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Graduate School of Management

Master in Management

Comparative Analysis of Advantages the Famous IT Companies and Their Impact on the Supply Chain Performance

Master's Thesis by the 2nd year student

Concentration — General Track

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ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

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АННОТАЦИЯ

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Название магистерской диссертации	Сравнительный анализ успехов ведущих IT компаний и их влияние на результативность цепей поставок
Образовательная программа	Мастер менеджмента
Направление подготовки	Международный менеджмент
Год	2018
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Описание цели, задач, и основных результатов	**Цель работы:** заключалась в сравнительном анализе влияния ведущих IT компаний на результативность цепей поставок. **Задачи:** на основе анализа литературы построить дерево критериев оценки влияния IT-компаний на результативность ЦП; выбрать метод и усовершенствовать методологию оценки IT-компаний; разработать опросник для экспертов отрасли; реализовать усовершенствованную методологию на примере ведущих компаний отрасли. **Результат:** Дерево критериев оценки влияния IT-компаний на результативность ЦП было разработано на основе предложений научной литературы и предложений экспертов по цепям поставок. Структура оценки влияния IT-компаний на результативность ЦП была построена и сформулирована на основе выбранных критериев и количественной оценки результатов опроса. Схема была применена к выбранным IT-компаниям для проверки структуры и в целях предоставления доказательств ее применимости
Ключевые слова	Цепь поставок; влияние IT компании на результативность ЦП; дерево критериев; система поддержки решений DSS APIs

ABSTRACT

Master Student's Name	Yuhang Zhao
Master Thesis Title	Comparative Analysis of Advantages the Famous IT Companies and Their Impact on the Supply Chain Performance
Education Program	Master in Management
Main field of study	International Management
Year	2018
Academic advisor's name	Nikolay A. Zenkevich, Associate Professor, Department of Operations Management, SPbSU
Description of the goal, tasks and main results	**Main goal:** The master thesis will compare major IT companies, in order to understand the advantages of their influence on supply chain management **Research tasks:** On the basis of literature review to create criteria tree of IT companies' influence on SCP; to select and modify a method for IT companies' influence evaluation; to test the modified method for famous IT companies **Main results:** The criteria tree for assessment of IT companies' influence on SCP were developed on the basis of scientific literature and supply chain experts' suggestions. The framework of the assessment for IT companies' influence on SCP was constructed and formulated on the basis of selected criteria and quantitative evaluation of the questionnaire results. The framework was applied on the selected IT companies in order to test the framework and provide evidence of its applicability
Keywords	Supply Chain; IT company's influence on SCP; criteria tree; DSS APIS

Content

Introduction

The introduction part first interprets the definition, evolution and some basic theories of supply chain and supply chain management, and then briefly explains the objectives and methodology of the research, as well as the structure of this paper.

0.1 The Definition of Supply Chain and Supply Chain Management

This section discussed the definition of supply chain and supply chain management given by several famous researchers, and later we summarized their opinions based on similar points.

0.1.1 The Definition of Supply Chain

With the process of economic globalization and the specialization of production, large companies no longer produce all the components for their products. Instead, they prefer to procure raw materials, components or equipment from suppliers who have comparative advantages in quality and prices, then assemble these parts into final products and deliver to retailers and customers. This supply chain strategy can improve the production efficiency, reduce cost and ensure company's profit and earning. Thus, supply chain has become a very important role in multinational companies' daily business.

Martin Christopher (1992, p2) defined Supply Chain as "A network of connected and interdependent organizations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users."

Jayashankar et al. (1996) define a supply chain to be "A network of autonomous or semi-autonomous business entities collectively responsible for procurement, manufacturing, and distribution activities associated with one or more families of related products."

Lee and Billington (1992) have a similar definition — "A supply chain is a network of facilities that procure raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system."

In conclusion, although these definitions have some differences, they all mentioned about major segments in a supply chain — procurement raw materials, manufacturing products, distribution, deliver to retailers and customers (see figure 0.1). Besides, there is one important concept in their definitions — cooperation between companies or organizations.

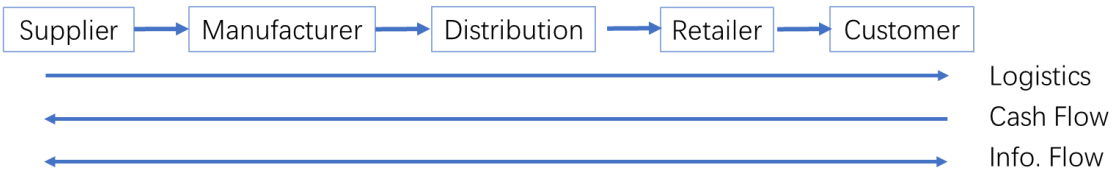


Figure 0.1 The Components of Supply Chain

0.1.2 The Definition of Supply Chain Management (SCM)

From Martin Christopher's (1992, p3) point of view, SCM is "The management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole."

Another researcher Amy Zuckerman (2002) describes SCM as "It involves looking beyond one organization and imagining all the entities involved in manufacturing and shipping a product or service, and then linking all of those entities so they can work efficiently and seamlessly as a team. That means uniting customers, suppliers, shippers, and more recently competitors, into a supply network for the most efficient use of time and resources."

From the definitions we can see that SCM integrates suppliers, manufacturers, warehouses, distribution centers and channel distributors as a whole, in order to effectively organize management methods for product manufacturing, transshipment, distribution, sales, and minimize the cost of the entire supply chain system while satisfying certain levels of customer service.

SCM includes planning, procurement, manufacturing, distribution, and return.

Plan: This is a strategic part of SCM. The company needs a strategy to manage all resources to meet customer demand for your product. A good plan is to establish a series of methods to monitor the supply chain so that it can effectively and cost-effectively deliver high-quality and high-value products or services to customers.

Procurement: Choose suppliers that can provide goods and services for company's products and services. Establishing a set of pricing, distribution, payment processes with suppliers and create method monitoring to improve management for the goods and services provided by suppliers. Combine the processes, including picking, verifying the bills, transferring goods to company's manufacturing department and approving payments to suppliers.

Manufacturing: The activities required to arrange for production, testing, packaging, and

preparation for delivery are the most measured parts of the supply chain, including measurements of quality levels, product yields, and worker productivity.

Distribution: It is also called "logistics." They are adjusting the user's order receipts, establishing a warehouse network, sending delivery personnel to pick up goods and delivering them to customers, establishing a goods pricing system, and receiving payments.

Returns: This is the problem-solving part of the supply chain. Establish a network to receive customer returned defective products and surplus products, providing support in the event of customer application product problems.

0.2 The Origin of Supply Chain Management and Basic Theories

0.2.1 The Origin of Supply Chain

Supply chain has existed for a long time, but as a planned management idea, the concept of Supply Chain was put forward in the 1980s. American scholar Michael Porter's concept of value chain is the most direct source that can be found as the origin of Supply Chain. In 1985, Porter put forward the concept of value chain in his book "Competitive Advantage." The value chain decomposes business operations into a number of strategically related activities. Basic activities include internal logistics, production operations, external logistics, markets, sales and services. Ancillary activities include procurement management, technology development, human resources management and infrastructure management. The concept of the value chain connects the corporate value activities as a whole, but this value chain is for individual companies.

The concept of value chain described by Shank and Govindarajan in 1992 was wider than Porter’s. They believed that any company should put its own value chain into the value chain of the entire industry, “the raw materials needed from the initial supplier until the final product will be sent to the user's entire process." At the same time, companies must fully analyze the competitors who live in the same or similar positions in the value chain and work out a reasonable strategy which can ensure that the company maintains and enhances its competitive advantage.

In 1996, the book “Lean Thinking” by James Womack and Daniel Jones was published. Derived from experiences, the lean production method has become theory, and the concept of

value chain was further extended to the value stream. “The so-called value stream refers to all the activities that transform from raw materials to finished products and give them value, including the process of getting raw materials purchased from suppliers to reach companies, transforming them into finished products, and delivering them to customers. And the information flow formed by the information communication between the company, suppliers and customers is also part of the value stream (James Womack, Daniel Jones, 1996).”

In 1996, Reiter put forward the definition of supply chain for the first time on the basis of integrating the above-mentioned value chain and value flow ideas: The supply chain is a physical network through which products and services are delivered to specific customer markets.

The whole history of SC evolution process can be seen in Table 0.1.

Table 0.1 The overview of supply chain evolution

Level	Period	Features
Born	1960s-1970s	1) Management for production 2) The compitition between enterprises is the competition on products quality and amounts 3) Departmentalism 4) There always exists interest conflicts among supply chain members
Beginning	The beginning of 1980s - the beginning of1990s	1) Enterprises started to focus on production efficiency 2) Stevens came up with the cncept of supply chain management in 1989 3) The practice of supply chain management derives from the final segment of suply chain — retail industry (POS) 4) Strategies and models Efiicient Customer Response/Quick Reply (ECR/QR) 5) The application and spreading of MRP-II/ERP/JIT lead to the internal integration of enterprises 6) Low supply chain performance due to the conflicts in enterprises' goals 7) Unable to achieve the breakthrough in value chain
Growth	The beginning of 1990s - the end of 1990s	1) The major competition among enterprises shifted to market and customer 2) ERP has been widely used, information among enterprises was highly integrated. 3) Financial management "Activity-Based Cost (ABC)" was introduced to supply chain management field.
Mature	The beginning of 2000s	1) The fully application of VMI/CPFR/CFAR/DI/3PL/4PL/PLM/SCP/SCE 2) Enterprises have known better about what is needed from suppliers and what to offer to customers 3) The systematic management of supply chain cooperation 4) Information sharing management of uncertain demand 5) The resource optimization management 6) Quick decision management

0.2.2 The Basic Theories of Supply Chain Management (SCM)

There are five major parts in SCM: collaborative development, system operation, win-win cooperation, core competence and customer service (Wang Wei, 2015).

1) Collaborative Development

Supply chain is actually the integration of internal and inter-enterprise resources through the efficient management of supply and demand. This requires that all members of the supply chain have the awareness of collaborative development, not only focusing on their own supply needs, but also pay attention to the status of the production and operation from the upstream and downstream enterprises, as well as timely feedback and sharing information. For the problems between each other, it is better to solve them together because this is no longer a question that only concerns one company's own survival and development. Only the healthy development of each member will create the greatest value in this supply chain, and at the same time every company will also get the maximum benefit.

The Early Supplier Involvement theory faithfully embodies the concept of collaborative development of supply chains which acquires suppliers' participation in the early stages of product design for manufacturers. On the one hand, suppliers can better understand the needs of manufacturers, other party's corporate culture and decision-making methods that help suppliers meet the needs of manufacturers; on the other hand, manufacturers can further understand the supplier's technological innovation, quality control, inventory management and other aspects of capabilities, thus for the future collaboration to develop a corresponding strategy to resist the uncertainty of the supply chain. This kind of close cooperation provides more communication and knowledge sharing for each other, greatly improving the level of decision-making and performance.

2) System Operation

Supply chain is an organic system. Through the close and orderly cooperation among the members, the whole function of the supply chain can be achieved. However, the whole function is not only the superposition of the individual members, it is an organic integration to operate supply, production and selling together. Every member needs to contact each other's upstream and downstream members in accordance with established rules, share information, share risks, support each other, and collaborate to complete all production and business

activities. The supply chain includes the logistics flow, information flow, capital chain, and knowledge flow. It is an effective way to ensure the efficient operation of the entire system by rationally constructing a logistics, information, and capital circulation system and improving the flow efficiency of goods in the supply chain. With more and more applications of information technology, the systemic operation of the supply chain will become more feasible.

3) Win-win Cooperation

The win-win cooperation is the general trend of economic globalization, and it is also the overall trend of supply chain development. With the further refinement of the global division of labor and the increasing number of companies in the supply chain, core companies effectively use unutilized production capabilities by integrating resources from different partners, outsource their own non-core businesses, and focus on cultivating their own core competences. It can avoid wasting in different parts of the supply chain, let more professional partners to complete these businesses.

4) Core Competence

When facing increased competitions and complex external environment, companies need to adopt more advanced technologies and management methods to reduce costs and improve their core competitiveness. The supply chain emphasizes that the company focuses its efforts on key businesses, outsourcing non-core businesses, and improving its core competitiveness to gain more competitive advantages. At the same time, companies form supply alliance relationships, and core companies outsource non-core businesses to other more specialized businesses to enhance the efficiency.

5) Customer Service

The supply chain continuously integrates various resources and continuously optimizes processes to better serve the needs of end customers. Therefore, companies must firstly clarify the needs of customers before they can carry out planning, procurement, production and other activities. In order to more accurately and quickly meet the needs of customers, the supply chain also emphasizes the participation of end customer in the early design of products and services. Nowadays, enterprises can form effective collaboration and communication with customers. Knowing what customers need and providing timely services is the key to seizing

market opportunities.

0.3 Research Objectives and Methodology

0.3.1 Research Objectives

In the information age, IT companies are playing more and more important roles to influence our daily life. It is known that a famous company must have great products to attract consumers and acquire profit, but it is hard to realize that behind the sense, a good and health supply chain system is the main character to support and maintain the competitive advantages for the company.

The goal of this article is to compare the major IT companies, in order to understand how these IT companies influence on the supply chain performance, further to know what specific criteria in their supply chain system can make them efficient in procurement, designing, manufacturing and delivery; what the best supply chain management methods in these companies are; how these methods influence the efficiency in product flow; how they can earn profit and reduce cost by control each segment; as well as how should we transfer the drawbacks to advantages in their supply chain system.

0.3.2 Research Methodology

Via literature review, empirical investigation and data analysis, it was expected that the following result would be achieved in this study:

Through literature review, expert in-depth interviews, an index evaluation system that assessed how famous IT companies influence on supply chain performance would be established, which is a hierarchical structure including metrics and categorized measures.

