suning Finance can provide one-stop financial solutions for consumers and corporate customers in the Suning ecosystem.

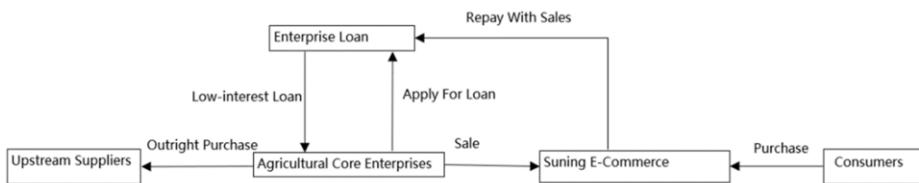
## 4. Case Study

### 4.1. Description

Suning has practiced agricultural supply chain finance with specific supply chain financial products as solutions to serve individual farmers and agricultural enterprises.

#### 4.1.1 Model 1: Suning Enterprise Loan

In recent years, Suning Finance has launched Suning Enterprise Loan service for agricultural enterprises (Operation mode was shown in Figure 2). In order to help agricultural enterprises break the capital restrictions, Suning launched the Suning Enterprise Loan at a low rate of interest, and allowed the upstream and downstream of agricultural core enterprises to apply for Suning Enterprise Loan based on their real trade to maintain the operation of the supply chain. Apart from producing products to the order delivery, core enterprises can sell products on Suning E-Commerce Platform, greatly expanding the sales channels. Suning Enterprise Loan solves the financing difficulty caused by information asymmetry between agricultural enterprises and traditional banks. As a bridge of real enterprises, Suning is not only a financial platform, but also a supplier of consumers, which forms a dual agricultural supply chain. Suning Enterprise Loan as a finance service provided by Suning Finance to agricultural enterprises effectively alleviates the capital pressure of prepayment and benefits the production and market of agricultural products from the supply side, fulfilling Targeted Poverty Alleviation.



**Figure 2.** Suning Enterprise Loan model

#### 4.1.2 Model 2: Suning Agriculture Loan

In practice, farmers and small agricultural firms have minor business scales and low credit records, certainly difficult to apply for loans from traditional financial

institutions such as banks[20]. In August 2016, Suning Finance announced to cooperate with Agricultural Installment to launch Suning Agriculture Loan which's operation mode is presented in Figure 3. Agricultural Installment, an installment especially serving the rural market, has set up more than 150 county-level offline branches, whose business covers more than 10000 surrounding villages and towns, serving more than 350,000 farmers in the country. As an important practice of O2O mode, the alliance between Suning Finance and Agricultural Installment is actually the combination of advanced technology and a powerful database. At present, the weekly amount of Suning Agriculture Loan for farmers is more than 8 million Yuan, while the total loan has reached 500 million yuan. It is estimated that about 1 billion yuan of agricultural loans will be invested in the national market in various ways within 2-3 years. Suning Agriculture Loan is an important way for Suning Finance to enter the rural financial market with the help of the third-party platform.



**Figure 3** Suning Agriculture Loan model

#### 4.1.3 Model 3: Suning Willful Pay

In addition to providing financial support at the supply side to maintain stable agricultural production, Suning Finance also pays attention to the layout of the consumer side in the strategic blueprint of rural finance. In order to improve the standard of consumption of farmers, Suning Willful Pay help farmers meet the daily consumption demand by providing micro-credit. (See Figure 4) Through micro-credit, farmers can spend on Suning E-Commerce in the current month and pay bills without interest next month. The payment can be finished in one, three, six or twelve months with a monthly interest rate of 0.9%. Undoubtedly, Suning Willful Pay is an important practice for Suning Finance to realize inclusive finance in rural areas. Farmers are encouraged to use Suning Finance payment product "YIFUBAO" for consumption, so that the both closed-loop payment and closed-loop consumption have achieved. Besides, credit risks have been mitigated for the connection to The People's Bank of China.



**Figure 4** Suning Willful Pay

#### 4.1.4 Model 4: Suning Willful Loan

Ordinarily, farmers are evaluated as low-quality customers without repayment ability and deposit by traditional financial institutions such as banks so it is hard for them to apply for bank loans [21]. Suning is committed to providing farmers with comprehensive financial services in the whole product chain, such as credit loans and cash loans. At present, Suning Finance has promoted Suning Willful Loan, a personal loan product for farmers to pay offline with cash. Suning Willful Loan allows all farmers to have a certain amount of loans according to their credit level and repayment records, and its operation mode is illustrated in Figure 5. As a kind of small loan, Suning Willful Loan makes it possible for the borrower to achieve a cash loan after a successful application. Furthermore, Suning Finance Big Data has built a real-time risk monitoring system, relying on abundant resources online and offline to let farmers approach offline consumption.



**Figure 5** Suning Willful Loan

#### 4.2. Case Analysis

##### 4.2.1 Classification of Agricultural Supply Chain Finance

For further understanding, we classify and summarize above four patterns according to types of financial products and customers and then provide practical solutions for rural customers. Suning Finance divides its rural customers into the supply side and demand side based on demand and form of funding [22]. While the supply side needs financial support to expand their production, processing, packaging, market and other businesses, the demand side wants to carry out daily expenses. Depend on whether to grant credit loans or cash directly, this classification corresponds to the four financial products launched by Suning Finance.

**Table 2.** Types of supply chain finance

	Types of Financial Products		
	Credit Loan	Cash	
Types of Customer	Demand side	Suning Enterprise Loan	Suning Agriculture Loan
	Supply side	Suning Willful Pay	Suning Willful Loan

##### 4.2.2 The Motivation of Solutions for Agricultural Supply Chain Finance

###### (1) External Stakeholders-Government

In September 2018, the CPC Central Committee and the State Council issued The Strategic Plan for Rural Revitalization (2018-2022), which made specific arrangements for the first five-year implementation of the Rural Revitalization Strategy. It proposed to increase financial support for agriculture, improve the rural financial system and allocate more financial resources to the key areas and weak links of rural economic development to fulfill the diversified financial needs of Rural Revitalization Strategy. So far, supports have been offered in various aspects to assist the development of rural Internet finance [23]. In 2017, regarding to rural finance, Document NO.1 of the Central Government encouraged financial institutions to actively utilize Internet technology and provided financial services such as small loans, settlement, and insurance for agriculture. Other typical documents and measures are followed.

**Table 3.** Government documents on rural finance in recent years

Year	Documents	Main Points
2017	Opinions on Pushing Forward the Structural Reform of Agricultural Supply Side and Accelerating the Cultivation of New Driving Forces for Rural Development.	Focusing on the "Agricultural Supply Side Structural Reform", we should start from the supply side and make efforts in the innovation of system and mechanism, so as to fundamentally solve the most prominent structural and institutional contradictions in agriculture.
2018	Central Finance Supports Rural Financial Reform and Development	We will continue to improve and optimize policies and measures to better support the healthy development of rural finance. Therefore, considering relevant policies, we should take advantage of existing policies and combine the needs of rural financial reform and development.

### (2) External Stakeholders- Agricultural Practitioners and Rural Consumers

In China's rural areas, the financial supply and demand gap for agriculture, rural areas, and farmers is more than 3 trillion Yuan. What's more, 56.8% of the farmers are in financial strain and 69.6% of them find it hard to get loans. However, the satisfaction rate of credit demand of farmers and agricultural production in China is only 27.6% and 28.5% respectively. Especially in recent years, with the decrease of small farmers, new types of agricultural operation entities such as professional large-scale households and family farms are emerging gradually [24]. To satisfy such a huge demand, Suning as a profit-oriented enterprise has extended its financial business to the most basic level in rural areas, hoping to release the huge potential of the rural market. As a pioneer in O2O mode, great efforts have been made to explore solutions suitable for local rural finance and its own development. Suning agricultural supply chain financial products generate strong power for integrating rural scattered capital and enriching the product structure of the rural financial market.

### (3) External Stakeholders- Competitors

Meanwhile, as leading enterprises in e-commerce, Ali's agricultural finance provides two different forms of agricultural financial solutions for individual farmers and agricultural enterprises. Namely, micro credit and micro mortgage for individual farmers. Based on agricultural enterprise needs and uses of financial resources, Ali proposed supply chain and industry model, OAO Credit model for them. Ali's thorough closed-loop financial ecology enables it to create a variety of profit models in the field of agricultural finance, which helps agricultural production and farmers get rid of poverty [25]. On the other hand, JD.com has been pushing the business of agricultural finance and releasing JD.com Agriculture Loan and JD.com Breeding Loan. JD.com

Agriculture Loan is characterized as low interest, no mortgage and fast aiming at the problems that poor farmers lack of mortgage assets and simplification of loan procedure. JD.com Breeding Loan which is jointly developed by JD.com and China United Property Insurance Company launched "small loan, insurance and e-commerce" business model [26]. The rural supply chain finance strategy of Ali and JD.com forces Suning E-Commerce to develop rural financial business and further improve the closed-loop ecology of supply chain finance, in conclusion, achieving sustainable development.

#### (4) Internal Stakeholders- Shareholders

Since the duty of the company is to make profits, financial affairs must be taken into consideration in the decision. Even though enormous capital is need, financial business in rural areas as "Blue Ocean" attracts investment from e-commerce giant represented by Suning, relying on its layout in rural offline e-commerce and the analysis of online behavioral data to carry out comprehensive financial business [27].

As the financial service system of "Agriculture, Rural Areas and Farmers" has been established, the great potential was found in the rural financial market due to the capital need. While Suning started the Internet transformation, its business gradually forms the whole market level to online and offline integration. Suning Square, Suning Convenience Store, Suning Lingshouyundai, Suning Jiwu, and Suning Fresh, have been built to fully meet the diversified consumption demands of different levels of users. Obviously, the expansion of business needs sufficient financial support and that is why Suning has to take advantage of the development of financial business in order to maintain the rapid growth of future revenue and seize the opportunity of development. In addition, it is also the response to the needs of the rural market. To sum up, Suning has enough power to provide flexible products and services for different types of rural customers, which may be a perfect chance for Suning to further integrate the whole industrial chain and build an ideal financial ecosystem.

#### (5) Internal Stakeholders- Employees

Rational employees have found great potential in the rural market in a long-term perspective. Either decision-makers or executors in Suning E-Commerce have common goals that take advantage of achievement in the rural financial market to develop Suning smart retail. Besides, employees need a company with social responsibility to fulfill their personal value and social value and that is why Suning E-Commerce has always been proactively playing its role in Targeted Poverty Alleviation. Oriented by rural inclusive finance, Suning E-Commerce broadens financial services in rural areas, small enterprises, and real enterprises and finally establishes four directions of financial poverty alleviation which are finance, e-commerce, industry, and science [28]. Suning employees approve their own enterprise, which is also a major power for Suning to steadily promote rural financial supply chain strategy. As the slogan goes: "Work hard and keep working for Poverty Alleviation Battle."

Accordingly, we propose the following proposition:

**Proposition 1:** Internal and external stakeholders may encourage companies to adopt agricultural supply chain finance measures.

### 4.2.3 The Result of Solutions for Agricultural Supply Chain Finance

#### (1) Social Performance

Recently, Targeted Poverty Alleviation is becoming an important social issue. With the advantages of resources and technology, Suning rural supply chain finance

project provides a new solution for the development of the rural market. While implement of the O2O business model in the rural market has greatly promoted rural employment, consumption, and production. Traditional finance services have hindered farmers from applying for funds, customized financial products and services have provided solutions for leading agricultural enterprises, small and medium-sized agricultural enterprises or individual farmers against funds shortage. Suning Finance has built a real inclusive financial system in rural areas, unblocked credit and loan channels, and realized Targeted Poverty Alleviation [29].

In 2017, Suning E-Commerce was honored as "2017 innovation case of Targeted Poverty Alleviation among listed companies", which further proves that Suning Targeted Poverty Alleviation has been highly recognized by the industry and society. The honor has improved its social reputation and business image, too.

## (2) Economic Performance

E-commerce giants, Ali and JD.com have already turned their attention to rural areas and agriculture, forming a new wave of rural finance driven by e-commerce.

Therefore, Suning Finance adopts agricultural supply chain finance to improve market competitiveness. First of all, the development of agricultural supply chain finance has facilitated Suning's business expansion and profit growth. The information of agricultural enterprises expands the Suning user database, which lays a foundation for behavior analysis by means of financial technology and big data, also conducive to Suning's long-term cooperation with leading agricultural enterprises. In the second place, developing the sales channels on Suning platforms online for agricultural products may increase active users of Suning E-Commerce. Finally, financial practice on consuming side end makes Suning crack the hard nut and increase subscriber numbers. Suning Finance offering credit loans and cash loans to individual users has greatly increased desire to consume and at the same time boost sales. Since the interest rate for providing financial services is also an important profit source of Suning, "YIFUBAO" expanded Suning Finance business from payment transaction to credit service, which enhanced the user loyalty and improved the financial closed-loop ecology.

Thus, we state proposition 2a and 2b as follows:

**Proposition 2a:** Measures of Agricultural finance supply chain enable companies to achieve their social benefits.

**Proposition 2b:** Measures of Agricultural finance supply chain enable companies to realize their s economic benefits.

### 4.2.4 The Influence of Moderator on the Practice of Agricultural Supply Chain Finance

#### (1) Support from Big Data Technology

Since the big data technology is a major factor for the steady progress of agricultural supply chain finance, Suning E-Commerce has invested a lot in advanced technologies such as big data, cloud computing, face recognition, artificial intelligence, etc. Finance and science technology are closely inseparable. Big data and cloud computing make it possible to calculate and evaluate personal credit levels while rural financial credit service is incomplete [30].

In our interview, Suning manager emphasized the importance of big data, which is used to provide financial solutions. Artificial intelligence technology based on big data may reduce labor cost, meanwhile, big data technology helps to complete rural personal credit information and confirms user information [31]. Platform data and credit model

is a typical service supported by big data and data mining technology of the cloud retail financing platform. On the other hand, it makes financial services more convenient and enables the financing platform to make real-time and intelligent.

For financial service providers, the outstanding contribution of big data technology is also reflected in the aspect of risk control. By using advanced risk management systems, the financial services in rural areas can be strongly supervised and the cost can be cut. The risk management system uses multi-dimensional data to control the whole process of supply chain financial services[32]. For companies practicing supply chain financial measures, it is possible to control capital flow and financial settlement if they have established pay channels.

Hence, we propositioned that:

**Proposition 3:** Advanced big data technology makes it possible for agricultural supply chain finance to help Targeted Poverty Alleviation.

#### (2) Support from Partners

Apparently, agricultural supply chain finance needs close cooperation among all participants in the supply chain to improve the sustainability of the whole supply chain just as Suning E-Commerce did to cooperate with other enterprises and platforms, such as financial institutions, large agricultural manufacturers and other large retailers. In rural areas of developing countries where credit systems are particularly imperfect, it is difficult to provide assistance to farmers. To collect their offline credit records, Suning cooperates with other entities, such as traditional insurance companies and non-profit organizations [33]. Suning E-Commerce also cooperated with Agricultural Installment to provide loans to scattered farmers outside their database, and this cooperation improves the inclusiveness of financial services and reduce the risk of incomplete credit information. Since Agricultural Installment has vast and extensive information network of offline individuals and small enterprises who need financial assistance and it solves information asymmetry. Cooperation between Suning and Agricultural Installment takes advantage of OAO mode, reduced the loan risk, provides financial services for farmers and facilitates the management of offline information. In short, the application of agricultural supply chain finance emphasizes the importance of cooperation between providers and other entities, breaks the information asymmetry, improves the accuracy of Targeted Poverty Alleviation, and further realizes Targeted Poverty Alleviation, so as to increase inclusiveness and reduce risks.

In the light of the preceding analysis, it is propositioned that:

**Proposition 4:** Through cooperation with partners, agricultural supply chain finance may help Targeted Poverty Alleviation.

## 5. Conclusion

This article has conducted an in-depth case study of Suning's practice in agricultural supply chain finance to demonstrate Suning's outstanding contribution to "Targeted Poverty Alleviation" and the application prospects of supply finance. This paper's contribution to the promotion of agricultural supply chain finance to help targeted poverty alleviation lies in the following aspects. First, this article establishes a link between agricultural supply chain finance and "Targeted Poverty Alleviation". From the perspective of stakeholders, it proves how Suning is promoted by internal and external stakeholders and provides a comprehensive agricultural supply chain financial

solution to help "Targeted Poverty Alleviation" and how these supply chain financial solutions create social and economic benefits for enterprises.

Secondly, by analyzing Suning's four major agricultural supply chain financial models, and classifying the solutions that act on different objects, the financial services are divided from the demand side and the supply side, providing a strong practice for other companies to implement financial services for poverty alleviation.

Finally, we use the example of Suning agricultural supply chain finance practices to prove that big data technology is indispensable for the development of online supply chain finance services. Since advanced technology methods and big data platforms are the important reasons for Suning's outstanding achievements, big data technology can reduce financial risks and improve service efficiency [34]. Cooperation with other partners provides a real data source for agricultural supply chain finance to help Targeted Poverty Alleviation and promotes the realization of poverty alleviation. In addition, the case selected in this study is an e-commerce enterprise that carries out online supply chain financial services, not a traditional financial institution, which also broadens the research perspective [35].

Although this study sheds new light on supply chain finance and Targeted Poverty Alleviation, several limitations may be addressed in future research. The single case study method is rich and deep, but it lacks universality. Taking Suning as the research sample, the reference significance for other countries is relatively low. In addition, only two moderators are considered in this study, while other possible factors may be ignored. The future research can adopt multi-case study method and consider other moderators. Furthermore, the contribution of this research is exploratory, so future research may apply empirical research to measure the benefits and cost of different agricultural financial solutions at enterprise and supply chain levels.

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# The Internationalization of Oil&Gas Family Businesses

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**Abstract.** The internalization of family businesses— i.e. of the companies that implement it - can be stimulated by numerous reasons: one of these is linked to the target markets, not in terms of market development, but of resource to be used / exploited. What makes the oil companies distinguishing is that: they follow the territory and the exploitation of the underground resources, wherever they are in the world. In the Italian context, this characteristic of oilfield companies is very noticeable due to the scarcity of underground resources, which characterize our territory. We propose an empirical approach. It has been considered the case of a specific Italian Oil&Gas family firm. The study consists of: a first part, in which an analysis of the main economic and managerial literature, both national and international, was made (on internationalization, SMEs and family businesses, industrial districts, oilfield environment); a second part, in which an empirical analysis was developed: interviews have been conducted with the owners and top management of the company, in order to study and analyze the firm development strategies.

**Keywords.** Family Business, oilfield, internationalization, oil district.

## 1. Introduction

The internationalization of companies has represented in recent years and still represents a fundamental strategy for all those companies with the wish and the need to broaden their economic horizons and their outlet markets. Being able to internationalize is not a common in all companies: this possibility and this “strength” are configured as the basic elements of the international corporation, which must have both the ability to face new and different markets and should have the “force” to deal with international competitors.

Until about twenty years ago, internationalization has been implemented as a strategy by large enterprises and multinational companies, which were and still are capable of dealing with complex and ever-changing environments, often conditioned and regulated by very different legislation.

In the Italian business context, this kind of development strategy has been less widespread: indeed, our business context is made up of both highly specialized small firms and small and medium-sized family businesses.

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Furthermore, in many geographic areas, SMEs have joined together and created industrial districts. These districts, depending on the nature of the good produced, can take on different conformations: among the most widespread, we find the DIM, Marshallian manufacturing district [1], and the Markusenian district of the “Hub & Spoke” type [2].

This work addresses the case of the internationalization of a SME’s family business belonging to the Oil&Gas sector [3]. The present work was performed starting from the study of the main theories in the field of internationalization, family businesses and SMEs. The case study considers the events and the international development of SMAPE Ltd, a company based in Abruzzo, in the province of Pescara, which has now expanded into several continents.

## 2. Family Businesses

SMEs tend to be associated with family businesses, even if it is not as common as it seems.

Many SMEs aren’t familiar and many family businesses aren’t SMEs! We can talk about Family Business (FB) when one or more family constitute a single economic and social identity with the company.

In the literature several theories and parameters define the FB [4-8]; the criteria are based on:

- *objective criteria*: are related to the role that the family plays in the ownership and management, as the percentage of ownership held, the right to vote, family members involved in the management and others;
- *subjective criteria*: concern qualitative variables, such as the degree of overlap between family and company matching values, the interdependence between the two systems, and so on.

Some authors [9] have identified three levels of family involvement in the company, thus giving them three different definitions.

**Table 1.** Definition of family business based on the degree of family involvement.

Broad Definition	Narrow Definition	Media Definition
<ul style="list-style-type: none"> <li>• Effective control over strategic direction</li> <li>• Intention to maintain the property in the family</li> </ul>	<ul style="list-style-type: none"> <li>• Founder/descendant manages the company</li> <li>• Legal control of the majority of votes</li> </ul>	<ul style="list-style-type: none"> <li>• More than one generation</li> <li>• Family directly involved in management and ownership</li> <li>• More than one member of the family with important managerial responsibilities</li> </ul>
▼ Direct family involvement	▼ Average direct family involvement	▼ High direct involvement of the family

Demattè and Corbetta [10] identify two types of family businesses:

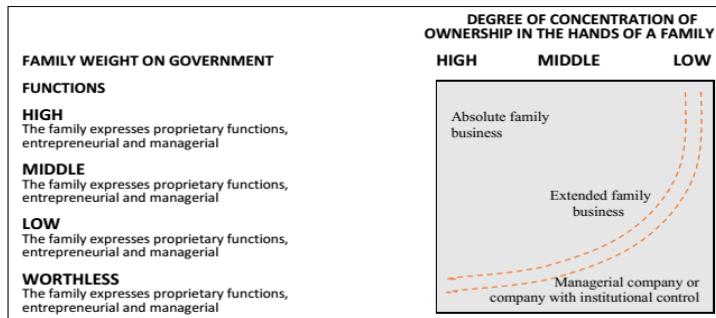
- *Family business in the strict sense*, in which the family has high proprietary functions, managerial and entrepreneurial, corresponding to a high degree of concentration of ownership in the hands of one family;
- *Extended family business*, a company where the family has medium or low ownership, managerial and entrepreneurial functions, to which corresponds a medium or low degree of concentration of ownership in the hands of a single family.

Finally, the managerial company, although present in the chart, is not classified as a family business, because the family has no ownership, entrepreneurial and managerial functions and the degree of family control is zero.

Subsequently, Corbetta [11] added a third variable to the model, and identifies the following three characteristics: a) ownership of capital; b) presence of family members on the board and in business management; c) staff size of the organization. So, four types of business have been identified, as shown in the table 2.

**Table 2.** Types of family businesses.

	Ownership model	Presence of the family in the BoD and in the management bodies	Size of the personal organization
<b>Domestic Family Businesses</b>	<i>A single subject or a small number of people</i>	<i>Family board Family management</i>	<i>Small</i>
<b>Traditional Family Businesses</b>	<i>A single subject or a small number of people</i>	<i>Family board Family and non-family management</i>	<i>Small Medium/Large</i>
<b>Extended Family Businesses</b>	<i>A larger number of subjects</i>	<i>Family and non-family board Family and non-family management</i>	<i>Medium Large</i>
<b>Open Family Businesses</b>	<i>Individuals belonging to the family and also other members external to it</i>	<i>Family and non-family board Family and non-family management</i>	<i>Medium Large</i>



**Figure 1.** Classification of Family Businesses

These typologies of enterprise can be seen both in the descriptive and in evolutionary sense: in them, you can read an inversely proportional growth between the dimensional development of the company with a progressive and less commitment of the same family in the enterprise, which is in the direction and in the ownership.

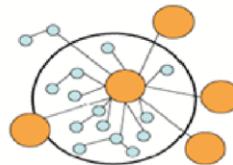
## 2.1. Industrial District

The Industrial Districts (ID) are production systems which, since the early 1970s, have represented a much-studied area. In the Italian economic literature, the first to integrate Alfred Marshall's studies with the entrepreneurial reality of our country was Becattini [12]. The scholar defined the Districts as "socio-territorial entities characterized by the simultaneous active presence, in a limited territorial area, determined from a naturalistic and historical point of view, by the presence of a community of people and population of businesses" [13]. In these contexts, the socio-cultural elements are decisive for the achievement of the competitive advantage realized by SMEs operating in the same geographical area [14, 15]. The local culture, therefore, becomes an element of cohesion, which allows individual actors to become part of the whole. The companies and the people who work there constitute the social environment of the district. With the evolution of business and economic studies, the industrial district has been classified according to different points of view: a) as an economic entity that is

halfway between business and industry [16]; b) as a cognitive system [17-20]. Ann Markusen, in the 90s, gives her own classification of the Industrial Districts [21, 22].

## 2.2 Hub-and-spokes ID

With Markusen's theories, the districts no longer have the characteristics theorized by Marchall and Becattini, but become systems that represent and follow different managerial philosophies, assuming very dissimilar conformations.



**Figure 2.** Hub and Spoke District.

In the Markusian districts it's possible to observe the presence of large companies, private and/or state-owned, which act as the fulcrum of business systems, in which local SMEs play the role of suppliers and sub-suppliers. The companies are linked by contractual systems that highlight the existence of asymmetries of power within the district. Large corporations exert and hold greater strength in inter-company relationships. The theorized district models are: a) Marchallian ID; b) hub & spoke district; c) the "satellite platform"; d) "state anchored" cluster.

The Hub and Spoke (H&S) ID have a conformation which sees the simultaneous presence of one or more large companies, that form the core of a system, geographically concentrated, also made up of many smaller companies. Given the asymmetry of power, the relationships that are established between firms are of vertical integration (with hub companies) and horizontal (with other companies). They can be shaped like a ring or a nucleus, according to the different kind of dependence that is generated between the businesses in the district.

Commercial dynamics between district businesses are based on long-term contracts and employee's management is often operated at the district level. This also implies the exchange of human resources between companies. However, inter-company HR exchanges concern only blue-collar and employee staffs, while company managers follow an intra-company management system.

## 3. The internationalization of businesses [23-30]

The term "internationalization" refers to the expansion of the company outside its national market. Actually, the internationalization of activities represents a fundamental way in which the company creates value, extends its competitive advantage, remunerates the resources invested, accesses new opportunities and resources for growth.

It is clearly a complex path that can't be underestimated: it is accompanied by a fundamental and often irreversible business transformation process, which involves financial aspects, organizational and technical structure, market positioning and human resources management. This process tends to create markets that transcend national boundaries, to the point of becoming international or, truly, "global".

Globalization, therefore, is the process of growing integration of the economies of different areas of the world: it reduces and ultimately eliminates the limiting obstacles for the free movement of goods, services, capital, people and knowledge.