With the questionnaire survey and Decision Support System APIS (DSS APIS) method, the evaluation process to obtain the index would be developed.

After the data analysis, there would be a ranking which illustrated the score of each IT company and what are their advantages and disadvantages in the supply chain performance. This ranking result will be the basis for the further analysis in this article.

0.4 The Structure of Thesis

This thesis consists of seven pats. The first part is the introduction with the basic concepts, origins, formation and theories of supply chain and supply chain management, and also with the objectives and methods of the thesis.

After the introduction, the first chapter described the definition of IT company, how this paper selects IT companies for comparative study of the influence on supply chain performance, and giving some introduction of each selected IT company.

In the second chapter, the first section described the process of constructing criteria tree for measurement of IT company's influence on SCP. The second section explained the methodology and what method will be chosen for this paper's analysis. The third part introduced how to use the software DSS APIs for data analysis.

In the third chapter, the first section uses DSS APIs to analyze the feedback data of the questionnaire and compare the rankings of each IT company. From the ranking of each single criterion, we can know the final rank in general, so as to learn the advantages and disadvantages of each IT company. The second section analyzes the results of the data obtained in the last section and combines the results of various IT companies in supply chain management to illustrate their unique advantages and what impact do they have in the supply chain.

The conclusion part interprets the theoretical and practical implication of this research. The reference part listed the literature and novels which this paper used. The last part appendix attached the questionnaire for the measurement of IT companies' influence on supply chain performance and the scores the supply chain experts gave.

Chapter 1. IT Companies & The Selection for Research

There are two sections in chapter 1. Section 1.1 will give the definition of "IT Company" and explain how we selected IT companies for this research. Section 2 is the introduction of the chosen IT companies.

1.1 The Definition of IT Company and the Selection of Companies for Comparison Analysis

1.1.1 The Definition of IT Company

To identify what is IT company, first we have to understand the definition of Information Technology (IT). IT is the use of computers to store, retrieve, transmit, and manipulate data or information, often in the context of a business or other enterprise (Daintith, John, ed. 2009). Thus, for IT companies, their business is mainly based on technology industry which includes computer hardware, software, electronics, semiconductor, internet, telecom equipment, e-commerce and computer services.

1.1.2 The Selection of Companies for Comparison Analysis

The company selection is from Fortune Global 500 magazine. The ranking is based on IT company's revenue and presented in Table 1.1.

Table 1.1 The ranking of IT companies on revenue

Rank by revenue	Company		Revenue	Fiscal Year
1	USA	Apple Inc.	$229.20	2017
2	South Korea	Samsung Electronics	$206.50	2017
3	USA	Amazon.com	$117	2017
4	Taiwan	Foxconn	$135.10	2016
5	USA	Alphabet Inc. (Google)	$111	2017
6	USA	Microsoft	$89.90	2017
7	Japan	Hitachi	$84.50	2016
8	USA	IBM	$79.90	2016
9	China	Huawei	$78.50	2016
10	USA	Dell Technologies	$74	2017
11	Japan	Sony	$69	2016
12	China	Lenovo	$46	2015

We select 10 IT companies for research analysis. However, the major business of 5th and 6th companies in the table 1.1 — Alphabet Inc. and Microsoft — is software such as Android and Windows operation system, Chrome browser, Office, search engine. Considering that it is difficult to measure the supply chain of software products, we deleted these two companies and take into account companies at the 11th and 12th in the ranking instead — Sony and Lenovo.

Thus, the IT companies which have been chosen in this research include:

- Apple Inc.
- Samsung Electronics
- Amazon.com
- Foxconn
- Hitachi
- IBM
- Huawei
- Dell Technologies
- Sony
- Lenovo

1.2 The Introduction of Selected IT Companies

1.2.1 Apple Inc.

Apple Inc. was founded by Steve Jobs, Steve Wozniak, and Ronald Wayne in April 1976. The company headquartered in Cupertino, California. It is an American multinational technology company that designs, develops, and sells consumer electronics, computer software, and online services. The company's famous electronic products include iPhone, iPad, and Mac personal computer. Its famous software includes macOS and iOS operation systems, iTunes media player, Safari web browser and so on.

1.2.2 Samsung Electronics

Samsung Electronics is a multinational electronics company headquartered in Suwon, South Korea. As a flagship subsidiary of the Samsung Group, it has long been a major manufacturer of electronic components such as lithium-ion batteries, semiconductors, chips,

flash memory and hard drive devices. Since 2011, it has become the world's largest mobile phones and smartphones manufacture, with the well-known Samsung Galaxy line of devices. Besides, Samsung is also the world's largest television, memory chips ang semiconductor manufacturer.

1.2.3 Foxconn

Foxconn Technology Group is a multinational electronics contract manufacturing company located in Tucheng, New Taipei, Taiwan. It is the world's largest contract electronics manufacturer who produces electronic products for major American, Canadian, Chinese, Finnish, and Japanese companies.

1.2.4 Amazon.com

Founded on July 5, 1994, Amazon.com is an American electronic commerce and cloud computing company located in Seattle, Washington. It is the largest Internet retailer in the world as measured by revenue and market capitalization, and second largest after Alibaba Group in terms of total sales. The website amazon.com started as an online bookstore and later diversified to sell different products. The company also produces consumer electronics like Kindle e-readers.

1.2.5 Hitachi

Hitachi, Ltd. is a Japanese multinational conglomerate company headquartered in Chiyoda, Tokyo, Japan. It is a highly diversified company that operates eleven business segments: Information & Telecommunication Systems, Social Infrastructure, High Functional Materials & Components, Financial Services, Power Systems, Electronic Systems & Equipment, Automotive Systems, Railway & Urban Systems, Digital Media & Consumer Products, Construction Machinery and Other Components & Systems.

1.2.6 IBM

IBM (International Business Machines Corporation) is an American multinational technology company which located in Armonk, New York, United States.

IBM manufactures and markets computer hardware, software, middleware and provides hosting and consulting services in areas ranging from mainframe computers to nanotechnology. Famous products invented by IBM include the automated teller machine (ATM), the PC, the floppy disk, the hard disk drive, the magnetic stripe card, the relational

database, the SQL programming language, and dynamic random-access memory (DRAM).

1.2.7 Huawei

Huawei Technologies founded in 1987, it is a Chinese multinational telecommunications equipment, networking and services company established in Shenzhen, Guangdong. It is the largest telecommunications equipment manufacturer and the second largest smartphone manufacturer in the world. The company focused on manufacturing phone switches in the beginning, but afterwards expanded its business to build telecommunications networks, provide operational and consulting services and equipment to enterprises inside and outside of China, and manufacturing communications devices for the consumer market.

1.2.8 Dell Technologies

Dell Technologies Inc. is an American multinational information technology corporation headquartered in Round Rock, Texas. Dell's products include personal computers, servers, smartphones, televisions, computer software, computer and network security, as well as information security services.

1.2.9 Sony

Sony Corporation is a Japanese multinational corporation headquartered in Kōnan, Minato, Tokyo. It is the electronics business unit and the parent company of the Sony Group, which is engaged in business through four operating components: electronics (AV, IT & communication products, semiconductors, video games, network services and medical business), motion pictures (movies and TV shows), music (record labels and music publishing) and financial services (banking and insurance).

1.2.10 Lenovo

Lenovo Group Ltd. is a Chinese multinational technology company founded in 1984 with headquarters in Beijing, China and Morrisville, North Carolina, the USA. It designs, develops, manufactures and sells personal computers, tablet computers, smartphones, workstations, servers, electronic storage devices, IT management software and smart televisions.

Chapter 2. Key Criteria for IT Companies' Influence on Supply Chain

The purpose of this chapter is to develop a framework of supply chain performance analysis for famous IT companies, based on the selected criteria and quantitative evaluation of the questionnaire results. The first part of this chapter will introduce the process of criteria tree construction based on literature, then next part will describe the methodology.

2.1 The Construction of Criteria Tree

The core of the research is to understand how IT companies influence on supply chain performance (SCP). In other words, we have to know the component of SCP first. This section firstly presented three SCP measurements based on different researchers' view and two unique features in large IT companies, and then combine these factors with literature and novels to construct a criteria index tree for the research analysis of this article.

2.1.1 The Component of Supply Chain Performance

Different researchers have various opinions on the composition of supply chain performance, but generally it has similar components. Here are three typical structures of SCP.

1) Vivek Sehgal (2010) indicated that all supply chains have a core sphere of influence that leads to defining the generic supply chain strategies and performance. The four basic components of SCP are (see figure 2.1):

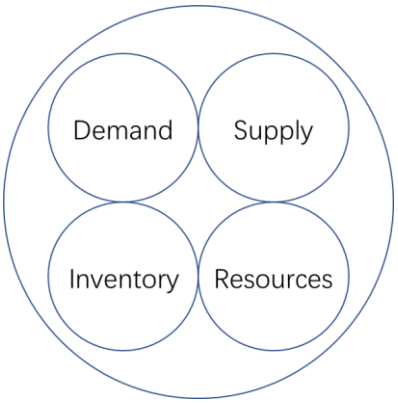


Figure 2.1 The components of SCP (Vivek Sehgal, 2010)

- *Demand Management.* The demand comes from consumers and is transmitted through the

supply chain network to retailers, then to warehouses, assembly plants and factories, and finally to raw material warehouses and suppliers. Along the way, the demand for finished goods will go down to its subassemblies, components and raw materials through bills of materials, manufacturing operations, routing and resource billing.

- *Supply Management.* As the demand passes from the consumer side to the supply side of the supply chain, the replenishment and procurement process begins. This enables the upstream link of the supply chain to perform production assembly to meet downstream demand for the final product. Suppliers manage their supply of raw materials and components to supplement supply chain requirements and coordinate supply plans
- *Inventory Management.* Inventory can make the supply chain maintain an acceptable performance rate when supply and demand changes, and avoid supply chain suspension due to insufficiency. However, inventory also increases the company's operating costs. Therefore, it is necessary to reduce costs through proper inventory management, and at the same time, to guarantee the ability of supply chain services and demand. The quality of the inventory planning process depends on a summary of history and scientific forecasts, and should be analyzed by establishing a data model of supply, delivery and lead-time.
- *Resource Management.* Resource is a very abstract definition. In a company, resources can be employees, machines, warehouses, trucks, conveyors and so on. Supply chain processes influence the efficiency and utilization of these resources by creating resource plans. In a broader definition, inventory and cash are also considered as resources. Inventory is undoubtedly a part of the supply chain. Cash is a legitimate resource of a company and it can affect the supply chain through working capital (inventory and operations), accounts receivable and accounts payable, however, supply chain management does not directly manipulate cash, so it is not considered to be a part of supply chain management

2) Tan Miller (2017) provided a more complicated hierarchical structure of Supply Chain Performance. The framework is composed by three levels, including the strategic, tactical and operational. Within each level, it has both external and internal measures.

Based on the figure 2.2, metrics that measure the performance of an entire major functional area are considered strategic, in which the external part measures the performance of whole

supply chain from suppliers to consumers, while internal part measures the performance such as manufacturing, demand management, distribution, sales etc. inside the company.

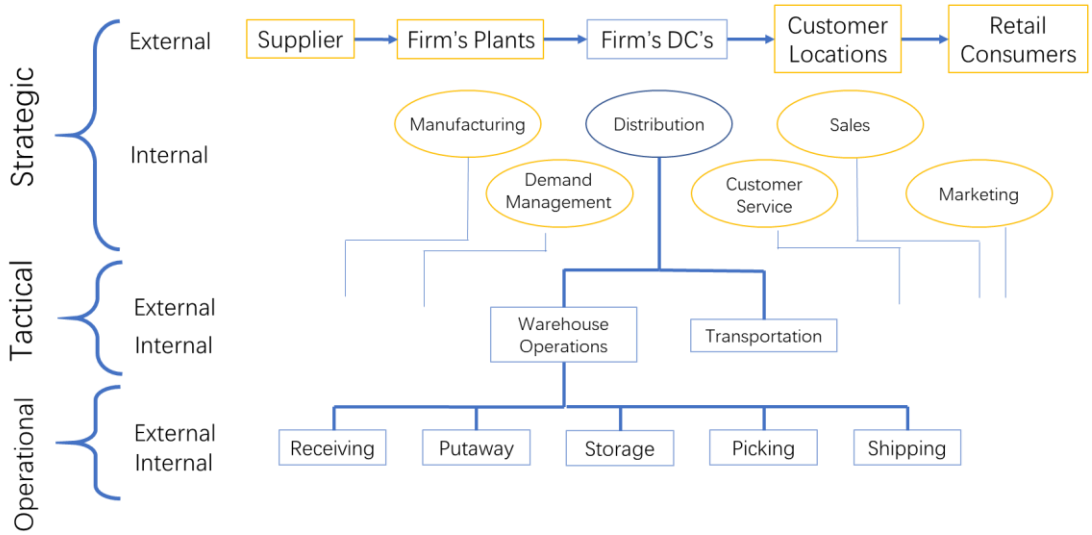


Figure 2.2 The components of SCP (Tan Miller, 2017)

Metrics that monitor major sub-functions (such as warehouse operations and transportation) are categorized as tactical. In order to interpret the details of external and internal types in tactical level, the author uses Warehouse Operations as an example. The external type measures "Percent of lines/orders picked correctly and Percent of orders picked on scheduled day"; the internal type measures "Total warehouse costs per unit of throughput"

The final metrics that monitor sub-functions of sub-functions (e.g., the receiving operation in a warehouse) are considered operational metrics. The author uses Receiving as an example to explain how to measure external and internal types — External measures "percent of cases/lines received correctly" in Receiving segment, and Internal measures "total receiving costs per unit" in this segment.