Companies have to deal with the world economy, as it provides market outlets, supply channels, knowledge, technology, resources and incentives needed for their business.

The approach to a foreign market involves many evaluations: in addition to the development prospects, it is necessary to consider the infrastructural and demographic conditions, the political, economic and cultural context, the tariff barriers and more. The development perspective is, therefore, the reason that pushes the manager to consider the hypothesis of an internationalization strategy, but it is not a sufficient condition for being able to pursue and complete this strategy.

Businesses must overcome information barriers higher than those present on the internal market. In order to develop an internationalization strategy, it is necessary to carry out in-depth studies of the target markets and to enter by playing according to the "house rules". It is important to use detailed planning to reduce risks. The planning process must be internal (through company controls) and external (market studies, business plans, marketing plans), in order to identify both the external positioning and the strategy.

The company that wants to internationalize must possess and offer unique and distinctive competitive advantages. Only in this way and going on according to defined rules, the goal will be reached.

Internationalization can be done by:

- a) *trade expansion*: is to export and marketing abroad of goods produced in the country of origin;
- b) *Foreign Direct Investment (FDI)*: This covers an investment system, made by a foreign investor, through the holding of shares in a domestic company;
- c) *intermediate forms of internationalization*: these are agreements, licenses, technical and commercial assistance contracts, etc., which make it possible to sell or rent the technology to local operators in foreign countries.

The main economic reasons that can push companies towards internationalization strategy can be traced to:

- find new business opportunities in a contracting market;
- avoid the price war;
- reduce risks by differentiating the markets;
- obtain faster and safer payments;
- stimulate new business ideas;
- reduce production and distribution costs.

Through internationalization, 4 strategic objectives can be achieved:

1. *Development of new markets*: every country is a market opportunity. For many companies it is necessary to enter markets that have a huge consumer base with a certain income, or to choose countries that can be "springboards" to enter new markets.
2. *Access to local resources*: such as low labor costs, technological skills, natural resources, raw materials, as in the case of Oil & Gas companies.
3. *Learning*: some companies decide to enter certain markets to learn skills or knowledge, regardless of market conditions.

4. *Coordination of international activities*: in order to decide which sector / market to enter, a risk / opportunity analysis must be carried out, because internationalization is not easily reversible.

The choice of the market/sector is influenced by:

- *International strategic orientation*. The company's competitive attitude is important: at the first entry into an international market, it will choose low-risk markets, similar to the domestic one, in terms of language, culture and more. If, on the other hand, the company is not at its first experience, it will have a greater risk appetite and it will look for markets other than the domestic one.
- *Characteristics of the market and industry*. It's necessary: to analyze the market potential, i.e. size and growth methods; obtain information, such as the degree of urbanization, climatic conditions and prevailing lifestyles; analyze market demand and its elasticity.
- *Nature of the competitive environment*. It depends on the structure of the sector and the strategies adopted by competitors. It is necessary to know the degree of concentration, the allocation of resources in the destination country, the presence of raw materials, the quality and cost of human resources and infrastructures.

The industry characteristics affect the company's conduct and its performance.

## 4. The SMAPE Ltd<sup>2</sup>

### 4.1. History: notes

The SMAPE Ltd. - Southern Society for Petroleum and Ecological Applications - is an Italian, privately owned partnership that operates as an international service provider in the Oil & Gas sector.

The company was founded in 1989 in Abruzzo, in the province of Pescara, by its founder, Stefano Bianchi, a former entrepreneur in the oilfield.

It is a family business whose ownership structure does not provide for the presence of a single family, but the union of three partners, owners of different amounts of capital: the Bianchi family, majority shareholder, and minority shareholders Rossi and Gialli.

The three founders, in 1975, had created another company, also a family business, with the same percentage split of the shares, the Italfluid Geoenergy (ITF), based in Notaresco, in the province of Teramo, which operated in profitable way. The ITF "group" in 1989, was formed by the companies:

- ITF Sefim, holding company of the Bianchi family, with real estate assets and shares in Geoenergy;
- ITF Geoenergy Ltd., the primary operating company;
- ITF Cosmep Ltd, a "wild card" company that, over the years, was used for different operating purposes;
- PTS - Petroservices Mediterranea Ltd - owned by Smape and a Sicilian partner.

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<sup>2</sup> We thank the sole director and the top management for their willingness to provide sensitive data and information concerning the company activity, regarding the internationalization strategies and the development of activity in foreign markets. The names of the members and others do not correspond to reality.

So, in 1989, driven by years of experience in the sector and taking advantage of the tax policy for investments in Southern Italy, the three partners created this new company (based in another province, Pescara) to develop special systems for the treatment of the hydrocarbons produced from wells, such as desulfurization.

The company was born with the presence of only two people: over the years it has had a staff of over 250 people, divided between Italy and abroad.

In the first years of operation, Smape built and managed a desulphurization plant used at the ENI well in Villafortuna, in the Ticino Park.

In 1990, the group began to take an interest in the "Coiled Tubing" (CT) activities carried out in Italy by the multinationals Nowsco, Dowell-Schlumberger, Halliburton, BJ - Byron Jackson and SIAT of Ravenna. In 1991, when Nowsco left the market and purchased some CT equipment, the company began developing the CT service.

In 1992, this service was further developed: four specific people were dedicated to its growth and implementation, Verde, as head of development; Nero, a Nowsco employee, as an "expert" in the sector; Blu and Arancio, seconded by ITF Geoenergy.

For most of its existence, Smape has operated in a close and connected way, often synergistically, with the "mother company" ITF Geoenergy: born as one of its branches, with specific attitudes and services complementary to those of the ITF, it is currently a completely independent company. In its field, Smape has shown great potential and capacity for growth, both for the experience it possesses and for its ability to innovate (with new equipment and new ways of using existing equipment). The first "innovative" operation was in 1992: the mining closure of the Guglionesi 5 well, carried out with the use of the 1-inch CT for pumping the cement. This type of application, never carried out before, will be resumed during the year and still today constitutes a valid and economical alternative to the closure of mining wells carried out in a classic way, with a work-over system. Subsequently, the company establishes working relationships with Agip (today ENI), incoming in their vendor list. After a year, 19 operations were carried out, including eight mine closures, and the use of new equipment was developed and tested (a 2-inch CT, complementing the "cheap" gas wells). The introduction of this format in Italy was absolutely innovative, to the point of making it necessary to purchase new equipment suitable for handling this tube. In 1995 the transactions carried out rose to 47. In addition, off-shore operations were intensified, reserved for the most reliable contractors, reflecting the greater experience and quality of the service offered.

In 1996 Smape, in collaboration with Transocean, carried out three CT drilling operations on behalf of ENI: a 27/8-inch TC was introduced. For this circumstance, Smape has developed an adaptation to the tower of an equipment (MS50), in order to adapt to the shaft for lifting and moving the injector used for drilling.

In 1997, the company recruits five new experienced employees, the number of works carried out in the open sea increases significantly and 75 operations are carried out.

In 1998-1999, during the first crisis in the O&G sector, the company still manages to stabilize its business and to promote the use of downhole tools for countless new applications. In 2000 Smape also started operating in the oil wells of Val d'Agri, introducing the new 13/4-inch CT and performing some innovative permanent "Velocity String" installations, always using CT. In 2002 the number of operations carried out rose to 170; in 2003, 300 operations were carried out in one year.

#### *4.2. Core business and services*

The company's goal is to provide specialized services in oilfields around the world, in compliance with the best practices, standards, quality, safety and environmental requirements recognized by the industry.

Provides the following service lines:

1. **Coiled Tubing:** the company has the largest fleet in Southern Europe of complete equipment for Coiled Tubing services, with units suitable for both on-shore and off-shore applications and for operations in sensitive areas for low noise and exhaust emissions. Dedicated engineering teams are involved in the initial design preparation, planning and simulation of the job. Technical chargeback is provided through engineering analysis and post-work reporting, to provide a continuous improvement process.
2. **Nitrogen:** The company offers a complete nitrogen pumping service (for on-shore and off-shore applications), starting from the initial design of the work up to the execution and analysis phases of the work. All nitrogen processes are supported by experienced teams of technicians and field personnel.
3. **Pumping and Stimulation:** Fluid pumping equipment includes pumping units specially designed for high speed / high pressure applications and are available for use in conjunction with CT operations. The engineering teams are available from the initial preparation of the design of the pumping stimulation service, to the supply of dedicated equipment and specialized personnel, able to meet the different technical needs which have their origins in the different markets and applications.
4. **CT Downhole Tools (TT):** the work-over operations are used to maintain the initial levels of productivity and efficiency. Smape has developed a wide range of tools for the drainage of passing pipes, positioning itself among the leaders in the provision of CT and TT services.
5. **Pipeline-Service:** the Pipeline-Service division covers a wide range of applications, both in the upstream sectors and in the oil and gas sector.
6. **Chemical Injection:** this division operates to provide injection services, performed with polymer gels EOR (Enhanced Oil Recovery).

#### *4.3. The ownership structure and management*

Smape Ltd. is a family-owned SME: it belongs to the extended family business type, joint venture, family and non-family, with the control package in the hands of the family that created the business. The family also holds key positions in the management and direction of the company. The company has already achieved a generational expansion: it is directed by a Sole Director, dr. A. Verde, who has managed it since its beginning. Compared to the Bianchi family, Dr. Verde is the son-in-law of prof. S. Bianchi, who, despite being its founder, has never interfered in operational management and has never held any role in the company organization chart. The second generation is already present, at various operational levels: two of the three children of Dr. Verde, Marco and Lucio, have already been introduced into the company, but only one, the primogenital, holds important roles in the company (management of foreign activities). The second, just graduated, is at the beginning of his training and does not yet appear in the organization charts of the company. The company, which has always been managed in a modern and managerial way, has received new life and new impulses from the co-optation of external managers and the

entry of close family members into the company. The new generation has undergone a long training, like any other employee, with the aim of being hardened for the job, understanding the reference markets, gaining experience in the field, in order to create their own know-how. This management strategy, both of the company and of the family, has been successful, as well as profoundly different from the one prof. Bianchi, former CEO of ITF Geoenergy Ltd., has adopted into his group.

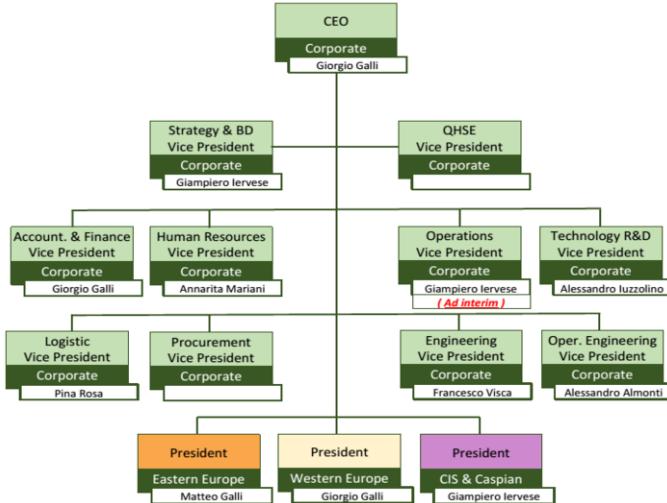


Figure 3. Organization of SMAPE Ltd

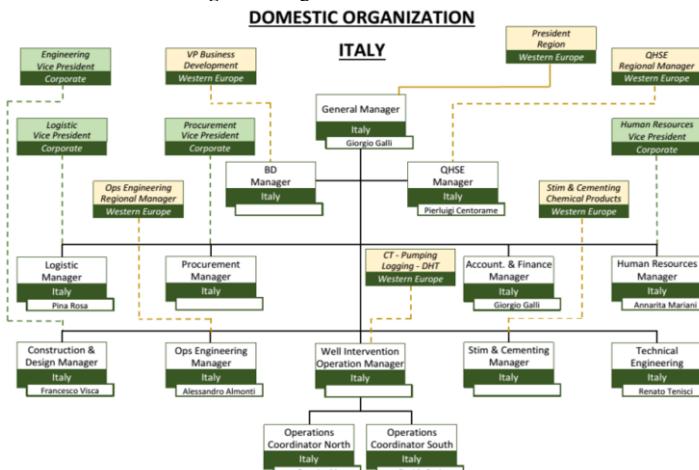


Figure 4. Domestic Organization: Italy.

Table 3. The increase of employees

YEAR	EMPLOYEES						
	TOTAL	ITALY	EGT	ALB	AZB	ROM	KAZ
1989	2	2	0	0	0	0	0
1990	2	2	0	0	0	0	0
1991	2	2	0	0	0	0	0
1992	2	2	0	0	0	0	0
1993	2	2	0	0	0	0	0
1994	4	4	0	0	0	0	0
1995	8	8	0	0	0	0	0
1996	12	12	0	0	0	0	0

1997	18	18	0	0	0	0	0
1998	19	19	0	0	0	0	0
1999	19	19	0	0	0	0	0
2000	19	19	0	0	0	0	0
2001	20	20	0	0	0	0	0
2002	22	22	0	0	0	0	0
2003	27	27	0	0	0	0	0
2004	31	31	0	0	0	0	0
2005	33	33	0	0	0	0	0
2006	39	39	0	0	0	0	0
2007	49	49	0	0	0	0	0
2008	82	55	27	0	0	0	0
2009	99	61	38	0	0	0	0
2010	123	65	58	0	0	0	0
2011	148	82	66	0	0	0	0
2012	171	103	48	18	2	0	0
2013	191	119	47	22	3	0	0
2014	226	136	41	26	3	0	0
2015	215	139	41	12	3	0	0
2016	235	120	99	7	3	6	0
2017	207	114	67	7	4	15	0
2018	223	115	58	22	4	23	1

Today, the ITF and Smape Ltd are not only two fully independent companies, but often operate as competitors. This radical change in relations between the two groups was caused by the generational change that took place in ITF in the last five years: this turnover, inadequately managed by both the founder and his successors, caused a break in the family system. The management strategy of ITF, in fact, was of a totalitarian nature: having created his “empire” from nothing and perceiving the company as part of himself, the founder has always kept all the power and decision-making in his own hands. From the point of view of ITF management, prof. Bianchi gave his two partners a fair amount of autonomy. The involvement of family members, especially daughters and daughters’ in-laws, proved to be completely marginal. The definition of roles and of the delegation system within the company, even if theoretically existing, has not actually been implemented.