3) Gartner Inc., an American research and advisory firm providing information technology-related insight for IT and other business leaders across the world, has its own methodology to measure SCP.

The figure 2.3 illustrated the methodology which Gartner Inc, used to rank the supply chain performance of companies. It is made up by two parts: Business Data (quantitative method) and Opinion Data (qualitative method).

Business Data is comprised of three financial metrics — Return on Assets, Inventory Turns,

Revenue Growth and a Corporate Social Responsibility metric which are combined to create a weighted average score. This score represents 50% of a company's total composite score in the ranking.

Business Data	Opinion Data	
	Global Peer View	Gartner Analyst Panel
• Return on Assets (ROA) • Inventory Turns • Revenue Growth • Cooperate Social Responsibility	• Professionals, suppliers or customers have experience in supply chain and the companies being ranked, will vote to evaluate the companies	

Figure 2.3 The components of SCP according to Gartner Inc.

Opinion Data has two sub-criteria: Global Peer View and Gartner Analyst Panel. This score represents the remaining 50% of a company's total composite score.

Global peer view is to draw on the extensive knowledge of the professionals that, as customers and/or suppliers, interact and have direct experience with the companies being ranked. Additional knowledge of companies on the list is gained by exposure to periodicals, websites, white papers and conferences. Supply chain professionals and academia are eligible to be on the panel, however only one panelist per company is accepted.

Gartner Analyst Panel is comprised of both industry and functional analysts, each of whom draw on their primary field research and continuous study of companies in their coverage area. The metric for Gartner analysts to reference is presented in the figure as a heptagon, in which includes:

- Strategic Governance
- Performance Enablement
- Supply Network Design
- Supply Operations
- Customer Fulfilment
- Demand Management

- Product Life Cycle Management

All this information — the four business data points and two opinion votes — is normalized onto a 10-point scale and then aggregated, using the aforementioned weighting, into a total composite score.

Although each supply chain performance measurement standard which presented above has its own characteristics, they still have a lot in common. For instance, they all mentioned about the performance of demand, inventory, supply. But each standard has its own advantages and disadvantage, and they are designed for general companies. Considering that our research is to analyze IT companies, we still need to find that some features in IT companies' supply chain and what they did to optimize it.

2.1.2 **The Unique Features of IT Companies in Supply Chain.**

1) Integration of Supply Chain (SCI)

Large IT companies take supply chain integration as an important task. The integration includes not only the company's internal business systems such as sales, procurement, manufacturing, logistics and customer service, but also external business with customers and suppliers (Ge Honglei, 2014).

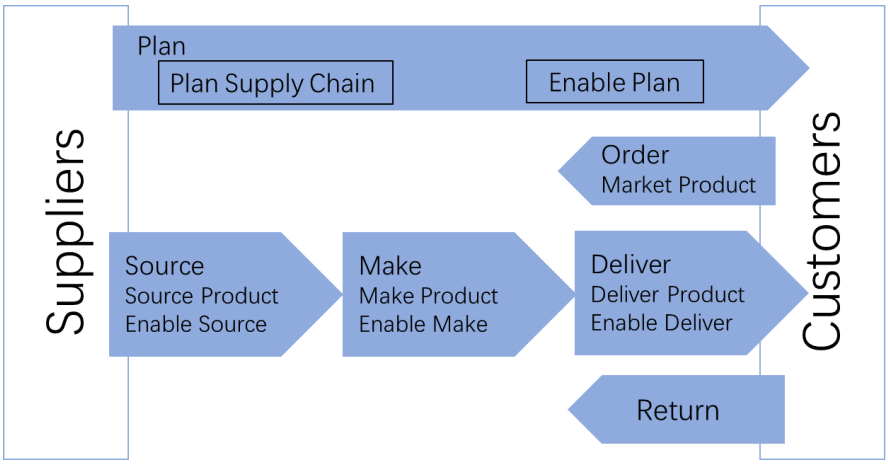


Figure 2.4. The framework of SCI in Huawei

Huawei Technologies started SCI reform since 2000, before that the company did not have a scientific SCM method to operate the company. By the assistance of IBM experts, the company attempted to compose all the members of the supply chain as a "virtual organization" based on common goals (see figure 2.4). The members within the organization coordinate and

cooperate with each other through the sharing of information, capital, materials, and optimize the goals of the organization (overall performance).

Samsung Electronics has also taken some measures to integrate its supply chain. The company owns numerous subsidiaries such as Samsung Semiconductor, Samsung Motor, Samsung SDI, Samsung Corning. Although each subsidiary is an independent entity, Samsung Electronics has maintained a high degree of consistency with its subsidiaries in raw material and components supply, thus it ensured the operation of the supply chain and enhanced the production efficiency of Samsung Electronics (Zhou Weixia, 2012).

Another case is from Apple Inc. The company used to be a self-sufficient company, producing chips, motherboards and assembling products all by itself in 1990s. However, the trend of IT industry was evolving to the precise division of labor, the situation which Apple insisted was already out of date. At the beginning of 21st century, the company simplified its product line, only maintained a few models of products. Meanwhile, it sold out some non-core business and outsourced some service, turned to collaborate and integrate with suppliers.

As can be seen from the above cases, SCI is widely existing in large IT companies. There are various concepts of SCI in extant literature, many of them are inconsistent and propose different definitions (e.g. Bowersox and Morash, 1989; Stevens, 1989; Lee and Whang, 2001; Vickery et al., 2003; Swink et al., 2007). Among them, Zhao et al. (2008) has a more comprehensive definition: "The degree to which an organization strategically collaborates with its supply chain partners and manages intra- and inter-organization processes in order to achieve effective and efficient flows of products and services, information, money, and decisions with the objective of providing the maximum value to the customer at low cost and high speed" (Zhao et al., 2008, p374).

Many studies identify that SCI has three major types: internal integration, supplier integration and retailer integration (e.g. Narasimhan and Jayaram, 1998; Narasimhan and Kim, 2002; Koufteros et al., 2005; Swink et al., 2007; Flynn et al., 2010). Supplier and retailer integration can be combined as external integration (see figure 2.5).

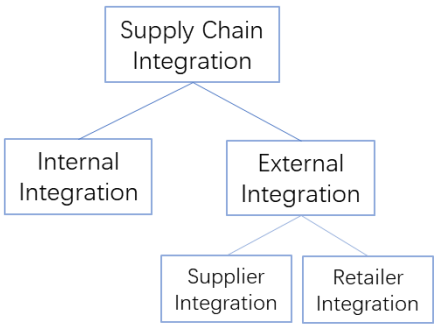


Figure 2.5. The structure of SCI

Internal integration refers to "the degree to which a manufacturer structures its own organizational strategies, practices and processes into collaborative, synchronized processes, in order to fulfill its customers' requirements and efficiently interact with its suppliers" (Flynn et al., 2010, p4). In contrast, external integration can be defined as "the degree to which a manufacturer partners with its external partners to structure inter-organizational strategies, practices and processes into collaborative, synchronized processes" (Flynn et al., 2010, p4).

2) Information Sharing and Communication Mechanism

Information sharing is an important component of cooperation in SCM. It can be categorized according to operations areas such as inventory, sales, demand forecasting, order state a production plan (R. Kumer, S. Pugazhendhi, 2012). Large IT companies need to purchase a huge number of parts for manufacturing and sell their final products, thus they must maintain close contact with suppliers and retailers, and how to deal with information and communication for them have become an important task.

Sony has adopted the following solutions for the communication mechanism with suppliers. The first is the rapid response material supply. If there are unplanned emergency orders to be met, the material manager will pass the information to the procurement immediately, and then pass to the suppliers to make quick feedback, find the problems of the material, and make improvement plans or the new mobile phone production plan for the materials based on problems, then the mobile phone delivery plan back to the factory and customers. The second point is information sharing. Sony will share its analysis and judgments with Tier 1 and Tier 2 suppliers, especially when Tier 1 and Tier 2 suppliers are unable to collect industry trends. This effectively shortens the time for information transfer (Zhang Chunyu, 2014).

Lenovo Group established the following communication mode with suppliers in

procurement:

- *Bulk Purchases*: Lenovo regularly gives suppliers a certain number of orders, and the suppliers send raw materials to Lenovo's manufacturing plants according to the order requirements, and manufacture factory receipt materials.
- *Consignment Purchase:* Suppliers replenish the designated warehouses according to the prediction provided by Lenovo and informs the company of the replenishment quantity via email. According to the daily demand quantity provided by the company, suppliers deliver to Lenovo's manufacturing plants in 2 to 3 batches, and the manufacturing plants receive materials into the storage.
- *JIT Purchase:* Lenovo will issue a framework order to suppliers. According to the characteristics of the material, the company will notify suppliers in advance of the usage of the next period. The supplier will deliver the product to Lenovo's factories and use it directly according to the demand quantity.

After the introduction of the SCP and the elaboration of unique components in the IT company's supply chain, we can know that in order to measure SCP, generally we have to consider the following points:

- Consumer/customer service
- Distribution
- Integration
- Marketing
- Retail/retailer
- Sales
- Supply chain network design
- And so on
- Demand
- Information sharing
- Inventory/warehouse
- Resources
- Return on assets
- Supply/supplier
- Transportation

Next, we will categorize these points and build a hierarchical structure of index to measure the influence of IT companies on SCP.

2.1.3 **The Process to Construct Criteria Tree**

1) Integration

As the previous section of this paper mentioned, SCI is divided by internal integration and external integration. In fact, internal and external integration can be seen as a part of the integration of internal supply chain and external supply chain.

The internal supply chain refers to the supply and demand network composed of the purchasing department, production department, warehousing department, and sales department involved in the production and distribution of internal products (Zhang Duo, 2000, P22). Internal integration emphasizes the coordination among internal functions and firm-wide standards and norms (Germain and Iyer, 2006), the core is the optimization of business processes. The purpose is to reconsider and improve the operation processes of various departments and businesses in the internal supply chain, through the coordinated operation of internal supply chain to achieve a significant improvement in key performance indicators. This indicated that internal integration is the integration of company's departments, production and circulation.

External supply chain refers to the supply and demand network consisting of suppliers, manufacturers, storage and transportation companies, retailers, and final consumers involved in the production and distribution of company's' related products (Zhang Duo, 2000, p22). While external integration as we mentioned in previous section, is the degree to which a manufacturer partners with its external partners to structure inter-organizational strategies, practices and processes into collaborative, synchronized processes" (Flynn et al., 2010, p4). According to these two definition, external integration should be the integration of suppliers, manufacturers, storage, transportation, retailers and final consumers. However, manufacturer usually is the company itself, storage can be categorized into inventory segmentation, transportation is a part of logistic segmentation, final customer belongs to customer relationship segmentation. Thus, we only left supplier and retailer to integrate, this result also matches other researchers' opinions (e.g. Narasimhan and Jayaram, 1998; Narasimhan and Kim, 2002; Koufteros et al., 2005; Swink et al., 2007; Flynn et al., 2010).

As the definition of external integration implemented, suppliers and retailers are "external partners", if an IT company wants to integrate with external partners, it must keep a good relationship with them. David Frederick Ross (2011, p187) provided several factors for it:

- *Partner Recruitment, Development, and Profiling.* Companies need to recruit and qualify

potential partners. After completing this work, the company conducts a database of partners' ranking analysis for procurement/sales tasks. By implementing a standardized approach to partner channels, companies can better manage the life-cycles with their partners cooperation by providing visibility to partnership risks and rewards, and maintain the company's profitability.

- *Performance Development.* After recruiting, IT companies also have to regularly make performance assessments on these partners. For partners with good performance to continue to cooperate, some partners with poor performance are ordered to improve or completely remove from cooperation. This can stabilize the cooperation and ensure the stability of raw material supply and final product sales
- *Sales Development.* This component consists of several functions that include team pricing, catalog management, needs analysis and order management with partners.
- *Training Service Development.* IT companies need to provide certain training and guidance for partners, especially suppliers. For example, a partner can accept a company's training on a product line to obtain certification, thereby ensuring that the partner can accurately provide the required raw materials or produce components that meet company's requirements.
- *Partner Relationship Management Collaboration.* In addition to basic functions, IT companies should facilitate channel networks to codevelop marketing programs and joint business plans. An effective collaboration with partners will require the ability to transmit analytics and metrics of customer performance, channel sales forecasts, and general marketplace feedback.

Based on the analysis above, we can construct the SCI with following structure (see figure 2.6):

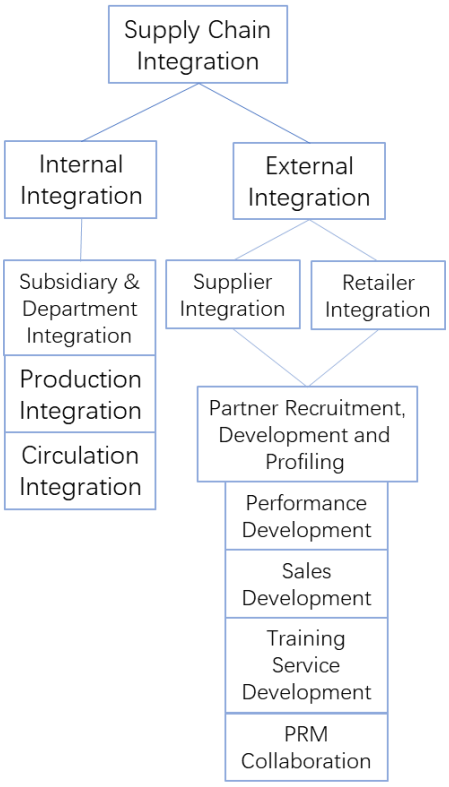


Figure 2.6 The structure of SC integration

2) Inventory

Inventory is the stock of any item held in an organization. The aim is, naturally, to have the right amount, in the right place, at the right time and the right cost (Geoff Relph, Catherine Milner, 2015, p7). When talking about inventory in supply chain, we must consider inventory management. It is the process of directing and administering the holding, moving and converting of raw materials through value-adding processes to deliver finished products to the customer (Geoff Relph, Catherine Milner, 2015, p7). Another definition says that inventory management is the management and control of all kinds of goods, finished products and other resources in the entire process of production or operation of the manufacturing or service industries, to let their reserves are maintained at an economically reasonable level (Cheng Xiaohua, 2007).

When it comes to specific segments of inventory management, Tony Wild (2002) thinks that inventory management equals to inventory control. Cheng Xiaohua (2007) holds the view that it includes warehouse plan and inventory control. Warehouse plan refers to the scientific storage of inventory materials to reduce losses and facilitate access; inventory control requires

the control of a reasonable inventory level, that is, to maintain a reasonable inventory to meet the use of the department with the minimum investment and the minimum inventory management fees, in order to satisfy departments' demand and reduce stock loss. Geoff Relph and Catherine Milner (2015) divided inventory management into two key pillars: inventory planning and inventory control. Inventory planning is about determining the optimum levels of inventory both for today and the future, inventory control is about managing the integrity of the stock, it is also, obviously, about the management of the physical inventory.

Comparing their definitions, first we can see that Chen's opinion about warehouse plan and Relph & Milner's inventory planning are quite similar, because a scientific storage of inventory needs to determine the optimum level. Thus, for supply chain inventory, we can build a structure like figure 2.7:

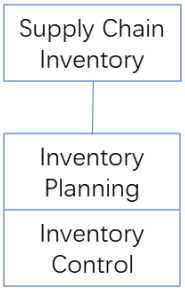


Figure 2.7 The structure of SC inventory

3) Demand

Speaking of demand, we have to think about demand management as a segment of supply chain. Demand management is a planning methodology used to forecast, plan for and manage the demand for products and services. Bisk (2018) thinks that the concept of demand management in fact is the same as the concept of demand planning, which uses analytics that examine historical sales data, customer orders, shipments, current sales and market indicators to better predict demand patterns based on market changes, enabling firms to make smart decisions about inventory and production levels. However, David Frederick Ross (2011) thinks that demand for products is shaped by forecasting, advertising, promotions and pricing. Based on this idea, he suggested that demand management should have two factors: demand forecasting and demand shaping. Demand forecasting is using tools to draw upon simple models or complex algorithms that attempt to project future demand driven by data from sales,

invoice, point of sales (POS), lost sales and promotion histories. Effective forecasting is needed for long-term planning and new product introduction. Demand shaping permits supply chain nodes to simulate demand intensity through the use of sales techniques such as channel promotions, bonus and incentives, pricing, and advertising and marketing strategies.

To compare the opinions of two researcher above, we can see that the idea of demand planning from Bisk is similar to the idea of demand forecasting from David Frederick Ross, and the word "forecasting" actually is more suitable here. Thus, we can combine their definition and conclude that demand in supply chain has these two sub-criteria (see figure 2.8):

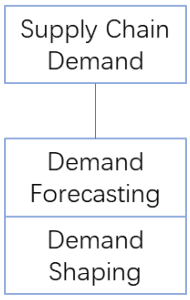


Figure 2.8 The structure of SC demand

4) Customer Relationship

Customer relationship management (CRM) is an approach to manage a company's interaction with current and potential customers.

Research refers to the components or segmentations of CRM has wide differences and divergences. Adeniyi Salau (2018) indicated that CRM has four components: the degree of understanding customer, the interaction with customer, technology for customer analysis, service for customer. The Hurwitz Group (2002) believes that the focus of CRM is to automate and improve business processes related to customer relationships in sales, marketing, customer service, and support. However, Michael Taylor (2014) has a more complicated explanation, he thinks that CRM is made up by eight components: salesforce automation, human resource management, lead management, customer service, marketing, workflow automation, business reporting and analytics.

The opinions above are discussing CRM only in its own field. Due to the fact that we have to analyze IT companies and their supply chain performance, when considering the components of CRM, we have to stand at IT companies' position and combine the theory of

SC. David Frederick Ross (2011) presented his view on CRM components as:

- *The Enterprise Business System (EBS).* EBS establishes a customer database to record customers' complete profile, including contact information, accounts receivable data, order management , shipping preferences, etc., to provide enterprise's managerial personnel with timely customer information for further analysis and service use.
- *Web System.* Companies provide their customers with easy to use website for the purpose of visiting catalogs, entering orders, reviewing pricing, configuring orders, participating in auctions, and performing a host of self-service functions from order status review to online learning.
- *External Data.* If a company wants to keep its competitive leadership, it has to continuous unfolding of collaborative relationships both within the organization and across resellers, suppliers, and channel support partners. Hence, to collect information like promotional/product bundling, financing, and packaging design, fulfillment, merchandising and transportation are crucial.
- *CRM Applications.* It has three segments. The first, operations CRM, consists of the traditional functions of customer service, ordering, invoicing/billing, and sales statistics found in the EBS backbone. The second, collaborative CRM, focuses on channel spanning functions such as forecasting and process design. The third segment, analytical CRM, consists in the capture, storage, extraction, reporting, and analysis of historical customer data.
- *Analytics.* CRM analytics is to deploy the ability to act on the data and analysis mined from customer and marketing repositories to improve business processes so that they are more customer-centric.
- *Service.* Being able to efficiently and effectively respond to the customer after the sale is critical in keeping current customers and acquiring new ones. In modern area, internet and other communications technologies have been widely applied for companies to improve customer service.

Considering these researchers' study, IT companies' features and supply chain performance evaluation, we can take into account enterprise business system, web system, CRM applications and customer service. But more specifically, enterprise business system should be

IT business system in our research. So, the structure of Customer Relationship segment can be organized as figure 2.9 presented:

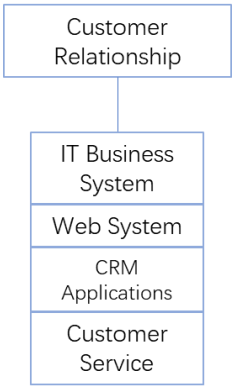


Figure 2.9 The structure of customer relationship

5) Supply Chain Network Design

Supply chain network design refers to the scientific and rational planning, design, construction of the flow structure of products and information etc. inside the supply chain, such as node layout, transportation line design, and capacity allocation (Li Yanfeng, Xie Kun, 2012, p146). Among them, conducting scientific and reasonable pre-planning and design is an important basis for the supply chain network design, and it is also an important guarantee for the efficient operation of the supply chain network.

Supply chain network design mainly includes two components (Li Yanfeng, Xie Kun, 2012): logistics network design and information network design.

Logistics network design is the foundation and the most important content of supply chain network design. It is the prerequisite for realizing fast and efficient space-time transfer of goods. The logistics network design mainly includes two segments, first is the design of logistics nodes, including the determination of the node amounts, location selection, volume planning, service market distribution. The second is the design of logistics route, which consists of the confirmation of the types of transportation network, the selection of transportation mode, and the transportation route optimization

The information network design of supply chain mainly includes the selection of network technologies, the configuration of facilities and devices, and the communication mechanism among partners. An important difference between modern enterprises and traditional

enterprises is the extensive application of information technology. This has become a basic means for communication and coordination among supply chain members and an important guarantee for the effective operation of supply chain networks.

Based on this interpretation, we can set the structure of supply chain network design as:

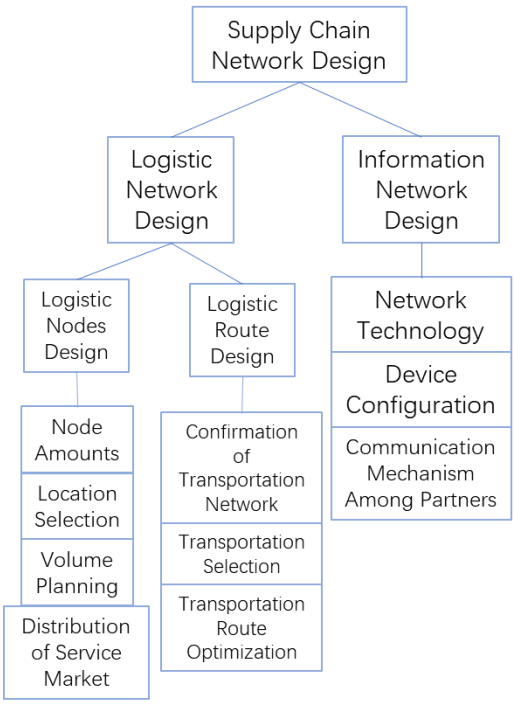


Figure 2.10 The structure of SC network design

6) Return on Assets (ROA)

In the supply chain performance measurement of Gartner Inc., there is a metric called "Business Data" which contains return on assets, inventory turnover, revenue growth and cooperate social responsibility. When talking about the core objective of this research — how IT companies influence on supply chain performance, we can also take ROA into account. The formula of ROA is:

$$\text{ROA} = \frac{\text{Net Income}}{\text{Total Assets}}$$

The reason is that Return on Assets shows the percentage of how profitable a company's assets are in generating revenue. It's a useful number for comparing competing companies how efficient a company's management is at using its assets to generate earnings in the same industry. That means the influence of IT companies on SCP can be illustrated by ROA in a certain degree, because if a high ROA represent that company is more efficient in its

management. Supply chain as a part of company's management, high ROA reflects a high SCP from the side.

As so far, the index to measure how IT companies influence on SCP is basically completed, as the figure 2.11 presented. The index tree has three layers. According to the opinions of supply chain experts who participated in the in-depth interview of this research, the criteria with blue frames could be used in the survey for evaluation, the sub-criteria with light orange frames are only the explanation of upper criteria but not for evaluation, due to the fact that these sub-criteria are difficult to evaluate specifically, unless you have one company's internal information. However, they are usually classified.

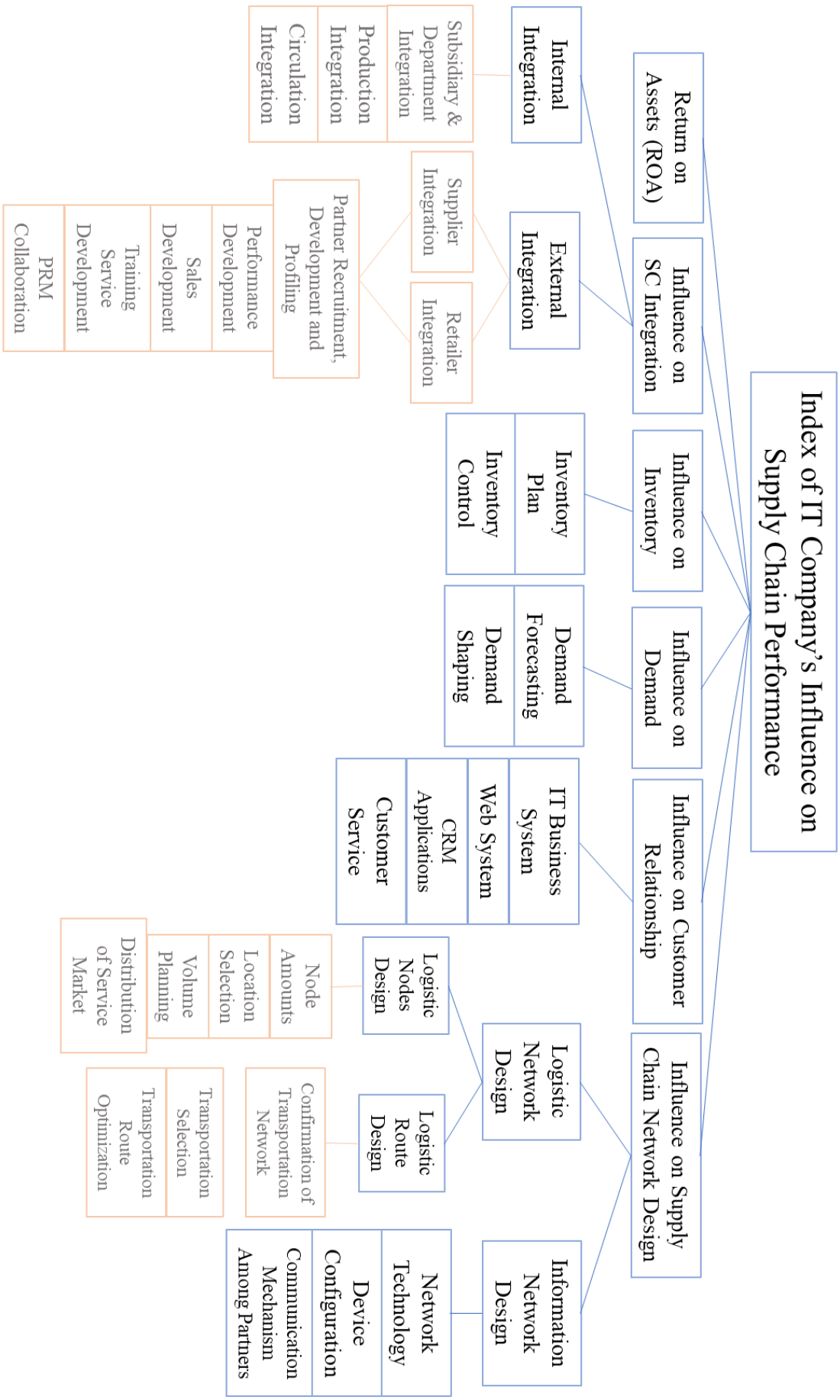


Figure 2.11 The structure of the index

2.2 Research Methodology

The research is composed by using several methods and tools, which are presented below in a chronological order:

- Analysis of scientific literature and novels
- Developing the framework of the research
- Framework application in the case of supply chain performance
- In-depth interviews
- Constructing the hierarchical index tree for IT companies' supply chain performance comparison
- Selecting suitable tool for quantitative evaluation
- Survey of criteria evaluation for supply chain experts in the IT industry
- DSS APIs software application
- Analyzing the results

The process of the research in detail includes:

1) The first step of the research was to analyze scientific literature and related novels of supply chain and supply chain management theories, as well as their application and development in IT companies. The purpose is to collect background information on the topic of supply chain and IT companies, understand basic theories and current situation in this industry, identify the relevant criteria of supply chain performance assessment for IT companies, and prepare the contents for interviews.
2) After the review of literature, a framework for the research about how selected IT companies influence on supply chain performance assessment was constructed, which would be the guideline of further research preparation. The framework is illustrated in figure 2.12:
3) The third step of the research process was to organize in-depth interviews. The interviews were conducted with two representatives from supply chain departments of JD.com and Alibaba Group respectively.