In fact, when the company and Professor Bianchi found themselves in front of the natural moment of the generational change, a myopic vision appeared in the eyes of the founder: this, combined with various family vicissitudes, led inexorably to a clear and inevitable corporate split [31].

This split did not concern Smape, which in any case already constituted an independent company from the ITF, but all the companies that made up the group. In the Smape management, instead, as in all multinational companies, managerial conduct provides not only a division and separation of roles for specific skills and knowledge, but also a remuneration system linked to results [32]. In this way, the motivation of the personnel, especially at managerial levels, is stimulated on to continuous improvement, in order to achieve ever higher performance levels. Regarding the management of personnel, different contractual situations are applied in the company, depending on the country of destination and allocation of the employee considered. In fact, for Italy both permanent contracts and fixed-term contracts are applied, governed by Italian legislation and the national contract of the sector.

As regards work contracts for foreign personnel, we can distinguish different cases: foreign staff is employed at the local office, with stipulated fixed-term contracts, with a contract provided for by local regulations. Furthermore, in the management of human

resources, the exchange of human resources between the various operational areas is often used, with the exception of the Schengen area, which is difficult to access for non-EU personnel. In some rare cases, some specific human resources, or sector specialists, have been hired under an “international” contract, as consultants. Finally, as regards the treatment of Italian personnel abroad, it takes the form of a “travel” regime: if the stay abroad is, cumulatively, 183 days a year, the “secondment” of the foreign employee.

Another fundamental resource, never underestimated in the company, is represented by innovation. Smape has always pursued the search for new ways of operating and exploiting technology (as for CT), to become one of the fastest growing segments in the oil services sector. This growth is supported by continuous technological advances and the use of CT to be able to perform an ever-growing list of field operations. An element that has played in favor of this development, in my opinion, lies in the multidisciplinarity and in the possession, which exists in the company, with a wealth of very different basic knowledge. The company, in fact, since its establishment and continuing with the co-optation of people of different educational backgrounds, includes engineers, both mining and chemists, economists, geologists, pure chemists, etc., who have been able to put together and compare their knowledge. All this, as our KM studies teach us, has led to a multiplicity of points of view, which has allowed us to broaden the physical and mental horizons of the company itself.

#### *4.4. Development and internationalization<sup>3</sup>*

Like many companies operating in the oil sector, Smape links its destiny to the oil market, the Oil & Gas economy and the exploitation of underground resources. The company is beginning to feel the need of expanding its boundaries. The first step abroad was in 2004, when the first operations were carried out in Croatia for INA-AGIP: however, beyond the foreign customer, this experience did not constitute a particular innovation, because they were carried out in the Adriatic off-shore, often with Italian starting point. The real international test took place in Algeria, for the AIFG group: even in this case, despite a good performance, the operations were wild shortly after, because the company had no direct interest in their development. However, thanks to these, Smape has realized that it has an interest in expanding abroad and internationalizing its business. In fact, in 2007 the ITF Egypt LLC was created in the Free Zone of Suez. The partners are 43% Smape and the same subjects of ITF Geoenergy and Smape for the rest. The original purpose of the company is to bring all the group’s services to the country. In 2008, however, the second “crisis” of the oil price occurred, with the consequent decrease in work volumes and turnover: thus, the Egyptian company was left on stand-by and Smape broadened its range of action in across the EU. The first works are carried out in Greece, then in Spain and Germany. In the years 2010/12, a collaboration started with the multinational TIORCO-Nalco for the exclusive worldwide pumping of special products in oil wells. Thus, he finds himself working in several foreign countries, including Azerbaijan, Russia, Congo, Equatorial Guinea. With the oil price crisis that started in 2014, the company chose a strategy of “conservation” of human capital, limiting itself to optimizing all costs and giving up all fixed-term relationships. In any case, the company still continues to work

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<sup>3</sup> Despite having specific and detailed data, it was decided to provide only aggregated data and values, as the company is in full operation and we do not want to disclose sensitive data, for competitive reasons.

for the development of new foreign markets: a lot of time and resources are used in this sense. On 6/12/2017 Smape Kazakhstan JV has been established in Almaty, with partners Smape Ltd at 70% and Kazburgas LLP at 30%, whose corporate purpose is the execution of the "high level CT" contract for Karachaganak Petroleum Operating Co.to Aksai. On 20/12/2017 the Smape Ltd. branch in Kazakhstan has been registered in Almaty.

**Table 4.** Corporate forms established in foreign countries.

COUNTRY	COMPANY	FORM	TAXATION	YEAR
Egypt	Italfuid Egypt	LLC (srl)	Free Zone	2007
Albania	Smape	Sh.p.k (srl)	Ordinary	2011
Azerbaijan	Smape	Branch	Ordinary	2011
Romania	Smape	Branch	Ordinary	2016
Serbia	Smape	Branch	Ordinary	2016
Kazakhstan	Smape	Branch	Ordinary	2017
Kazakhstan	Smape JV	LLP (srl)	Ordinary	2017

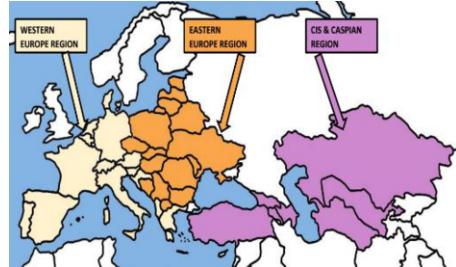
The choice of the corporate form has undergone an "evolution" over time: the first foreign company was under local law with the participation of the Italian company (30-40%) and the direct participation of private individuals for the remainder.

In Albania, the choice fell on LTD with a single shareholder, Smape Ltd., for legal issues relating to the direct liability of Smape Ltd. and for the need to protect the latter in countries characterized by low legal certainty. Therefore, to encourage a correct tax structure (according to the principles of the OECD and Italian taxation), to encourage the transfer of assets from the Italian body to the foreign one and vice versa, and to "consolidate" foreign companies in the Smape Ltd. financial statements, the solution chosen was to establish branches, both with and without legal personality, depending on the country considered. An exception was made for Smape Kazakhstan LLP, which is a JV with a local partner, as requested by the host country and by the client.

However, Smape's foreign works have gone further. There are many activities carried out in other states and with various oil companies, taking the existing foreign offices as an organizational basis and employees.



**Figure 5.** SMAPE in the world.



**Figure 6.** Geomarket division.

The geographical areas identified above, indicate the areas of operation, independently from the specific foreign offices, of which single and detailed data will not be provided in his discussion. The organization for operational areas has been designed as indicated in the following organization charts.



Figure 7. Regional Organization Eastern Europe.

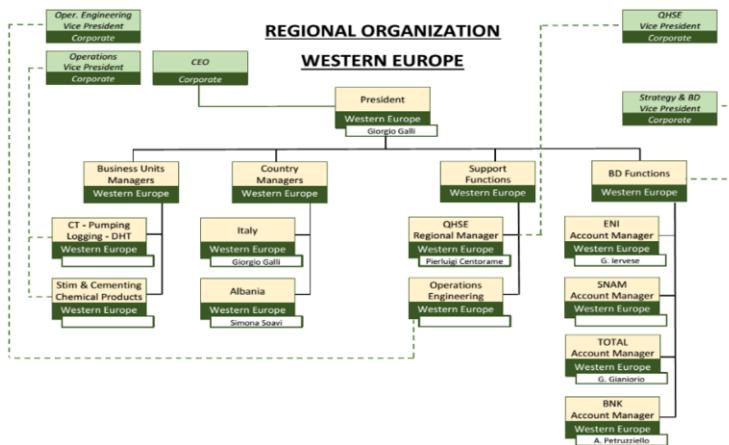


Figure 8. Regional Organization Western Europe.

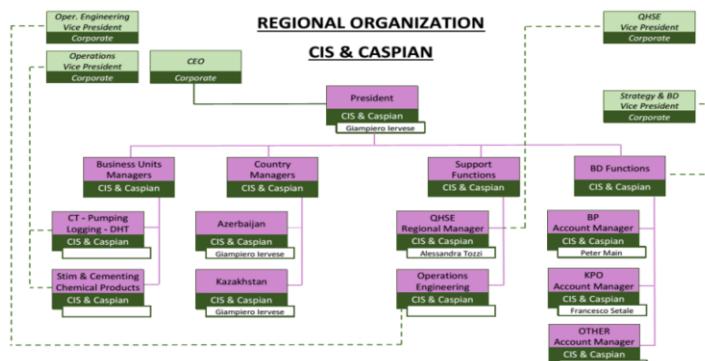


Figure 9. Regional Organization Cis and Caspian.

In previous organizational charts, the lines represent the type of relationship existing between the different company figure: Dotted Line, means understanding the presence of a double relation to the general guidelines of the company; Solid line, is intended as the main report for the daily and weekly assignments, annual activities and the direct management.

Some of the organizational charts are currently subject to revisions, as regards the assignment of roles and activities.

**Table 5.** Global function Summary

<b>CHIEF EXECUTIVE OFFICER:</b>	is responsible of making major corporate decisions for Company's long-term strategy with a view to creating shareholder value.
<b>VICE PRESIDENT STRATEGY AND BUSINESS DEVELOPMENT:</b>	is responsible of the development and execute the Company market development strategy globally.
<b>VICE PRESIDENT QHSE:</b>	is responsible of issuing global policies and guidelines to Regional QHSE departments and of the continuous monitoring, auditing and verification of the compliance of local and national systems to the corporate guidelines and to national laws and regulations.
<b>VICE PRESIDENT ENGINEERING:</b>	is responsible for all the new equipment design, construction and heavy maintenance to support the global activities. Is responsible of issuing the global policies and guidelines related to engineering and construction.
<b>VICE PRESIDENT ACCOUNTING &amp; FINANCE:</b>	is responsible for managing the global financial matters of the Company, including international transaction policies of the company, compliance to international regulations.
<b>VICE PRESIDENT HUMAN RESOURCES:</b>	is responsible of global human resources management and of issuing policies and guidelines to local and national departments; manages international rotations and relocations.
<b>VICE PRESIDENT OPERATIONS:</b>	is responsible of the global operation planning and execution in compliance with the global policies and guidelines; is responsible of the management of mobile assets and equipment dedicated to operations, of the optimization of corporate material resources, of the data gathering and reporting on operation execution and economy.
<b>VICE PRESIDENT OPERATIONS ENGINEERING:</b>	is responsible of the global operation-oriented engineering, of the issue of all company's technical documents related to operations, of the issue of global policies and guidelines related to operative engineering.
<b>VICE PRESIDENT TECHNOLOGY AND R&amp;D:</b>	is responsible for all the new technology development to support the global activities.
<b>PRESIDENT ESTEARN EUROPE REGION:</b>	is responsible for the management and results of the region.
<b>PRESIDENT WESTERN EUROPE REGION:</b>	is responsible for the management and results of the region.
<b>PRESIDENT CIS AND CASPIAN REGION:</b>	is responsible for the management and results of the region.
<b>VICE PRESIDENT LOGISTIC:</b>	is responsible of management and planning logistic activity globally and in compliance with the global policies and guideline.
<b>VICE PRESIDENT PROCUREMENT:</b>	is responsible of management and planning procurement activity globally and in compliance with the global policies and guideline.

#### *4.5. Internationalization strategies considered and implemented*

The oilfield internationalization strategy follows three main guidelines: firstly, it is necessary to go abroad to follow the exploitation of a natural resource, which is not present in all territories and which, in Italy, is present to a limited extent; secondly, internationalization is implemented to expand markets for business; not least, companies that work for Oil Companies often have to follow the hub company in the countries where it operates. This happens because often the oil system (national and international) is constituted in district form (H&S district). The strategy followed by Smape was conducted autonomously, that is, in an absolutely independent way and unrelated to the internationalization and development policies implemented by the Italian government.

The factors that outline the company's internationalization strategy are:

- evaluation of the necessity for internationalization, as a factor for the development and stability of the company;
- market analysis with consideration and evaluation of the following factors:

- a) *Logistics*: choice of geographically not too distant markets, in order to easily transfer human and material resources already used in Italy;
- b) *Political and cultural*: operating simultaneously in different countries, but similar to us, would have made it “easier” to deal with this situation, especially for the workforce.
- c) *Competition*: do not try to enter markets where there is strong competition, such as those of the North Sea districts;
- risk analysis: socio-political, economic;
- market analysis: market value, presence and strength of competitors, cost / benefit ratio;
- technical analysis: services requested in O&G, opportunities for the services offered by Smape, technical standards required;
- legal analysis: consider the existing laws, regulations and legal constraints of the countries in which we want to internationalize, in order to evaluate the opportunity and the concrete possibility of being able to enter the new market, investment protection;
- economic analysis: taxation, degree of market liberality, possibility of repayment of capital, customer solvency.