   JD.com was founded in July 1998, it is a Chinese e-commerce company headquartered in Beijing. It is one of the two largest B2C online retailers who sells electronics, mobile phones, computers and similar items in China by transaction volume and revenue. It is also a member

of the Fortune Global 500. Besides, JD.com is the world's leading company in high tech and AI delivery through drones, autonomous technology and robots, and possesses the largest drone delivery system, infrastructure and capability in the world.

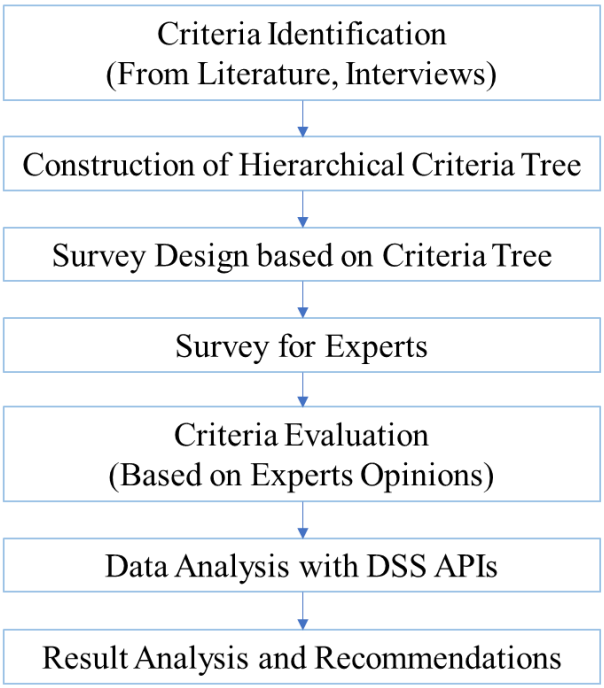


Figure 2.12 The framework of the research

Alibaba Group is a Chinese multinational e-commerce, retail, Internet, AI and technology conglomerate founded in 1999 that provides consumer-to-consumer, business-to-consumer and business-to-business sales services via web portals, as well as electronic payment services, shopping search engines and cloud computing services. It owns and operates a diverse array of businesses around the world in numerous sectors.

From representatives' working experience and skills, the interviews provided some valuable information, opinions and suggestions about IT industry, supply chain and the construction of hierarchical index tree for the comparison of IT companies' influence on supply chain performance.

4) The fourth step was based on the first and second steps of research process. The hierarchical index tree was established and presented in figure 2.11. According to this index tree, a questionnaire was designed for supply chain experts to evaluate the supply chain performance of famous IT companies which have been chosen in this research. The questionnaire is presented in the appendix A1.

5) The next step was using a statistical software named Decision Support System APIs (DSS APIs)

to analyze the data result from the questionnaires after the evaluation of experts. There are 11 experts from JD.com, Alibaba Group, Gartner etc. participated in this survey. The DSS APIs tool was applied for the analysis of information gathered through interviews, survey and evaluation. It was applied on the specific analysis of 10 famous IT companies, and the precise application of the APIS tool can be seen in section 2.4.

6) The final step of research was results analysis, to compare the advantages of selected famous IT companies in their supply chain performance, as well as what kind of impact they brought into supply chain management. Later on, the research will give a conclusion about the contribution of this article.

2.3 Method Selection for Multiple-Criteria Decision-Making

In this section, we will introduce the definition of Multiple-Criteria Decision Making (MCDM) and some typical methods of MCDM. Then after comparison of these methods, we will choose the most suitable method — DSS APIs for our research data analysis.

2.3.1 The Introduction of Multiple-Criteria Decision-Making (MCDM)

The assessment of IT company's influence on SCP is a multiple-criteria decision-making (MCDM) problem, because it searches for solutions among conflicting criteria and indicators (Janeiro and Patel, 2015). The main goal in the "influence on SCP" evaluation is to identify and choose the most suitable method among different alternatives. This process in general involves a large number of factors with multiple conflicting dimensions. Facilitating and solving such difficult decision problem can be quite complex. Thus, a more formal and systematic approach to this type of problem may be necessary (Azapagic and Perdan, 2005). This leads us to a number of Multi-Criteria Decision Making (MCDM) or else called Multi-Criteria Decision Analysis Techniques. The appropriate MCDM technique will aid in problem analysis and resolution for a specific problem of IT company's influence on SCP.

MCDM cannot be automated and it remains as a task of a human, or more specifically, a manager. However, MCDM techniques were invented in order to provide guidance to the decision makers for the purpose of finding out the preferred solution to the problem. Each of the presented MCDM techniques is created in order to make the process of decision making as efficient as possible (Stewart, 1992).

There are a lot of different decision-making methods that all attempt to solve problems of choosing among a distinct set of alternative decisions using numeric techniques. The earliest model proposed is Weighted Sum Model (WSM). It is widely used in a variety of problems. However, it has certain weak points to overcome which was upgraded by Weighted Product Model (WPM). WPM can be regarded as a variation of the WSM. Later development based on these methods created Analytic Hierarchy Process (AHP), and Saaty. Belton and Gear have created an alternative method derived from AHP, which is called the Revised AHP. TOPSIS is another method that are widely used for similar problems of a given set of alternatives with weighted criterions for selection (Triantaphyllou, 2000). Russian professor Hovanov has developed an approach that is used for similar problems and is based on a special software DSS APIs for the execution of the method. His method takes into account non-exact, non-numeric and deficient information on weights, which make this method especially applicable to the context of supply chain evaluation problem, as it encompasses non-exact, non-numeric and deficient information on weight coefficients.

All the methods mentioned above have similarities in structure. Each of these methods uses numerical analysis of alternatives and thus has three steps in common:

1. Firstly, determining the relevant alternatives and criteria
2. Secondly, attaching the numerical measures to the relative importance of the criteria as well as values of each criteria in relation to the alternative
3. Thirdly, in order to determine the ranking of each alternative, the numerical values are processed by mathematic models or software (Triantaphyllou, 2000).

Decision-making methods oftentimes lack the ability to exactly evaluate the applicable information. When the decision-making methods are applied to real life, the decision maker often encounters that information is inexact and fuzzy (Triantaphyllou and Lin, 1996).

2.3.2 The Introduction of Major MCDM Methods

In this part, we compared six MCDM methods: The Weighted-Sum Model, The Weighted-Product Model, The Analytic Hierarchy Process Model (AHP), The Revised Analytic Hierarchy Process Model (RAHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) And Decision Support System APIs (DSS APIs). After comparison we decided to choose DSS

APIs ang provided reasons why it matches our research analysis

.

1) The Weighted-Sum Model (WSM)

The WSM is most widely used in practice for its relative simplicity of execution and ease of application. Here is an examination of the method based on maximization case, where the values of criteria are the higher the better.

Weight sum method is used frequently because of its relative ease of implementation. In the example illustrated in Table 2.1, a problem is characterized by m alternatives and n criteria, where m=3 and n=4. Furthermore, relative weights for criteria are also given in the table.

Table 2.1 The example of weighted-sum model

$Alternative_i$ / $Criteria_j$	Cr1	Cr2	Cr3	Cr4
Relative Weights (w_j)	0.15	0.40	0.25	0.20
Alt.1	35	30	25	40
Alt. 2	20	40	30	40
Alt. 3	40	20	40	20

In this example, the problem is easily expressed in the matrix format. Every value in the table expresses the performance of a given alternative in terms of the corresponding decision criteria. The score for alternatives is calculated by using the following formula:

$$A_{WSM} = \max \sum_{j=1}^{N} q_{ij}\, w_j, for\ i = 1, 2, 3, \dots, M.$$

and then depending on the initial problem type, whether it is maximization or minimization, either an alternative with a maximum value or with a minimum value is chosen. It is a standard method for Pareto set creation in multi-objective optimization problems. However, weighted sum method has two disadvantages (Das et al., 1997). First, with the even distribution of the weights on the objective function does not necessarily lead to an even distribution of solutions on Pareto front. Frequently solutions are seen in some parts of the Pareto front, while they are not seen in other parts of it. Second, this method does not find solutions on non-convex parts of the Pareto front, while such Pareto optimal solutions frequently exist (Kim et al., 2005).

The weighted-sum method can be easily applied in cases where all units of measurement are all the same (for example, rubles, km, minutes, etc.). However, there is an assumption embedded in the method, precisely, the additivity utility assumption and hence this method is not applicable to situations and problems including different units of measurement in them, because the conceptual violation occurs (Triantaphyllou and Lin, 1996).

2) The Weighted-Product Model

"If weighted sum model used addition to rank alternatives, the weighted-product model uses multiplication". The comparison of alternatives is done through multiplication of ratios for each criterion. All of these ratios are raised to the power of the comparable weight of the matching criterion. In general, the following formula is being used for the comparison of the two alternatives A_K and A_L" (Triantaphyllou and Lin, 1996):

$$R\left(\frac{A_K}{A_L}\right) = \prod_{j=1}^{N}\left(\frac{a_{Kj}}{a_{Lj}}\right)^{w_j}$$

Let us consider the maximization case again, which is the higher the values, the better they are. In the maximization case, if the ratio above is greater or equal to one, then the decision maker can conclude that the alternative A_K is better than alternative A_L. Therefore, the alternative that needs to be chosen is better than all the other alternatives or at least as good as all of the other alternatives. The weighted-product method is very similar to the weighted sum method, it can be seen as a modification of the weighted-sum method. Another name for weighted-product method is "dimensionless analysis" because by its structure it eliminates any units of measurement. Hence, it overcomes the major weakness of the weighted-sum method and therefore can be used for both single and multidimensional decision-making problem. Additionally, the comparative values of measure of alternatives in matching to corresponding criterion can be replaced with actual values in weighted-product method (Triantaphyllou and Lin, 1996).

3) The Analytic Hierarchy Process (AHP)

In the AHP method, the final step is related to the construction of an M x N matrix X. We would use the same notation and denote M as the number of alternatives (rows) and denote N as the number of criteria (columns). In this constructed matrix, the element a_{ij} represents the relative

performance of the *i* alternative in terms of *j* criterion. The row vector $X_i = (a_{j1}, a_{j2}, ,\ldots, a_{jN},)$ for the alternative *i*, *i*=1,2,…, M is actually the eigenvector of an N x N reciprocal matrix, determined through a series of pairwise comparisons. For each of these vectors, the elements add up to one. AHP method does not use the actual values, but rather uses the relative ones instead. As like weighted-product model, it can be used in both single and multidimensional decision problems. The formula used by AHP is actually the same one as the formula used by weighted-sum model (Triantaphyllou and Lin, 1996).

4) The Revised Analytic Hierarchy Process (RAHP)

Belton and Gear (1983) proposed this method, later it was accepted by the originator of AHP method, Saaty and now is also known by the name ideal-mode AHP. This method was derived out of observation that Belton and Gear noticed. They noticed that in some cases AHP yields unjustifiable ranking reversals. For instance, in the example provided, they introduce a new alternative which is identical to a non-optimal one. As a result of this new alternative introduction, the ranking results for the existing alternatives change. Belton and Gear proposed that the reason for this ranking inconsistency lies in that all the comparative performance measures of alternatives for each criterion is summed to one. Instead, they argue that the relative value of each alternative will be divided by the maximum value in the matching vector of comparative values.

5) The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)

This method was developed by Hwang and Yoon (1981). TOPSIS assumes that the distance between the alternative that is need to be chosen has two forms — the ideal solution should be the shortest, and the anti-ideal solution should be the farthest in the geometric distance. TOPSIS evaluates a decision matrix through a series of steps:

1. Normalized decision matrix construction
2. Weighted normalized decision matrix construction
3. Ideal and anti-ideal solutions determination
4. Separation distance calculation
5. Comparative closeness to ideal solution calculation
6. Ranking of the alternatives

6) DSS APIs method

The Decision Support System APIs (DSS APIs) is created for holistic evaluation of specific systems in the environment of uncertainty of the complex multi-parametric objects. Objects of the evaluation may be complex technical systems, various managerial and organizational issues, expert opinions, economic objects such as stores, banks, insurance companies and so on. The properties of evaluation could be effectiveness, efficiency, reliability, applicability, security, profitability, and so on. DSS APIs is a universal tool applicable in circumstances of non-numeric, non-exact and deficient information (Hovanov et al., 2009). Among various problems that could be solved with the use of DSS APIs, the most common are:

- Support of decision-making process in situations characterized by prevalence of qualitative information that cannot be directly described numerically
- Evaluation in the environment of uncertainty of effectiveness, quality or other property of a complex system of various implications and its projects
- Multi-criteria selection of the course of action given the uncertainty of the importance of individual criteria and support in the identification of the preference of the decision-maker
- Synthesis of the collective opinion of a group of experts in the environment of information deficiency of the degree of reliability of a single expert
- Creation of a hierarchical system of evaluation of complex multi-level objects or properties given the information deficiency at each level of hierarchy

The essence of the DSS APIs is the method of aggregated indicators, which is the convolution of multiple characteristics of the complex object or property into the aggregated index, which represents a convoluted (aggregated, integral, general, etc.) indicator, synthesizing individual indexes that characterize the property of an object, such as effectiveness, reliability, security, profitability and so on (Hovanov et al, 2009). An object in the analysis should be a complex multi-criteria system, such as an alternative course of action, service, a store, a bank or an insurance company, and so on.