From the analysis of the aforementioned factors it emerged, for example, that the East-Europe-Caspian geographical area is the one that collects the highest score in the evaluations, and it is exactly the strategy that Smape is implementing.

Egypt, on the other hand, which has met most of the requirements considered, has shown a low propensity to reward the quality of the service offered and the presence of local competitors not of the same level, but extremely cheap. However, this assessment, which did not emerge in the preliminary phase, conditioned the local development of the company to the point of blocking it; to date, the country is considered attractive for other types of activities (e.g. EPF or similar projects), but not for those offered by Smape. In the future, Smape could consider, for further growth and evolution, objectives different from those considered so far. Naturally, the strategic analysis of the choice to internationalize in a particular country is made in relation to the specific moment in which one operates: tomorrow, some considerations may no longer be valid.

Here is an example of selecting an international market:

1. We start by excluding countries that are not doing well, for strategic reasons or for lack of interest;
2. Among those that remain, we consider those in which we consider particular difficulties of penetration and / or too many risks of various kinds, mainly public and political order;
3. Among those that remain, the choice may be the consequence of very different elements and events, both occasional and systematic, such as, for example, the randomness of a contract or a single job.
4. For the other markets, a comparison is made between the respective cost / benefit analyzes carried out.
5. Parallel to the above, the positions of the competitors are analyzed to verify where there are greater (and fruitless) probabilities of confrontation and where, on the contrary, a more peaceful penetration is possible.

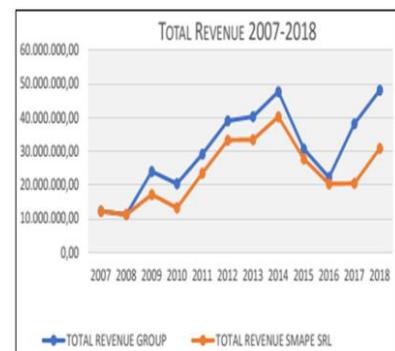
Not all competitors are the same. Smape, due to its structure and its skills, is often faced with companies that are superior in order of magnitude: in this case it is not uncommon for the interests to be different. It has to be considered, however, that entrepreneurial activity, like all economic activities, is subject to a part of risk and the choice made is not always the best, not leading to the desired and planned results. In the case of Egypt, e.g., an in-depth analysis was carried out by searching for specific

data on the Oil&Gas market and building a dedicated business plan. Not for this, however, the real result turned out to be in line with expectations and with the plan forecasts.

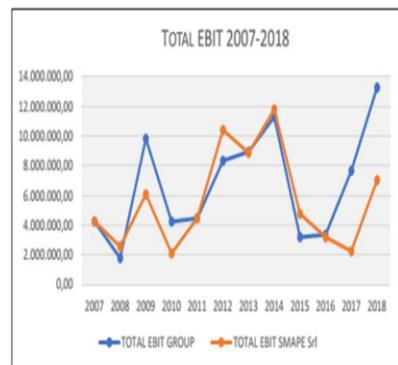
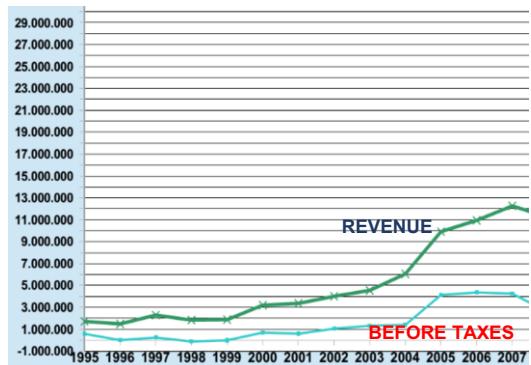
#### 4.6. Some economic performance of internationalization.

Going beyond the purely strategic point of view, to understand and appreciate the development that Smape has been able to pursue, to make an economic assessment of how the company's activity has evolved and grown, from its creation to today, just take a look at the numbers. If you look at the following two graphs, of which the second is simply the highlighting of the economic results of the company, when it was still operating mainly in the national context, you can easily see how the implementation of internationalization strategies constituted, for Smape, a development booster. The graphs below, however, show the development, from an economic and revenue point of view, the company in the international arena. As previously mentioned, the tables and the specific numbers are not reported, for privacy reasons.

**Graphic 1.** Smape global sales and profits in Euro 1995-2018    **Graphic 2.** Total Revenue 2007-2018



**Graphic 3.** Smape global sales and profits in Euro 1995-2007    **Graphic 4.** Total EBIT 2007-2018



The graphs, concerning the economic results achieved by the company over the years, show a significant increase in revenue (Graphic 2 and 4). International development, despite having led to huge investments, have given a great boost to corporate activity. Certainly, with the start of the implementation of internationalization strategies, the company has shown a more fluctuating economic

trend, characterized by high peaks of activity, both very positive and lower (Graphic 1 and 3). In any case, there has never been any real economic losses, but rather a settling of the activity in unfamiliar and highly competitive markets. The years when there was no activity growth correspond, essentially, to periods of global Oil & Gas crisis. Despite this, the Smape has managed to maintain an adequate economic result. In this way, through effective and efficient management of internationalization strategy, the company has established itself in foreign markets in a competitive way.

## 5. Conclusions.

In a global universe, where there are no longer borders between countries, limited information, difficulties in accessing technology and explicit knowledge, the entrepreneurial and strategic choice to internationalize has increasingly become an “obligation” for entrepreneurs. The increase in competition and the limited barriers to entry into the market can no longer guarantee small and medium-sized enterprises to live, and not survive, only by operating in their national reference market. Even family businesses, generally characterized by small to medium size, are not protected from globalization and the risks of competition. In the Italian business structure, SMEs and family businesses are the backbone of the economy: our companies have always been medium to small in size and have served as supporters and subcontractors of services to larger companies, or have joined the district systems to be able and possess the necessary skills for the production of finished products.

However, there are exceptions: the Smape Ltd case proves it.

The company, which was absolutely small and essentially family at its inception, has grown. Born thirty years ago, with an initial investment of 500,000 euros discounted, Smape has been able to grow and develop constantly. It represents a case of excellent SME and family business: the family business was addressed according to managerial methods, abandoning the classic organizational and managerial paradigms, characteristic of its type of business. The management has been stimulated to continuous improvement and the company has become a multinational, able to compete with business categories of all sizes and occupying market segments, often “reserved” for much larger companies.

The combination of two key factors has led it to become the market leader in the TA and auxiliary services sector: first, dimensional flexibility, considering that Smape is a medium-sized company, which has allowed it to bear operating costs “content”; second, the managerial vision of a large company.

After thirty years the company has about 250 employees, a managerial organization, seven foreign offices / companies, depending on the types adopted in the different countries and dictated by specific regulations, and a global sale of about 40 million euros per year.

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# Environmental Awareness and Adoption Intention of Electric Cars in Young Adult

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**Abstract.** The world is being heavily polluted, which is contributing to many natural disasters. Attempts are being made to come up with innovations that lessen the impact of pollution. Electric cars are one such innovation. Here we investigate the awareness of and decision making about buying electric vehicles among 204 young adults. We propose that consumer decisions related to several factors, which include global warming, air pollution, electric cars, travel and socialization, green self-identity of young adults, and intentions on the use of electric cars. This research was able to show that independent variables can affect consumer awareness and decision making towards the purchase or adoption of electric cars.

**Keywords.** Young adult, electric car, environmental awareness, eco-friendly

## 1. Introduction

Over 100 years ago, the electric car was initially introduced to the United States, Hungary, and the Netherlands as an option to reduce the dependency of steam-based and gasoline-based power. By the beginning of the 1970s, the electric car had emerged as an innovative option for customers, particularly in the United States, as a means to avoid the possible and unprecedented oil shortage as a result of the oil crisis in the Middle East, as well as to help reduce the emission of carbon dioxide (CO<sub>2</sub>) [1].

Although many questions have been raised regarding the reliability of statistic environmental awareness, the data collected from. Participants with diverse background showed differences interesting point of views. Concerning the market adoption of this technology, data on global warming, air pollution, travel socialization, green self-identity was needed. Here we investigate young adults' intention to use an electric car and explore their awareness of electric cars and the factors that affect their decision making in purchasing electric cars.

Participants were asked, "How can electric cars solve the global warming crisis?" and "Do they see positive or negative potentials of the electric car?". This analytical research, therefore, was created to explore the perception and decision-making of young adult consumers and to assess the awareness of this innovative product. Also, this research assesses the current and future position of electric vehicles, and whether it

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is justified for consumers to purchase the product. By estimating consumer evaluations via questionnaires, this research should shed some light on consumers' perception of electric cars and how likely they are to purchase an electric car.

## 2. Literature review

### 2.1. Electric car

The rising number of personal cars in cities and towns is creating traffic congestion, parking problems, and noise pollution. Personal vehicles are parked for very long hours, so there are secondary usage levels. Vehicle sharing programs are structured on multiple-person pooled usage of cars, and the use rate of such automobiles, typically operated by corporations or organizations, is far higher than private vehicles. Typically, they serve their users following a subscription scheme and charge use through distance or time traveled. Because of this, sort of consumers prefers to travel less frequently. Car-share programs, coupled with the introduction of environmentally sustainable cars, can reduce these critical community concerns.

Depending on whether passengers are expected to enter those stations or not, car-share programs can be divided into two types, station-dependent and free-roaming. Two categories of trips can be found in station-based, car pick-up programs. Round trips require more abandoned stations, while one-way trips require more dumped stations. One-way systems provide users with greater versatility but require more complex maintenance because severe load imbalances can occur at stations. The cars can be placed anywhere inside a predefined zone in free-floating structures, so consumers can choose the vehicles from within the zone they are positioned. Per the emergence of interests from a versatility standpoint, the free-floating models are unable to affirm consumers that there is sufficient parking space available for them at the destination, and vehicles necessarily need to be stopped at the place where there is sufficient petrol or electricity. Also, such networks usually involve car movement to match the supply in various areas in town as well as to conduct operations either on refueling or recharging [2].

Power protection and urban air emissions concern, resulted from operations of automobile production, are becoming progressively more severe [3]. With transport cars, for example, toxic tailpipe pollution has become a troublesome environmental issue, of which battery-electric vehicles (BEVs) can be an alternative solution. Besides, the BEV market share remains small because of restricted all-electricity (AER) drawbacks, nuisance charging, high upfront costs, and security issues [4]. Of these, battery-electric cars (BECs) would need a long AER to be acceptable to consumers. There have been recent significant and incremental changes in BEC's AER and an increase in the battery pack capacity. In the future, super-fast charging (thereby shortening the charge time of long-range BECs) is likely to be realized. Such a phenomenon connected to the production of more powerful HPCs has recently prompted several national governments to draw up a technical strategy to build and improve super-HPCs for electric cars [5].

## 2.2. Methods for modeling the use of electric vehicles

Among available survey methods, activity-based modeling (ABM) offers a framework for fusing cross-sector studies [6]. This is needed for advancing the integration between transportation and electricity networks. However, there is the limitation to this mode as the behavioral changes of the users are difficult to measure. Per the study of this research, this said model can be employed to explore people's intentions and awareness towards the importance of the use of the electric car in the context of global warming.

## 2.3. Green self-identity

By identity theories, self-identity is the primary motivating factor underlying behavior [7]. The study was adopting a sociological personality strategy [8]. It is also known for a definitional collection in supporting their positions. The essence of identification is to imagine oneself in a role and to integrate the values and self-expectations. Those values and definitions then form a collection of criteria that govern actions [9]: by taking a position of identification, people take expectations that follow the function, and then behave in a way that embodies and maintains those expectations [10]. The higher of the equal prominence, the more the individual participate in acts that enforce their uniqueness [11]. Consequently, the self-identification of a customer (i.e., whether people understand themselves concerning different roles) is an independent indicator of perceptions and consumer habits, since consumers pursue conformity with the identification norm by interpersonal acts [12].

## 2.4. Environmental awareness

The impact of consumption on the environment is the reflecting of a concept of consequentialist on the degree to which customers are alert to the ecological implications of their use [13]. In reality, customers will buy goods based on the degree to which they are concerned about how the use of such things affects the biological environment [14]. Environmental awareness, in this respect, also affects the purchasing intention of environmental-friendly products [15]. Considering the environmental impact, they might interpret something as immoral and environmentally unfriendly. Responsibility for the ecological consequences of use is a profound notion reflecting how responsive customers are to the environmental implications of their consumption. The values of universalism are of greater interest in such persons, such as the protection of the environment and peace of nature [14].

## 2.5. Green moral obligation

Ethical science, users continue to focus on the philosophical principles of teleology and deontology to form their behavior in ethical circumstance [16]. Green moral responsibility is noted as the degree that a person recognizes the negative moral aspects of adopting specific products that damage the environment. Green moral obligation can be described as a personal internal state construct (that) concerns the degree to which an entity feels a sense of duty to behave when confronted with an ethical circumstance, such as protection of the environment. This notion is following the norm activation paradigm, where pro-social conduct is supposed to emerge from personal expectations that represent senses of moral obligation to undertake or refrain from acts. Customers

should keep within an eco-friendly best practice. Ultimately, the infringement of such values is wrong [17]. These results suggest that environmental self-identity is linked with an obligation-based intrinsic desire to behave for the world, which its effect arbitrates the linkage between environmental self-identity and environmentally sustainable behavior. In the United States, for example, the declaration of the 1990 Clean Air Act Amendment and the 1992 Energy Policy Act was noted as the regulation that signified the regulations concerning the transportations emissions sparking the raising of awareness among American public concerning the alternative vehicle to help reduce the carbon emission that affected the global warming issue [1]. Taking all the above into account, this research distinguishes green moral obligation from the context of the US by considering, among young adult Thai citizens, the sense of obligation towards environment impact caused by the high numbers of manufacturing and the use of non-eco-friendly options.