The method behind the DSS APIs is as follows:

1. Individual characteristics vectors formation

2. Selection of the aggregation function
3. Determination of the vector of weight coefficients

The third step is the most interesting step in the procedure that DSS APIs performs. Actually, the researcher is rarely given the exact weight-coefficient of the variety of characteristics. In general, the researcher possesses only non-numeric, non-exact and deficient information on weight-coefficients. Sometimes, however, the researcher has interval information on relative importance of characteristics and therefore relative importance of weight-coefficients, which may be expressed as an inequality, such as w1 > w2 > w3 (Hovanov et al, 2009).

2.3.3 The Reason to Select DSS APIs for This Research

DSS APIs was chosen as a tool for MCDM analysis in this article because it uniquely combines several characteristics. Other examined methods do not possess the same set of characteristics as DSS APIs. The combination of all the characteristics makes DSS APIs such a valuable tool. Although various characteristics can be analyzed by other methods as well, only DSS APIs uniquely combines and considers all of them. These characteristics are:

- It is applicable in the condition of uncertainty
- It allows to analyze a hierarchical system of criteria
- It has a complementary software for precise and accurate calculations
- It gives out the range of the convoluted index, therefore allowing to get an understanding of the risks related to the certain value
- It allows to work with inexact information (Hovanov et al, 2009).

2.4 The Using of DSS APIs

After receiving the survey result from supply chain experts, we need to analyze the data with DSS APIs. Here is an example to illustrate the procedures of using DSS APIs. Assume that there are three IT companies will be analyzed according to four criteria. Suppose the criteria are evaluated by experts as presented in Table 2.2.

Table 2.2 The evaluation of each criterion by experts

	Criterion 1	Criterion 2	Criterion 3	Criterion 4
Company A	7	5	5	4
Company B	6	6	7	4
Company C	5	7	6	7

After finishing it, the next step is to allocate weights to each criterion. In this example, the following relationships were set:

- Assessment Criteria 1 > Assessment Criteria 2
- Assessment Criteria 2 > Assessment Criteria 3

When the relationship for weight coefficients were confirmed, the next step is to run calculations in APIS software. This gives out a ranking of alternatives, in our case IT companies, based on the level of influencing on SCP. The example of how the ranking looks like for the given IT companies is presented in Figure 2.13.

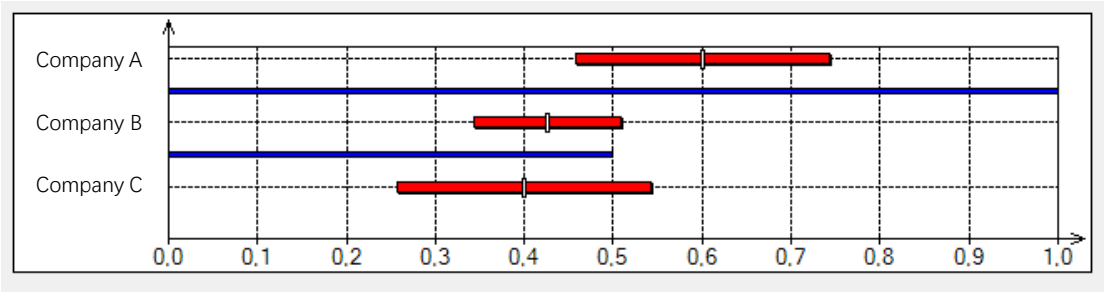


Figure 2.13 DSS APIs' calculation result example

In this example with three IT companies, we could see that the company A has the best security level, followed by company B and company C. DSS APIs gives out the range into which the exact value of the index will fall, and although the ranking shows that company B is better than company C in terms of security, it also shows that the values of the two overlap, meaning that their order in the ranking in terms of security level may be as well reversed.

Chapter 3. The Comparative Analysis of IT Companies

This chapter will present the result of data analysis based on the expert's survey. According to the criteria index tree, return on assets will be calculated by its own mathematic formula, other five criteria will be analyzed by DSS APIs, the scores that supply chain experts gave to IT companies can be seen in appendix A2. In the final step we will compare the results of each criterion together and make a total ranking of 10 selected IT companies.

3.1 The Comparative Key Criteria Analysis

According to the index tree (see figure 2.11, p35) there are six criteria in the first layer need to be evaluated and analyzed. In this section we will give the data analysis of these criteria by mathematic formula of ROA and DSS APIs step by step.

3.1.1 The Result of Return on Assets (ROA)

According to the formula of ROA, we have to know the net income and total assets of each selected IT company first. These data can be found from each company's annual report.

The calculation uses a three-year weighted average for the ROA metrics. The yearly weightings are as follows: 50% for the most recent year, 30% for the second year and 20% for the third year. Considering that the nearest year with accurate financial data is 2017, we choose 2015, 2016 and 2017 these three years for measurement. However, there is one exception which is Dell Technologies. On September 7, 2016, a merger subsidiary of Dell Technologies merged with and into EMC Corporation, with EMC Corporation surviving the merger as a wholly-owned subsidiary of Dell Technologies. This change made the financial data of Dell before 2017 are not valuable to consider. Hence, we only use the financial data in the first quarter of 2018.

The result of ROA is listed in table 3.1. Due to the fact that the good level of ROA is higher than 5%, there are five companies reached this level: Apple Inc., Huawei, IBM, Samsung Electronics and Foxconn. It proved that these five companies are quite efficient in their management when using its assets to generate earnings. Considering that supply chain management is also an integral part of company management, it can reflect that they also have higher efficiency in supply chain management.

Table 3.1 ROA of each IT company

Return on Assets (ROA)						
Year / Company	2015 (20%)	2016 (30%)	2017 (50%)	2018	3 Years Average	Rank
Apple	18.38%	14.20%	12.88%		14.38%	1
Huawei	9.92%	8.35%	9.39%		9.18%	2
IBM	11.57%	10.42%	4.74%		7.81%	3
Samsung	7.91%	8.89%	6.10%		7.30%	4
Foxconn	9.59%	7.89%	5.48%		7.03%	5
Amazon	0.99%	3.19%	2.83%		2.57%	6
Hitachi	1.85%	1.38%	2.08%		1.82%	7
Lenovo	3.65%	-0.49%	2.05%		1.61%	8
Dell				1.54%	1.54%	9
Sony	-0.81%	0.91%	0.43%		0.33%	10

3.1.2 The Result of IT companies' influence on SC Integration

The first criteria to be calculated by DSS APIs is SC Integration. According to experts' opinions, the following weight-coefficient relationship were set (see figure 3.1):

w (Internal Integration) > w (External Integration)

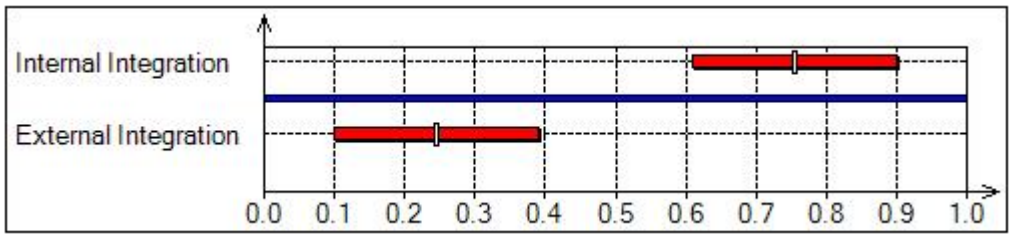


Figure 3.1 Weight-coefficient relationship in SC integration

After the information on relative weight of criteria was input, the DSS APIs software calculated the following aggregated preference indices for the influence on SC Integration, the result presented in figure 3.1 and the table 3.2.

Figure 3.1 implemented that there are three obvious group in the Integration level among these ten IT companies. Apple Inc and Samsung are at the highest group with outstanding performance; Amazon.com, IBM, Dell, Hitachi and Lenovo are at the middle group with normal performance; Foxconn, Sony and Huawei are at the low group with poor performance in Integration Management. However, the integration level of the last three companies is still at a relatively high level in the entire industry, it is relatively low if

compared with companies with excellent integration capabilities such as Apple Inc. and Samsung.

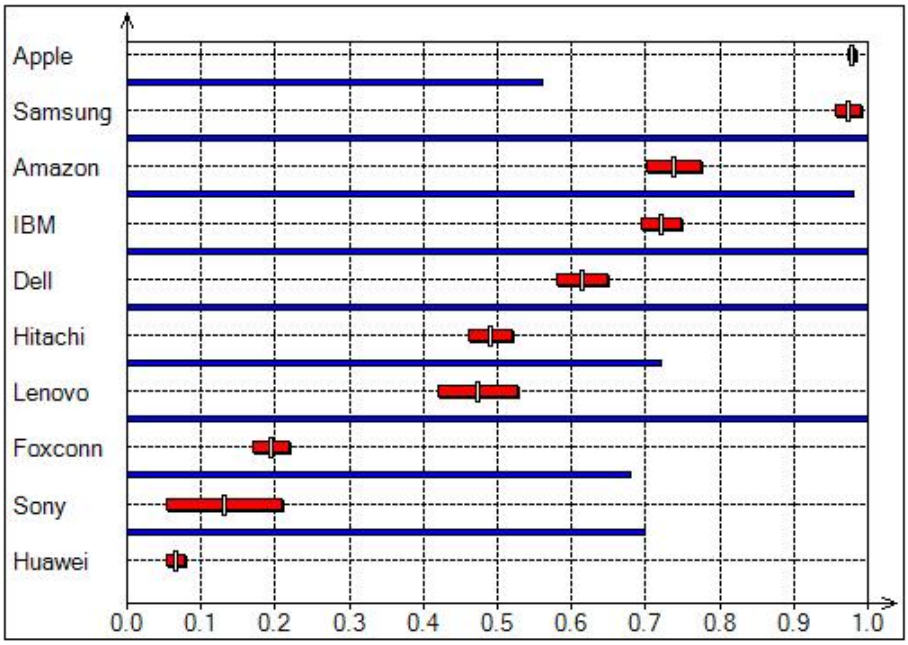


Figure 3.2 Aggregated preference indices visualization for SC integration

Table 3.2 has listed the ranking of IT companies under the criterion of the Influence on SC Integration.

Table 3.2 The ranking of IT companies' influence on SC integration

Influence on SC Integration			
Company	Mean	StDev	Rank
Apple	0.9778	0.0042	1
Samsung	0.9738	0.0155	2
Amazon	0.7382	0.0364	3
IBM	0.7207	0.0261	4
Dell	0.6144	0.0327	5
Hitachi	0.4906	0.0281	6
Lenovo	0.4742	0.0531	7
Foxconn	0.1951	0.0236	8
Sony	0.1312	0.0773	9
Huawei	0.0666	0.0127	10

3.1.3 The Result of IT companies' influence on Inventory

The next criteria to be calculated is Inventory. It contains two sub-criteria: Inventory Plan and Inventory Control. This was done using the information gathered in the survey on the relative importance on criteria. The following rules were set (see figure 3.3):

w (Inventory Control) > w (Inventory Plan)

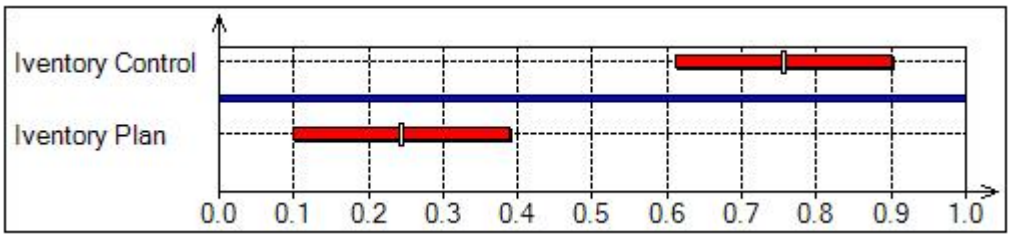


Figure 3.3 Weight-coefficient relationship in inventory

In the figure 3.4, we can see the ranking of IT companies. Amazon.com as the world largest internet retailer, its efficient cargo delivery capabilities and fast shopping experience cannot be separated from excellent inventory management. Following by Apple and Samsung, these two companies also have relatively efficient management of inventory

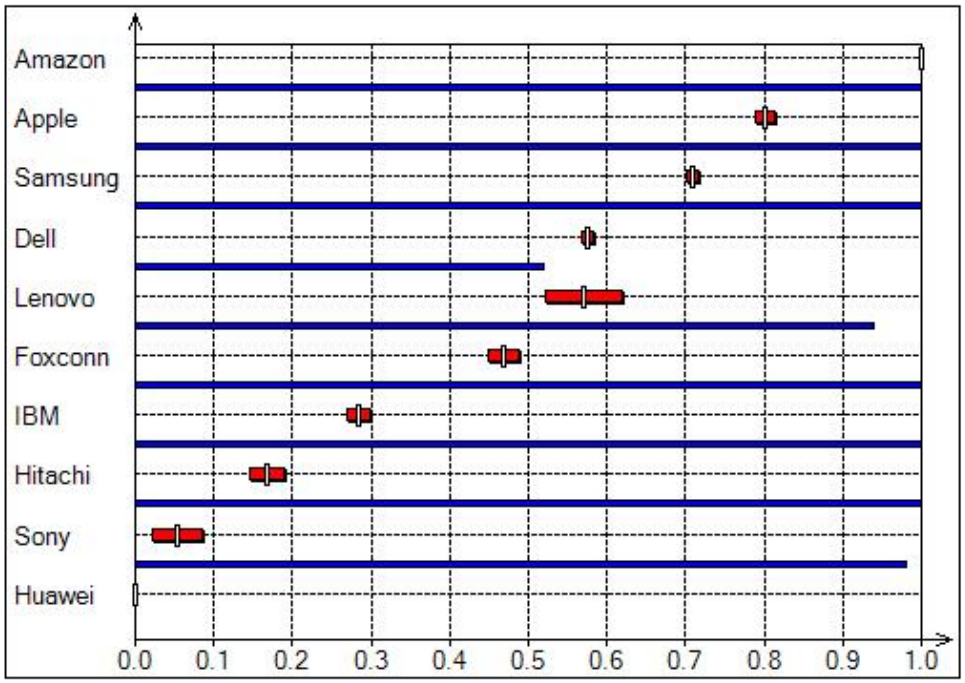


Figure 3.4 Aggregated preference indices visualization for inventory

Table 3.3 has listed the ranking of IT companies under the criterion of the Influence on Inventory.

Table 3.3 The ranking of IT companies' influence on inventory

Influence on Inventory			
Company	Mean	StDev	Rank
Amazon	1	0	1
Apple	0.8009	0.0108	2
Samsung	0.709	0.0078	3
Dell	0.5755	0.006	4
Lenovo	0.5711	0.0477	5
Foxconn	0.4682	0.0197	6
IBM	0.2845	0.0139	7
Hitachi	0.1685	0.0224	8
Sony	0.0525	0.0309	9
Huawei	0	0	10

3.1.4 The Result of IT companies' influence on Demand

The third criterion is Demand, which is made up by two sub-criteria: Demand Forecasting and Demand Shaping. The evaluation followed the rules as (see figure 3.5):

w (Demand Shaping) > w (Demand Forecasting)

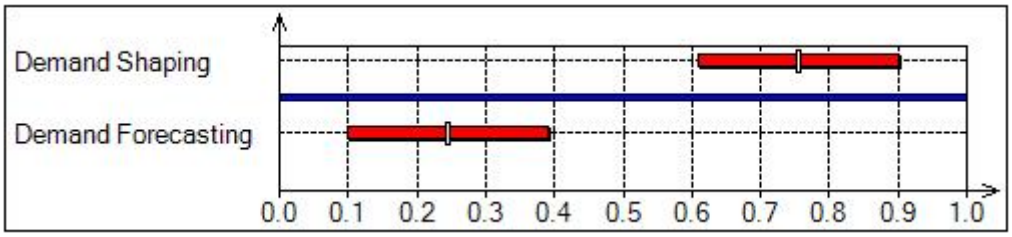


Figure 3.5 Weight-coefficient relationship in demand

The result is showed in the figure 3.6. In this round, Apple, Huawei, Lenovo and Samsung occupied the top four positions. Based on our experience in daily life, these four companies have the most powerful multimedia advertising and physical product promotion in the current electronic product field. The experience shops or specialty stores of these four companies can be seen everywhere. In this respect, the four companies are undoubtedly very successful in demand shaping. In contrast, at the last position of the ranking is Amazon.com, because it is an online retailer and does not need the shaping of the product's demand, which also led the

company to bottom out in this ranking.

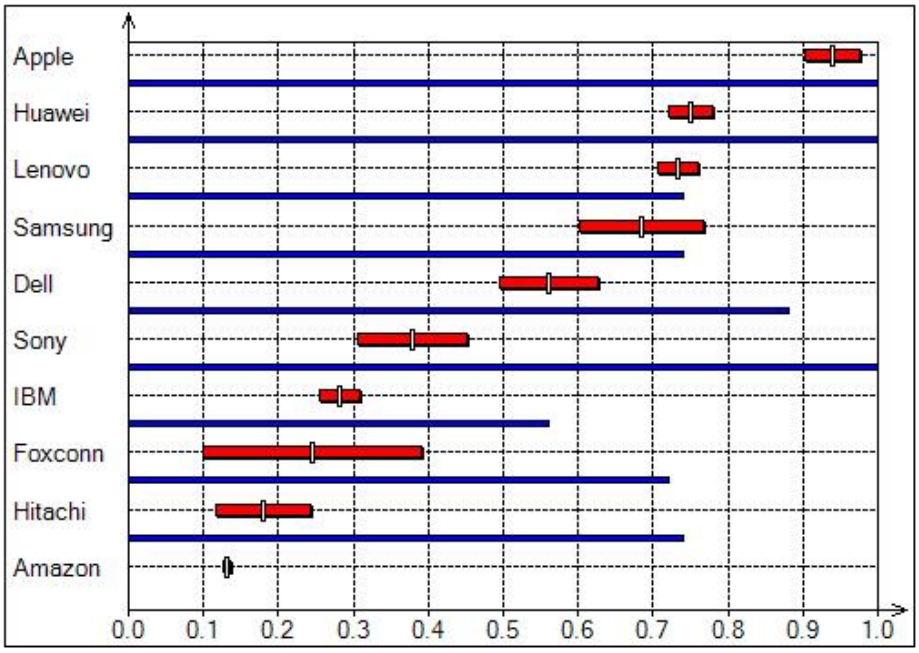


Figure 3.6 Aggregated preference indices visualization for demand

Table 3.4 has listed the ranking of IT companies under the criterion of the Influence on Demand.

Table 3.4 The ranking of IT companies' influence on demand

Influence on Demand			
Company	Mean	StDev	Rank
Apple	0.9388	0.0361	1
Huawei	0.751	0.0289	2
Lenovo	0.7321	0.0252	3
Samsung	0.6841	0.083	4
Dell	0.5602	0.0649	5
Sony	0.3775	0.0722	6
IBM	0.2821	0.0252	7
Foxconn	0.245	0.1443	8
Hitachi	0.1791	0.0613	9
Amazon	0.1311	0.0036	10

3.1.5 The Result of IT companies' influence on Customer Relationship

The fourth criterion for computing is Customer Relationship. It includes four sub-criteria: IT Business System, Web System, Customer Relationship Management Applications (CRM

Applications) and Customer Service. The following weight-coefficient rules are set according to experts' views:

w (IT Business System) > w (CRM Applications)

w (CRM Applications) > w (Customer Service)

w (Customer Service) = w (Web System)

The relationships are presented in the figure 3.7:

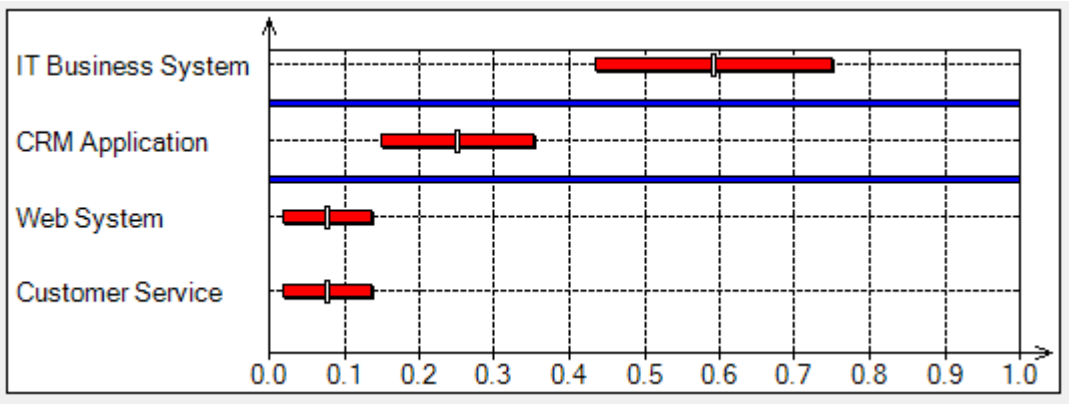


Figure 3.7 Weight-coefficient relationship in customer relationship

The result is presented in the figure3.8. From the figure we can see that the performance of Amazon.com and IBM are far ahead of other eight companies in customer relationship management.

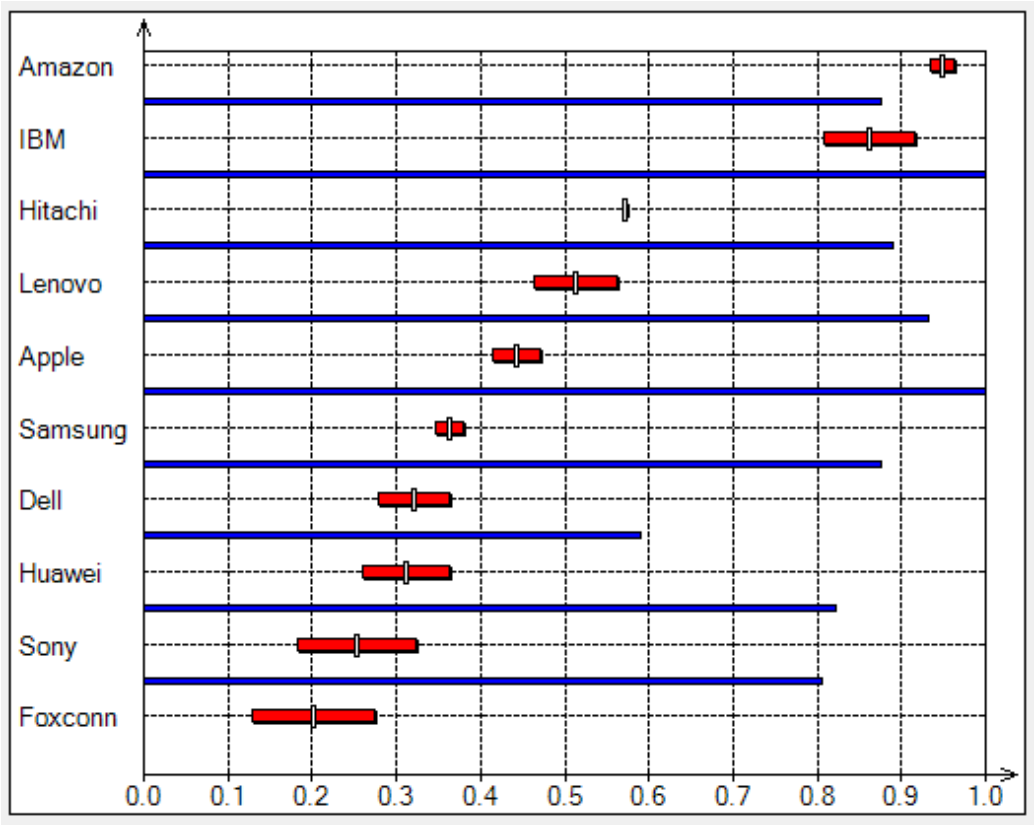


Figure 3.8 Aggregated preference indices visualization for customer relationship

As a giant internet retailer who sells a huge number of diversified products, Amazon must handle good relations with product transactions, complaints, and disputes arising from customers. Otherwise, as a retailer, losing customer trust also means loss of its own credibility, which will have a serious impact on company performance. And IBM provides information technology solutions and terminal products for a large number of enterprises and individual customers all the year round. As a company that often deals with various types of customers, it naturally continues to develop and improve its own capabilities to meet customer needs. Therefore, the two companies performed better in customer relationship management than the other eight companies.

Table 3.5 The ranking of IT companies' influence on customer relationship

Influence on Customer Relationship			
Company	Mean	StDev	Rank
Amazon	0.948	0.014	1
IBM	0.861	0.054	2
Hitachi	0.571	0.002	3
Lenovo	0.512	0.048	4
Apple	0.444	0.028	5
Samsung	0.363	0.015	6
Dell	0.321	0.041	7
Huawei	0.311	0.052	8
Sony	0.253	0.07	9
Foxconn	0.202	0.073	10

Table 3.5 has listed the ranking of IT companies under the criterion of the Influence on Customer Relationship.

3.1.6 The Result of IT companies' influence on Supply Chain Network Design

This criterion is more complicated than other five criteria in the whole Index Tree. The Supply Chain Network Design is made up by two sub-criteria: Logistic Network Design and Information Network Design, and under these two sub-criteria there are still several branches. First let us start from Logistic Network Design.