### *2.6. Intention to adopt eco-friendly habits*

When purchasing and embracing environmentally sustainable electric vehicles, this research claims that the more people view themselves as green customers, the more they have a social obligation to reduce their use of environmentally unfriendly products. The further optimistic their views about the introduction of eco-sustainable electric vehicles, the more likely they are to purchase such goods [18].

## **3. Hypotheses**

- Hypothesis 1: Green self-identity positively estimates environmental awareness.
- Hypothesis 2: Green self-identity positively influences a green moral obligation.
- Hypothesis 3: Environmental awareness positively impacts the attitude towards the adoption of electric cars.
- Hypothesis 4: Moral obligation positively impacts attitude towards the adoption of electric cars.
- Hypothesis 5: Attitude towards the adoption of electric cars positively estimate the evaluation of electric cars.
- Hypothesis 6: Evaluation of electric cars positively influence the intention to adopt an electric car.
- Hypothesis 7: Green self-identity positively impacts the evaluation of electric cars.

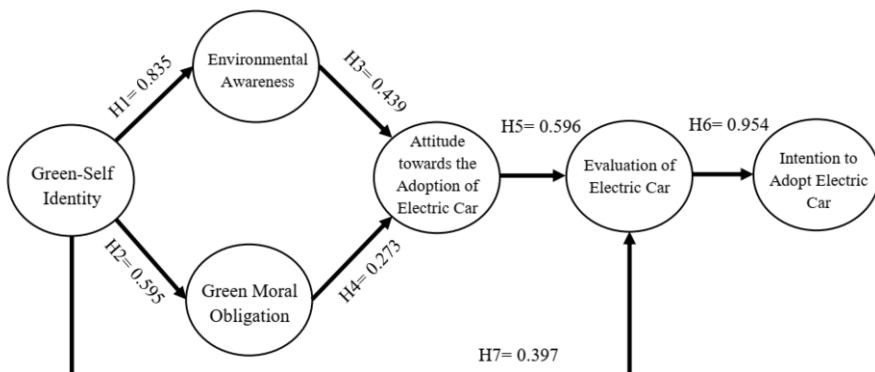
## **4. Research Methodology**

### *4.1. Sampling*

The data were collected through an online survey with information written in both Thai and English, and through a social media platform, requesting informants to fill out their

details to make more understanding which is to make result receive high satisfaction so that this research can test hypothesized relationships towards those variables in the proposal of this research model. The study participants are young adults between 19 and 36 years old. As of February 2020, 208 young adults have responded to the survey. Most of the respondents are males between 18 and 23 years old and who are currently studying bachelor's degrees. Respondents' salaries were mostly less than 10,000 baht per month. Also, their career is mostly student. Four respondents not within the target group were excluded from our analyses. The sample characteristics are present in Table 1.

The survey was designed into two parts. Part 1 addresses the respondents' demographics (gender, age, education, salary, and career). Answers involved assigning ratings from one to five or multiple choice. On the other hand, in terms of specific detail, there are green self-identify, environmental awareness, green moral obligation, attitude towards the adaptation of electric cars, evaluation of electric cars, and intention to adopt electric vehicles. In each of these, this research has three sub-questions for those sampling to answer for the satisfaction of it, which is a five-point Likert scale, ranging from "(1) Dissatisfied" to "(5) Satisfied" strongly disagree, disagree, so-so, agree, strongly agree. This research has adapted the previous research that related to the research study in making the result to be more satisfactory [19].



**Figure 1.** Structural model results.

**Table 1.** Sample characteristics (n = 204).

Measure	Frequency	Percent	Measure	Frequency	Percent
<b>Gender</b>			<b>Salary</b>		
Male	104	51	Below 10,000 baht	102	50
Female	100	49	10,001 - 50,000 baht	94	46.1
<b>Age (year old)</b>			50,001 - 80,000 baht	4	2
18 - 23	174	85.3	Above 80,000 baht	4	2

Measure	Frequency	Percent	Measure	Frequency	Percent
24 - 29	21	10.3	<b>Career</b>		
30 - 35	7	3.4	Student/ College student	169	82.8
36 - 39	2	1	Personal business	9	4.4
<b>Education</b>			Governme nt Employee	8	3.9
Senior High School and under	9	4.4	Office employee	10	4.9
Vocational Certificate, or Diploma	5	2.5	Other	8	3.9
Bachelor's degrees	184	90.2			
Above bachelor's degrees	6	2.9			

**Table 2.** Factor loadings and CR and AVE values.

Variable	Item	Factor loading	CR	E	AV
<b>Green self-identity</b> (M = 3.6683, SD = 0.835, $\alpha$ = 0.827)	G	0.704			
	S1		4	0.8	0.6
	G	0.768			
	S2				
	G	0.9			
	S3				
<b>Environmental awareness</b> (M = 3.8987, SD = 0.882, $\alpha$ = 0.822)	E	0.859		0.8	0.6
	N1		24	1	
	E	0.754			
	N2				
	E	0.722			
	N3				
<b>Green moral obligation</b> (M = 3.2826, SD = 0.968, $\alpha$ = 0.839)	G	0.726		0.8	0.6
	M1		4	4	
	G	0.831			
	M2				
	G	0.842			
	M3				
<b>Attitude toward the adoption of eco-friendly electric cars</b> (M = 4.1225, SD = 0.881, $\alpha$ = 0.916)	A	0.886		0.9	0.7
	T1		0	8	
	A	0.918			
	T2				
	A	0.852			
	T3				
<b>Evaluation of Electric car</b> (M = 3.6912, SD = 0.976, $\alpha$ = 0.785)	E	0.918		0.6	0.6
	V2		2	6	
	E	0.75			
	V3				
<b>Intention to adopt eco-friendly electric cars</b> (M = 3.9134, SD = 0.941, $\alpha$ = 0.912)	IN	0.884		0.9	0.7
	1		1	8	
	IN	0.877			

Variable	m	Ite	Factor loading	CR	AV
	2	IN		E	
	3		0.881		

**Table 3.** Correlation matrix of the critical variables.

	GS	EN	GM	AT	EV	IN
<b>GS</b>	<b>1</b>					
<b>EN</b>	0.61	<b>1</b>				
	4					
<b>GM</b>	0.48	0.40	<b>1</b>			
	8	9				
<b>AT</b>	0.45	0.45	0.35	<b>1</b>		
	2	4	4			
<b>EV</b>	0.52	0.42	0.38	0.75	<b>1</b>	
	3	7	1	7		
<b>IN</b>	0.55	0.48	0.35	0.70	0.85	<b>1</b>
	2	8	7	0	5	

**Table 4.** Result and goodness-of-fit indices.

	Relationship	Standar dized Estimates ( $\beta$ )	Critic al (C.R.)	P Value
1	H Green self-identity → Environmental awareness	0.835	7.385	*
2	H Green self-identity → Green moral obligation	0.595	5.697	*
3	H Environmental awareness → Attitude	0.439	4.651	*
4	H Green moral obligation → Attitude	0.273	2.717	*
5	H Attitude → Evaluation of Electric car	0.596	8.855	*
6	H Evaluation of Electric car → Intention to drive an electric car	0.954	4.364	*
7	H Green self-identity → Evaluation of Electric car	0.397	11.859	*

## 5. Results

This research model was tested using SPSS version 26 and AMOS 26. The mean, standard deviation, and alpha values were calculated using SPSS. For factor loading, composite reliability (CR) and average variance extract (AVE) were computed using AMOS. Before testing the relationship of assumptions, this research analyzed the reliability and accuracy of the scale. Legality has been inspected which shows that the

items are related to each other. The sample characteristics are present in Table 1. The sample characteristics are present in Table 1.

Furthermore, whether they are in the same scope or not, the lower acceptable values are 0.70 for CR and 0.50 for AVE [20] (Table 2). The CR of each variable is more significant than 0.8. The AVE of each variable was higher than 0.50, which means the completion of convergence. Table 3 shows that all variables have a significant correlation with each other as these correlations can be explained as the moderate and robust levels because of the correlation coefficients ranging from 0.30 and above, indicating strength and direction of positive association.

In terms of results and goodness-of-fit indices, there are Standardized Regression Weights, C.R., which Critical Ratio and p-value explain \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$  in each of relation of it or hypothesis. Thus, we found that all hypotheses were statistically significant.

First, H1 (when young adults identify themselves as an environmentally friendly consumer, it leads to them having environmental awareness) was confirmed ( $\beta = 0.83$ ,  $p < 0.001$ ). Next, we found that when young adults identify themselves as an environmentally friendly consumer, it leads to more green moral obligation. So, H2 was also supported ( $\beta = 0.59$ ,  $p < 0.001$ ). Following this, when young adults have environmental awareness, it leads to an attitude towards the adaptation of electric cars. H3 was positive ( $\beta = 0.43$ ,  $p < 0.001$ ). Besides, H4 was supported; that when young adults have a green moral obligation, it leads to an attitude towards the adaptation of electric cars ( $\beta = 0.27$ ,  $p < 0.001$ ). H5 has a positive influence on young adults with an attitude towards the adaptation of electric cars ( $\beta = 0.59$ ,  $p < 0.001$ ). H6 (when young adults evaluate electric cars, it leads to the intention to adopt an electric car) ( $\beta = 0.95$ ,  $p < 0.001$ ) and H7 (when young adults self-identify as an environmentally friendly consumer, it gives a positive evaluation of electric cars) ( $\beta = 0.39$ ,  $p < 0.001$ ) were also supported.

The goodness-of-fit of Confirmatory Factors Analysis (CFA) indices show that the model did fit the data at a higher level:  $\chi^2 / \text{d.f.} = 1.804$ ;  $p < 0.001$ ; GFI = 0.9; AGFI = 0.853; CFI = 0.962; RMSEA = 0.063. On the other hand, the goodness-of-fit of Structural Equation Modeling (SEM) indices indicate the model did fit the data:  $\chi^2 / \text{d.f.} = 1.795$ ;  $p < 0.001$ ; GFI = 0.893; AGFI = 0.854; CFI = 0.96; RMSEA = 0.063.

## 6. Conclusion

This research This study aimed to examine the awareness, including the decision making of young adults concerning electric cars, through the research model titled of the information acceptance model or IACM. The online survey for those sampling to answer precisely. This research engaged with 204 people through an online platform for sampling (after four respondents were excluded). Most of the respondents were interested in electric cars, were male, and 18–23 years old. They were mostly students studying their bachelor's degrees.

Moreover, most of the respondents have a salary of less than 10,000 baht per month. The respondents had high levels of awareness which proved their decision making to purchase the electric car, due to p-values that are significant in each relation of hypothesis. All of the proposed hypotheses were accepted. Most of the people who identify themselves as an environmental-friendly person are indeed interested in adopting a new innovative product, such as electric cars. Due to their moral obligations

and better environmental awareness, it helps an individual's decision making for choosing their superior electric and future cars. While another research mention that primary sources of information and motivations are the essential points for people to select an electric vehicle [21]. Each young adult might prefer different ways of creating their awareness and decision making. The rational model is a logical system, which the problem will be identified before an individual generating alternative solutions [22]. For the Bounded Rationality Model, it is about creating the expression bounded rationality to explain an individual's decision-maker who tries to find the best decisions whereas end up with the decision making [23]. Therefore, both models will allow young adults to make their final decision of using the electric car.

Moreover, the policy will be another way of raising people's awareness in the country. [1] The U.S. Department of Transportation has promoted Corporate Average Fuel Economy (CAFE) Standards since 1975, encouraging people to use the vehicles that save fuel and reduce energy consumption.

This study has some limitations. The research explored only or mostly young adults in Khon Kaen, Thailand. The responders were fairly homogenous and not representative of the whole society. Furthermore, the topic of electric cars is relatively new, and still is not accessible within the selected area. Therefore, there were only a few people that were well-informed about electric cars. Therefore, we would advise future researchers to collect data from multiple, diverse populations. Lastly, the findings reported here are will likely be useful for manufacturers when designing electric car marketing campaigns.

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# A Design and Study on the Framework of University Academic Atmosphere Governance Based on IT Governance Theory

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**Abstract.** Information technology profoundly affects both the teaching and the scientific research activities of the universities and determines their core competitiveness. In recent years, the academic atmosphere construction in universities has increasingly resulted in exposing large number of management problems. Therefore, the application of IT governance is perhaps the only way for the development of informationization in the universities. This paper attempts to integrate IT governance theory into academic atmosphere construction, in a controlled state, by avoiding various risks in the construction process and finally, accomplishes the purpose of informationization construction leading to the reforms in university education system.

**Keywords.** Information technology; IT governance; academic atmosphere construction

## 1. Introduction

The academic atmosphere construction is the core content which paves a way for all the universities to implement the quality education projects. The rapid developments in modern society put forth higher demands on the comprehensive ability and overall quality of the talents. The systematic research in university academic atmosphere construction helps academic community to grasp the characteristics, understand its connotation and thus, provide a theoretical foundation for the establishment of work elements in setting the target system. In addition, it significantly promotes its all-round development through long-term mechanism in achieving good educational effects.

Steven Farr [1] believes that by establishing a new education system, reducing the impact of the family's socioeconomic background, establishing the idea of changing fate by improving grades and providing learning guidance and financial support in school can build good academic atmosphere. Wang Enjuan[2] believes that academic atmosphere assessment includes students' attitude towards learning, integrity condition, and management of students in the universities. According to Zhang Diping[3] the students' quality, teachers' teaching abilities and overall academic atmosphere are the

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key evaluation indicators of any academia. Students' qualities include learning status, after-school arrangements and student management. Teachers' teaching includes class management, class teaching and students' learning status. The academic atmosphere includes regulations, degree of influences, and academic atmosphere activities. Whereas, Zong Hongyu[4] trusts that school's security system, teacher's teaching and students' learning are the key academic atmosphere indicators. School's security system comprises of human, material and management security while, teachers' teaching includes the teaching staff and the results of teaching.

Academic atmosphere governance has become one of the most important link in teaching quality monitoring system in the universities. Its governance efficiency greatly affects or even determines the overall level of the university. However, the detailed study of traditional governance reveals that its evaluation methods are relatively simple. The usual way is to calculate the weighted average score based on the teacher's evaluation score of each teaching class, and then simply rank with class as a unit according to the score. Hui Zhibing[5] believes that each student possesses distinct own characteristics, and the construction of class style should be taken as a unit, strengthen the construction and guidance of class style, and enhance students' sense of collective honor. The advantage of building class style is mainly, the students in the class. They are of the same major, and can be guided by the class style according to the characteristics of each major. The ranking order of the class is however, the sole basis for assessment of academic atmosphere. Although this assessment method has certain effectiveness, it also has obvious shortcomings and is mainly reflected in the inability to accurately distinguish among classes with outstanding academic performance, ordinary performance, and poor performance. Therefore, it is impossible to formulate and implement targeted governance programs based on the characteristics of each group. This hampers the effect of academic atmosphere governance to a certain extent, and its value in helping to improve university's academic atmosphere is also very limited. The reference value is not high. However, in today's data era, the idea of data-driven decision-making has gradually become a mainstream. Starting from the actual needs of university academic management, based on the application and function realization of data science-related technologies, it is necessary to explore and formulate a set of programs that can effectively improve the efficiency of academic atmosphere governance.

The domestic and foreign researchers show different characteristics on the academic atmosphere construction in various universities. The study of foreign scholars mainly emanates from the perspectives of academic integrity, academic misconduct, academic cheating, etc., and has a great reference value for the study in China. The domestic research focuses on the theoretical research and construction of evaluation index system, and conducts empirical research in combination with the evaluation methods. The academic atmosphere is mainly based on the colleges and universities, teachers and students. In a broad sense, the academic atmosphere includes the style of colleges and universities, the teaching style of teachers and the academic atmosphere of students. There are generally two types of academic governance requirements in colleges and universities: one is an annual long-term plan, and the other can be seen as a temporary special operation. But no matter what kind of demand it is, it can be completed under IT governance. The governance process generally includes five parts: governance planning, governance initiation, implementation and control, governance maintenance, and governance performance. Since the formation and development of the academic atmosphere in the colleges and universities is not just completed by an individual, but

by the individuals in the groups and inter-group interactions. The construction and formation of the academic atmosphere is a group or organizational behavior, so the governance of academic atmosphere can be regarded as a systematic project.

## 2. Theoretical Researches of University Academic Atmosphere Governance Based on IT Governance

At present, colleges and universities have paid attention to the construction of academic style from the top-level design. YU Chang[6] used the construction of schools, departments, and classes, as well as the microcosmic students' personal growth goals, to study the main factors affecting the current style of study construction from three levels and perspectives, so as to develop a theoretical framework for the construction of academic atmosphere. Through the profound implementation of the concept of "three holistic education", Hou Yajie[7] conceptualized the school's all-employee collaborative education model to stimulate students' interest in learning, to create a positive style of study, and design guidance and implementation methods for the construction of college style of study in order to realize the collaborative education of all the school staff. From the point of view of the problems of emphasis on evaluation and neglect of governance in the style of study in colleges and universities, we propose a theoretical and logical interpretation of the problems in the process from three perspectives: macro, meso and micro in a more comprehensive, precise and standardized manner.

### 2.1. Characteristics of University Academic Atmosphere Governance Based on IT Governance Theory

The theory and practice of IT governance need to run through the entire life cycle of the academic atmosphere governance management and accurately relate to its day-to-day management. In view of the inherent differences among the universities, the application of university IT governance in academic atmosphere governance is divided into following three characteristics:

*Top-level Promotion:* As the executors of specific policies for the academic atmosphere construction in universities, the high awareness and the importance attached to it, will directly affect its effectiveness. In addition, the position of these administrators in academic atmosphere construction will also influence its development and implementation.

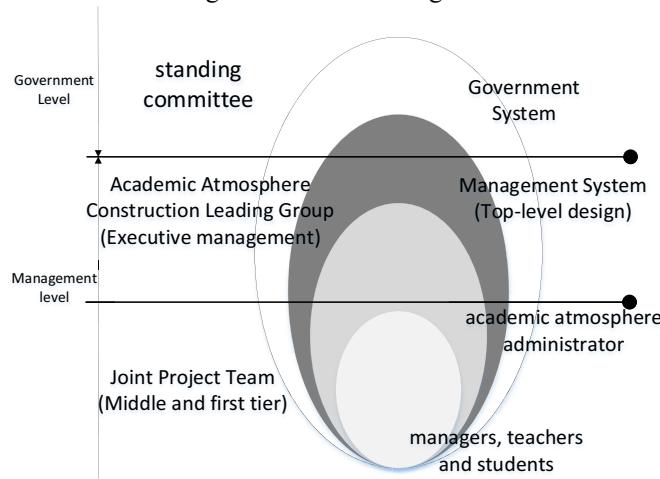
*Stability of the Subject:* The subject of academic atmosphere in universities is relatively fixed comprising of Managers, teachers and students. These are also the core and key components which enhance its competitiveness. Based on this, the strategic objectives of the academic atmosphere are set and then the development strategic planning of university is completed.

*Group:* Managers, teachers and students play a major role in the academic atmosphere construction, strengthen it by multiple approaches, and help to achieve good results. The academic atmosphere of the teachers and students influence, promote and develop interactively. Different subjects collectively play their respective synergic roles in the process of academic atmosphere construction.

## 2.2. The Relationship between IT Governance and Academic Atmosphere Management

IT governance is to build an information-based decision-making system and organizational structure that takes into account the interests of all the relevant parties. Its basic approach involves performance evaluation and the risk management, and drives consensus between the application of informationization and the organization's strategic goals as the fundamental principle to create value for the organization. Among them, strategic coordination, value output, resource management, risk management, and performance evaluation are the main areas of concern for IT governance. As the source of IT governance, corporate governance has played a significant role in the development of enterprise informationization. Similarly, the introduction of IT governance in university academic atmosphere construction is very effective for the development of universities. Academic atmosphere governance in the university is the process of integrating academic atmosphere construction, organizational structure, operating processes and daily management of the university. The depth of its integration continues to advance with the passage of time and the development of technology.

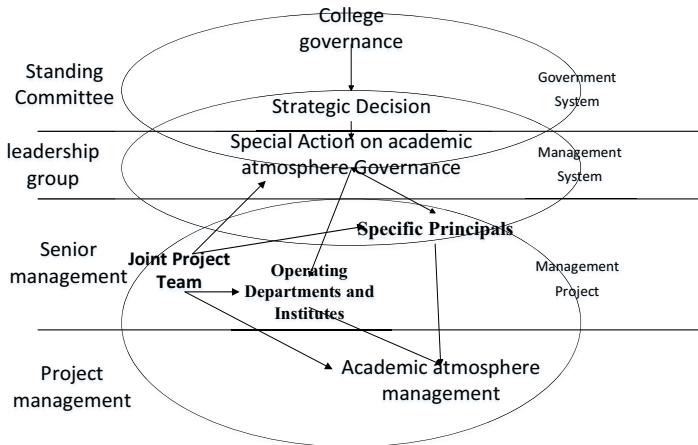
Both the governance and management can be viewed as a hierarchical system, with authority and responsibilities delegated from the top to bottom for effective execution through supervision to ensure proper authorization. The authorization is the key principle in the governance. The core part is to ensure that the right persons with appropriate authority are placed in the right management structure to build an effective management institution according to the needs of the governance.



**Figure 1.** Nesting model of academic atmosphere governance and management relationship.

However, mere governance is not management. The management scope and authority need to be clearly separated. The Standing Committee (Board of Directors) is responsible for setting long term strategic goals whereas, the middle level is responsible for formulating the performance indicators. The relationship between the governance and management is shown in Figure 1. The governance system is responsible for formulating the strategies to ensure effective utilization of resources. But the success of academic atmosphere construction relies heavily on the management system of the entire organization. The top-level personnel may participate in some

management processes, for example, designing school-wide governance actions. The management system manages the entire organization within the governance framework. The leading group (executive management) of academic atmosphere construction is responsible for creating and maintaining the goals determined by the governance system. At the same time, it also provides a guarantee for the governance system, so that all the types of resources are effectively used. The middle and the front-line staff from different departments are responsible for the proper execution of each item in terms of quantity and quality. As regards specific management, it is accomplished and executed through three relevant key elements namely, Principals, Operating Departments and Institutes, and Joint Project Team as shown in Figure 2.



**Figure 2.** The Relationship between IT Governance and Academic Atmosphere Management

**Specific Principals:** It can be envisaged as a temporary institution established within the framework of a permanent institution. It does not have ready-made means to link to the entire organizational structure. Each connection must be “newly” created, and the specific principals in charge of academic atmosphere need to play a key role in this process. Ordinary departments must meet the governance requirements through established methods. But these methods however, do not exist in the temporary institutions. In order to meet the governance requirements, the management must ensure coordination between permanent and temporary institutions. Therefore, a specific principal in charge of the academic atmosphere is the key link to support good governance. These principals are responsible for all the activities in the entire life cycle namely, determine the business needs, establish specific key strategies, set definite specific project, negotiate goals, determine specific success standards, and continuously monitor the operating environment and benefits.

**Operating Departments and Institutes:** This in fact, is an important link which ensures the successful implementation of the university strategies. At the same time, it is also the core entity that connects the main body of the academic atmosphere. It supports the overall process of academic atmosphere governance by balancing workload, ensuring the reliability of information used for decision-making, and identifying future uncertainties. In short, as a part of academic atmosphere governance, the functions of operating departments and schools include the collection and verification of resource

availability, crafting policies, procedures, methods and standards to formulate and implement effective decisions, ongoing monitoring and generating innovative ideas in governance.

*Joint Project Team:* The unprecedent management environment growth for specific academic atmosphere action necessitates joint project team to undertake multiple projects tasks. Every member of the project team needs to have the ability to manage a single project while coordinating multiple specific projects. They need to acquire multidisciplinary knowledge and skills in project management, standardized operations and maintenance. They focus mainly on synchronization, teamwork and inculcate team spirit to obtain higher quality information to improve efficiency and balance the competitive needs of various projects thus, meeting the structure of the overall governance framework.

### 3. Conclusion

This paper explores a set of overall solutions for academic atmosphere governance based on IT governance in practice. This idea is more suitable for the governance thinking of operating informationization and management datamization from the perspective of big data. As compared to the traditional academic atmosphere governance plans, this effect is more significant and is essentially, an ideal alternative plan. Subsequently, the school administrators can establish a more focused and long-term effective academic atmosphere governance system through exploration and practice of the program in university for ongoing improvements. In the long run, it will make a virtuous cycle between the teaching operation and teaching construction in the universities, and better adapt to the requirements of rapid development education informationization in the era of big data.

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# Study on the Profit Model in the E-commerce

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**Abstract.** E-commerce is an emerging industry. It has brought new opportunities for global economic development. The update of e-commerce technology and the improvement of e-commerce profit models promote the profitability of e-commerce enterprises. Nowadays too much emphasis was placed on theoretical teaching in the e-commerce courses. The courses lack case analysis for learners to better understand the actual situation of e-commerce. This study analyzed the profit model of existing e-commerce companies, and used case analysis methods to find the profit dilemma and effective breakthrough methods for the profitability of two typical B2C e-commerce companies. With disassembling specific e-commerce cases, this study completed the conversion of e-commerce courses from theoretical teaching to case teaching.

**Keywords.** B2C e-commerce, JD, Vipshop, profit model

## Introduction

The teaching of e-commerce in universities tends to be theoretical teaching and defining teaching. The courses lacked example teaching. Stressing theory and neglecting practice, it cannot keep pace with the times. The e-commerce course is a practical course with strong application. Teachers should focus on cultivating learners' theoretical and practical ability. Instead of letting learners passively accept theoretical concepts and fail to apply them. Since most e-commerce courses cannot meet the needs of learners. Base on the above, this study starts with examples, and provides actual case analysis of e-commerce and discusses analysis methods.

## 1 Overview of B2C e-commerce profit models

### 1.1 Five Basic Components of B2C E-commerce Profit Model

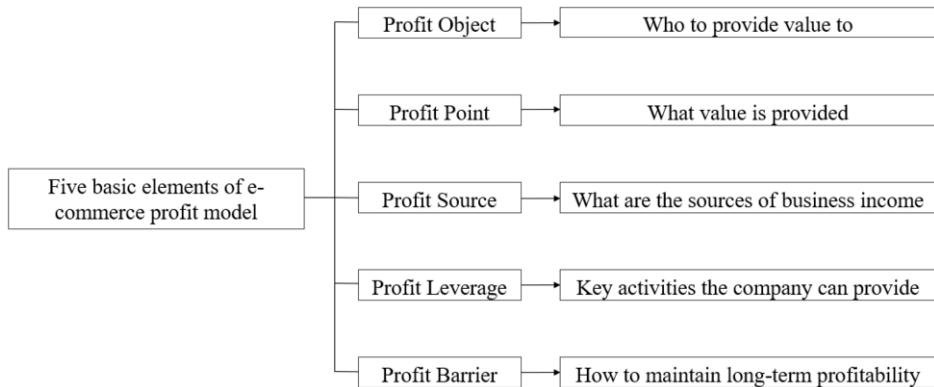
The five basic components of the B2C e-commerce profit model were an interconnected and indivisible organic whole. As shown in Figure 1.

Among the five basic components of e-commerce, the profit object solves the problem of "who to provide value to". The profit point solves the problem of the value the enterprise provides to users. The profit source solves the problems of the enterprise's

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profit source. Profit leverage solves the problem of what key activities an enterprise provides to attract more target customers. The profit barrier solves the problem of how to keep the market from being invaded by other enterprises and keep themselves profitable for a long time [1].



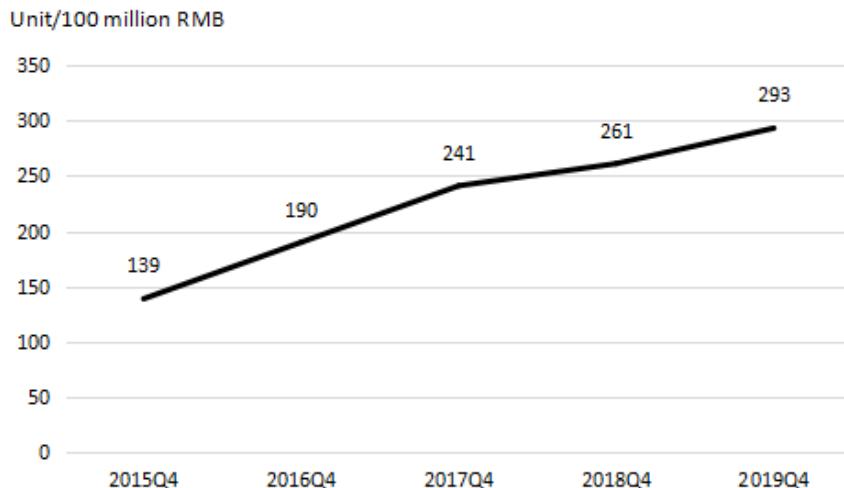
**Figure 1** The five basic components of e-commerce profitability

## 1.2 Case study of e-commerce profit model

The profit model analysis starts with the company's profitability, and then starts the research.

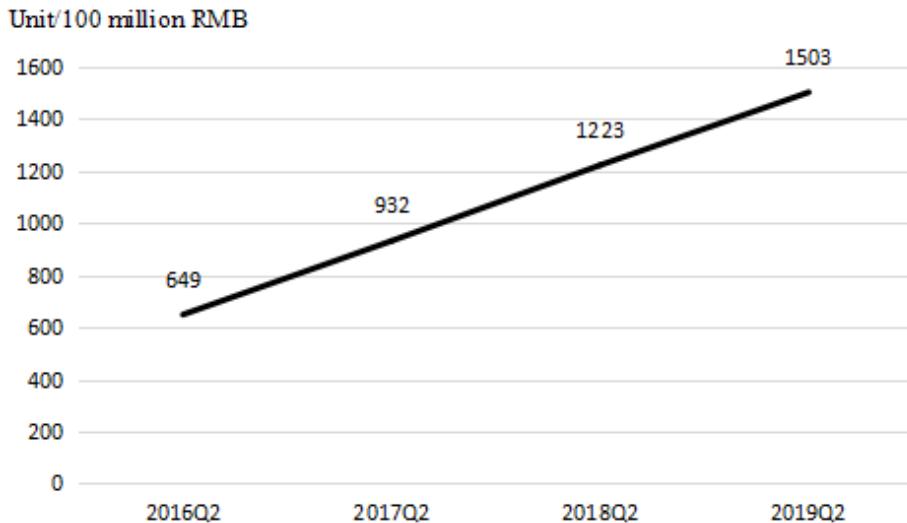
The scale of e-commerce transactions in China in 2017 was RMB 28.66 trillion and increased 24.77%. B2B transaction value was RMB 20.5 trillion. Online retail transaction value was RMB 7.17 trillion. Living service e-commerce transaction value was RMB 998.6 billion.

The net profit of Vipshop in the third quarter of 2018 was RMB 681.6 million (approximately \$103 million). It increased 76.4% from RMB386.5 million in the same period of last year. The growth momentum was very rapid, as shown in Figure 2.



**Figure 2** Vipshop Q4 net revenue growth in the last five years

JD's operating profit margin was 1.1% in the second quarter of 2018. Compared with 0.8% in the same period last year, JD's operating profit margin was 2.1% in the first quarter. Compared with 2.2% in the same period last year, the total net profit of JD in 2017 was as high as RMB 5 billion, as shown in Figure 3[2].



**Figure 3** JD's Q2 quarter net income in the last five years

The growth momentum of the two companies is very strong. It sends a very important signal. The business models are recognized by the market. We discuss its profitability and in-depth exploration of the company's excellence, and then summarize the company's good profit model.

## 2 Analysis of the profit model of Vipshop [3]

### 2.1 Profit object

- **Youth consumer groups who were keen on fashion.** With the development of society and economy, social consumption was gradually escalating. In the Chinese market, especially the B2C e-commerce market, it was the young consumer groups who were keen on fashion. Youth consumer groups were at the backbone of society and they were also part of the backbone of purchasing power [4]. Compared with gold collars, Youth consumer groups' spending power on luxury goods was still limited. Their wages were on the rise and they were more resistant to the cheaper Taobao explosions. Such a profit object will greatly help Vipshop's profit [4].
- **Genuine female consumers in second and third tier cities.** For women in second and third-tier cities, counters were not common locally. The price of counters was not cheap. Such groups pursue fashion but do not have enough budgets. Vipshop was like tailor-made for them. Genuine brand names were discounted. They cover mid-to-high-end and low-end products. They can choose more space and fast delivery.

## 2.2 Profit point

- **Vipshop would target mass brands.** By selling carefully and selecting brands and deep discounts on brands, Vipshop will grow rapidly with the supplement in the time-limited snap-up model. The sales profit of commodities was the basic profit point of the initial stage of Vipshop. One of the reasons for the high gross profit margin of Vipshop was to make the flash sale the best known. With the Matthew effect, the strength of the bargaining power of Vipshop could charge a certain fee for brands. It wanted to promote and sell on the platform of Vipshop. This was another profit point. The sharing fee of Vipshop's warehouse logistics was also one of the profit points of Vipshop. Vipshop's logistics controlling ability was getting stronger and stronger. While meeting its own logistics needs in the future, Vipshop will also be able to undertake other logistics tasks. Vipshop's current new strategy "Global Selection, Genuine Sale", coupled with support from JD's flagship store and Tencent's social traffic, can make many innovative products [5].
- **Source of profit.** Vipshop's profit source was in the second and third tier cities in China. It had certain economic strength. It had higher requirements for product quality. But it did not have much time for online shopping. In recent years, Vipshop's quarterly earnings growth has tightened. According to the fourth-quarter 2019 financial report data, Vipshop's total net revenue has increased to 29.3 billion yuan (approximately \$ 4.2 billion). The increase of 12.4% realized 29 consecutive quarters of profit. In the previous six years, Vipshop's revenue also continued to grow. The profit of Vipshop was not only in brand sales, but also in terms of advertising revenue and collection of merchant fees. Vipshop would invest a large amount of funds raised in the listing into the construction of logistics. It would improve the service quality of products. And it would increase the gross margin of Vipshop [6].
- **Profit leverage.** The main characteristics of Vipshop's profit leverage were a purchase-first pay-after-purchase model, and a large-scale warehousing model. Most of the products that Vipshop sells were the tail products, the brand that needs to handle. So the brand was also happy to have e-commerce companies to solve the problems of the tail cargo. The brand owners firstly sold the goods to Vipshop for online sales and then pay. Vipshop places great emphasis on logistics by the limited-time sale model and limited product time. Logistics should be faster than other e-commerce providers. These two characteristics made the gross margin of Vipshop increase year by year [7].
- **Profit Barrier.** Vipshop officially went online at the end of 2008. It quickly opened the market in the "authentic sale" mode. It was successfully listed in the United States less than 4 years after its establishment. How would Vipshop find its own value and why its market has not been squeezed by the giants? At that time, Dangdang not only listed in the United States, but also had a turnover of 10 billion yuan. In the end, Dangdang's market share gradually decreased after a price war with JD. The path chosen at the time was wrong. The key to Vipshop's success was that the initial entry point. Its subsequent development path was very correct. Vipshop did not have many product categories. The company focuses on mass fashion brands. The

company had a clear position. It was also very clear on its main audience. There was no obvious competitor with the same business model as Vipshop. This innovation has enabled Vipshop and allowed it to gain a foothold in today's B2C e-commerce market [8].

### 2.3 Analysis of JD's profit model

- **Profit object.** JD's target market has shifted from the original benchmark electronics consumer to the online mass consumer [9]. Because JD's transition from the previous vertical B2C business model to today's comprehensive B2C.
- **Profit point.** JD's profit point was to make shopping easier and happy. JD had a wide range of products. It combined basically everything you want to buy. In addition, JD also paid special attention to user experience. In order to effectively protect the interests of consumers. It has continuously introduced new service measures.
- **Source of profit, self-operated sales income.** From vertical B2C to comprehensive B2C, JD's self-operated sales revenue has been the main source of revenue. Businesses need to pay JD as an advertising fee based on a certain percentage of sales. Businesses entering the JD Mall need to pay the platform usage fee. To use the JD Logistics distribution system, they also need to pay a certain fee. Fees for the use of warehousing and logistics systems. When JD Mall meets its own logistics needs, it leases out the logistics system to other companies to earn profits. JD collects the advertising costs of businesses to promote on the platform.
- **Profit Leverage.** JD often holds various festivals and various holiday promotions. Online activities were quite adequate.
- **Profit Barrier.** Adhere to the core concept of "first person before the enterprise", it is the information system. Through this information system, the four flows in e-commerce transactions were perfectly combined to improve the efficiency of the supply chain. They were information flow, capital flow, business flow, logistics and distribution. JD Logistics' next day delivery is one of the advantages of JD Logistics. JD was gradually becoming a logistics provider. Logistics services would be another profit point for JD.

## 3 Comparative analysis of profit models of different B2C e-commerce companies

Based on the above discussions on the profit models of Vipshop and JD Mall, and combined with the five elements of profit model, a comparative analysis of the profit models came. Because of their different market positions, they had different profit targets. Their target customers were different. The market environment, business strategy, income structure and cost of different enterprises were greatly different. So there would be different profit models. The analysis here starts from theory and deeply explores the different situations of specific enterprises. It belongs to the combination of theory and practice. It is important in the future. Combining the theory with the

practice to improve application ability, it needs to develop in e-commerce courses in the future.

Vipshop and JD also had a big difference in profit point. Vipshop focused on "flash purchase". JD focused on the platform. The profit margins brought by the two platforms were different. The JD platform was large enough, and there were many places in its value chain. It could be profitable. But it was also prone to encounter diseconomies of scale. Vipshop did not have many profit points. But it won in finesse. Vipshop was not the first company to do "flash purchases". But it is currently the only company that does "flash purchases" well [9].

At present, the development models of Chinese e-commerce companies are mostly the same. Different enterprises often have many similarities. The profit sources of Vipshop and JD have many similarities. Most B2C e-commerce companies now have the same profit sources. But the proportion of each profit source will be different. Enterprise's position is important to ensure that the business will not be swallowed up. In addition, corporate positioning must be clear, and innovation is also important.

#### **4 Practical Teaching**

Based on the case analysis of two companies, we summarized the general process of case analysis. Firstly, we analyzed the industry space, stage and competitive landscape of e-commerce. Secondly, we pay attention to the business model of the company. Finally, we compared the same enterprises.

This study only explains the profit model. The profit model is important, which determines whether the company can develop rapidly. We provide only one case analysis method. And the main purpose is to make everyone aware of the example teaching of e-commerce courses.

After graduation, most of the learners in colleges choose to find jobs. When receiving invitations from several companies at the same time, choosing one of these companies is beneficial to their own development. At this time, learners can use the case analysis methods learned in the course. They can analyze the company's business model, profit model, future development. It will help learners find a good job during the interview. And learners can have a comprehensive understanding of the company through case analysis of the company. It is more conducive to learners' choice.

In terms of academic research, universities have more in-depth research on enterprises. It is more conducive to enterprise development. Only by allowing enterprises to influx more high-end talents, will enterprises thrive and the social economy will be continuously promoted.

#### **5 Conclusion**

Colleges and universities should attach importance to case teaching in e-commerce courses. They can enhance learners' interest. It helps learners better understand the current development of e-commerce.

The goal of B2C e-commerce companies is to make a profit. The fundamental difference between enterprises lies in which profit model they adopt. In addition, companies need to understand and analyze the e-commerce market and various profit models. So it can get rid of the profit dilemma they face. At the same time, enterprises

should integrate the original profit model and carry out continuous innovation to build a long-term sustainable profitable business model.

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