1) Logistic Network Design

This sub-criterion has two branches: Logistic Nodes Design and Logistic Route Design. The following weight-coefficient rule is set on the basis of experts' opinions:

w (Logistic Nodes Design) > w (Logistic Route Design)

As it illustrated in the figure 3.9:

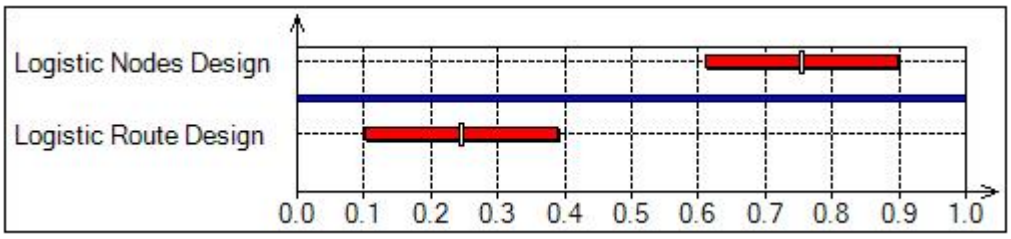


Figure 3.9 Weight-coefficient relationship in logistic network design

The result is presented in the figure 3.10:

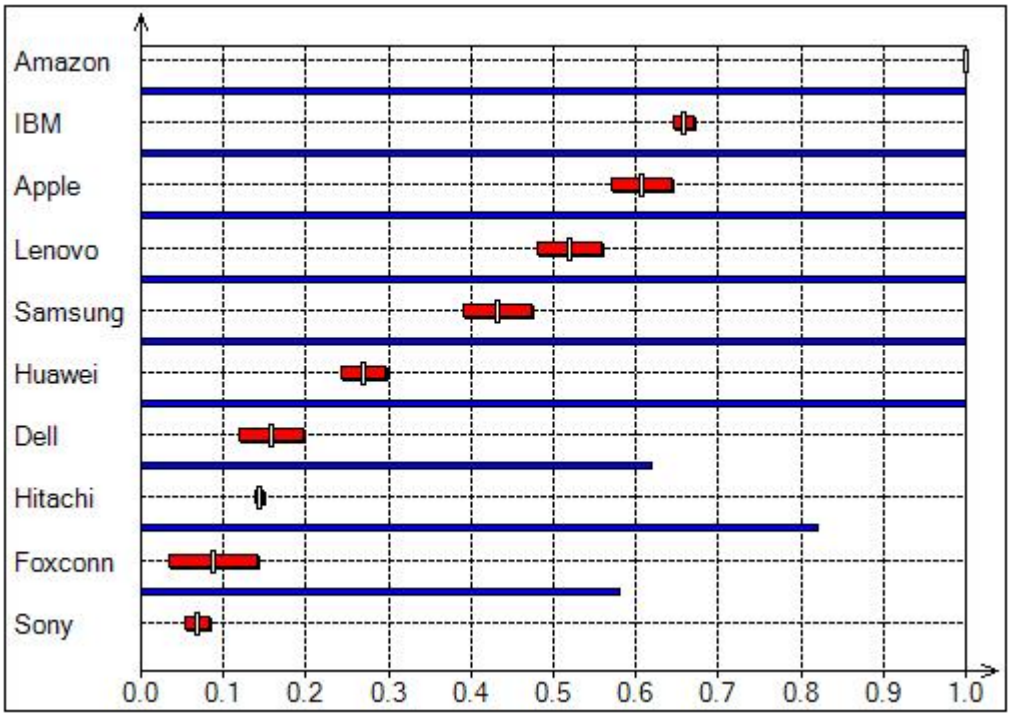


Figure 3.10 Aggregated preference indices visualization for logistic network design

From the result, it is apparent that Amazon.com's performance on logistics network design once again throws away other opponents. Amazon.com is a large online retailer whose products can be sold worldwide. To achieve efficient logistics capability, increase delivery speeds, improve customer satisfaction and reduce transportation costs, Amazon has continuously optimized its logistics nodes, the settings, quantity and distribution through years of practical experience, in order to achieve higher transport capacity and delivery speed. This is an advantage

that has been accumulating as a retail company. While the other nine companies are mostly electronic product manufacturers, the accumulated experience in this area is naturally inferior to that of the Amazon.com.

Table 3.6 The ranking of IT companies' influence on logistic network design

Logistic Network Design			
Company	Mean	StDev	Rank
Amazon	1	0	1
IBM	0.6569	0.0121	2
Apple	0.6078	0.0367	3
Lenovo	0.5196	0.0383	4
Samsung	0.4313	0.0399	5
Huawei	0.2696	0.0249	6
Dell	0.1568	0.0388	7
Hitachi	0.1422	0.0034	8
Foxconn	0.0882	0.052	9
Sony	0.0686	0.0131	10

Table 3.6 has listed the ranking of IT companies under the criterion of the Influence on Logistic Network Design.

2) Information Network Design

This sub-criterion has three branches: Network Technology, Device Configuration and Communication Mechanism among Partners. The weight-coefficient rules are set as:

w (Network Technology) = w (Communication Mechanism among Partners)

w (Network Technology) > w (Device Configuration)

The figure 3.11 illustrated the rules:

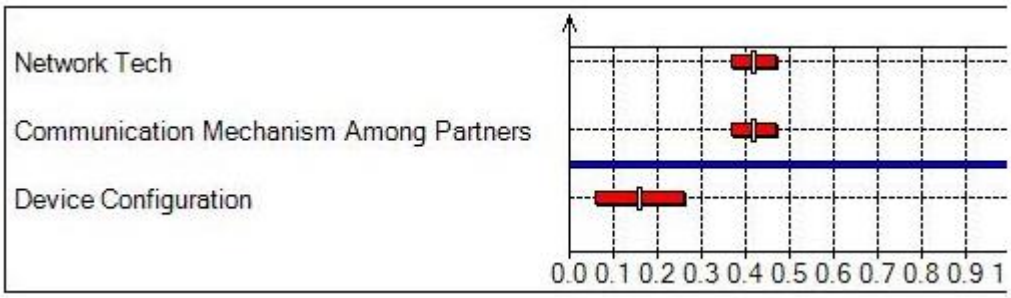


Figure 3.11 weight-coefficient relationship in information network design

From the figure3.12, we can see that in this evaluation segment, Amazon.com still wins, and

according to the results of the figure 3.12, there are four clear layers in company's information network design performance.

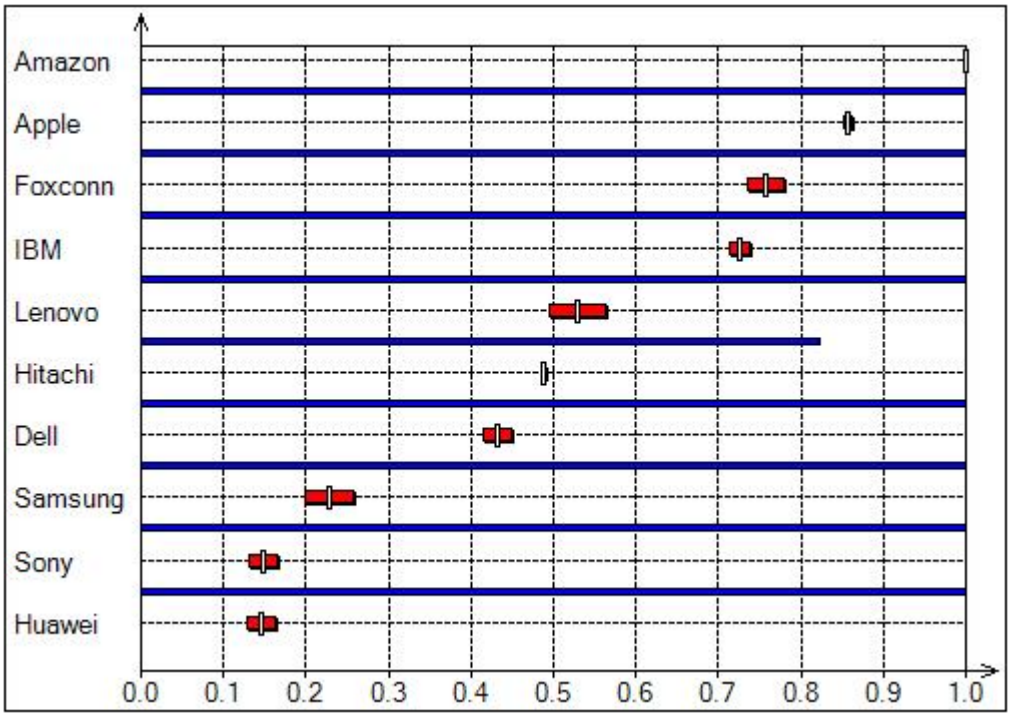


Figure 3.12 Aggregated preference indices visualization for information network design

The first layer is Amazon.com alone, the second layer has Apple, Foxconn and IBM, the third layer includes Lenovo, Hitachi and Dell, and the last layer is made up by Samsung, Sony and Huawei. The evaluation of this criterion is based on the level of the company's information exchange network system with suppliers, retailers and customers. Amazon.com is a giant internet retail company, in order to ensure supply and sales, the company is undoubtedly doing its best to exchange information with suppliers and customers. The three companies of the second-layer team, Apple and IBM also spent a lot of time on improving the information exchange mechanism with their customers. Foxconn, as a large-scale foundry company, attaches great importance to the construction of information exchange networks in order to ensure that product quality and output meet the requirements of the entrusted companies. The companies of the latter two teams are obviously not as good as the first two teams in this respect, although their information network construction is still ahead of the industry average.

Table 3.7 has listed the ranking of IT companies under the criterion of the Influence on Information Network Design.

Table 3.7 The ranking of IT companies' influence on information network design

Information Network Design			
Company	Mean	StDev	Rank
Amazon	1	0	1
Apple	0.8558	0.0038	2
Foxconn	0.7575	0.0214	3
IBM	0.7258	0.0114	4
Lenovo	0.5303	0.0342	5
Hitachi	0.4867	0.0019	6
Dell	0.4327	0.0162	7
Samsung	0.2278	0.0283	8
Sony	0.1482	0.0173	9
Huawei	0.1461	0.017	10

3.1.7 The Total Ranking

Based on the survey data analysis result, a summarized ranking result was conducted in Table 3.7. Each number in the table is the ranking of this company under the specific criterion. The blue highlight part is the total ranking derives from the ranking of six major criteria:

Table 3.8 The total ranking of IT companies' influence on SCP

Company	ROA	Integration	Inventory	Demand	Customer Relationship	Supply Chain Network Design		Rank in Total
						Logistic Network Design	Information Network Design	
Apple	1	1	2	1	5	3	2	1
Amazon	6	3	1	10	1	1	1	2
IBM	3	4	7	7	2	2	4	3
Samsung	4	2	3	4	6	5	8	4
Lenovo	8	7	5	3	4	4	5	5
Dell	9	5	4	5	7	7	7	6
Hitachi	7	6	8	9	3	8	6	7
Foxconn	5	8	6	8	10	9	3	8
Huawei	2	10	10	2	8	6	10	9
Sony	10	9	9	6	9	10	9	10

From the ranking we can see that:

- Holding the first position in the ranking, Apple Inc. has the great influence on ROA, SC Integration and Demand;
- Ranking at the second position, Amazon.com has outstanding influence on Inventory, Customer Relationship and Supply Chain Network Design;

- The third company IBM received good scores in Customer Relationship and Logistic Network Design;
- Samsung Electronics has great influence on SC Integration;
- Lenovo has good influence on Demand;
- Although all the scores of Dell Technologies are at a medium level, it has certain advantage in Inventory;
- The shining point of Hitachi is its influence on Customer Relationship;
- Foxconn is good at Information Network Design;
- Huawei received high performance in ROA and Demand;
- Last but not least, the ranking of Sony under each criterion is not good enough, the only ideal score it has is Demand.

3.2 The Advantages & Impact of Each IT Company in Supply Chain Performance

Based on last section's result and ranking of data analysis, this section will introduce the advantages that each company has in their supply chain management and describe what impact did they bring into supply chain.

3.2.1 The Advantages and Impact on SC Integration: Apple & Samsung

From the data analysis of last section, we have known that the major advantage that Apple and Samsung own is the companies' integration capability.

1) Apple

Apple Inc. achieved great performance in supply chain integration sphere. At the beginning of the 21st century, the company has started to simplify its product line and reduce the product types, in order to realize the goal "less products, more value". Comparing with other electronic product manufacturer, Apple only has a few models of computer, tablet and smartphone. Due to a smaller product types, the company has a very efficient internal supply chain operation, making the planning, execution, procurement and logistics to be simpler and more convenient.

Talking about external integration, Apple established a strategic partnership cooperation model to achieve the best supply chain management. First of all, Apple has moved the

capital flow forward and provided enough funds for the suppliers. The company pays suppliers for the cost of the required equipment, but in return the suppliers only produce products for Apple. This is very cost-effective for suppliers who have to pay a large purchase and labor costs in advance for the next order. As a result, suppliers will eliminate the risk of investment in equipment and depreciation, as well as the uncertainty of the business. For example, Apple will purchase 50% of the equipment and provide free of charge to small OEMs.

From the selection of OEM manufacturers, Apple has maintained a very cautious attitude and high standards. When selecting suppliers, Apple’s US headquarters will send a team to the factory for inspections. The production process requirements for parts and components are very high. The suppliers must have a certain production strength and the output must be stable and sufficient. Therefore, Apple is only interested in the manufacturers who occupy the top five positions in the processing industry. it attaches great importance to whether companies focus on the construction of information systems, because if a manufacturing company has an information system, it proves that the company is good to pay more attention to process control. Through the information system, Apple's U.S. headquarters will be able to access the factory's product information through remote control. Once the supplier was selected, Apple's control over the OEM business is begun. OEMs will get Apple's mandatory suggestions from the planning and construction of the factory buildings on how to train workers, to the computer systems and software needed for production monitoring and raw materials. Sometimes, Apple may even designate suppliers of raw materials and end-of-end outsourced OEMs. All OEMs selected by Apple must use Apple's designated production equipment to ensure the quality of each product's mold. After selecting OEMs, Apple will conduct trial production. The time for each trial production will last up to two or three months, and it will be repeated four to five times according to the product results, in order to give the foundry business ample time to improve product quality.

2) Samsung

In order to reduce the cost of delivery and shorten the time for manufacturing, Samsung has implemented an industrial park model, which assembles its major suppliers around its

own mobile phone factories. Suppliers directly provide components to the factories, reducing agency fees and transportation costs, and accelerating response time. The biggest feature of the Industrial Park mode is its super rapid supply chain response capability. After receiving the order, it immediately starts production and the logistics center will issue the finished product within 24 hours. At present, there are more than 26 Samsung suppliers in the "Samsung Mode" Industrial Park, providing the necessary spare parts around Samsung to ensure timely production and supply. In order to meet the needs of production companies, Samsung Logistics Center also operates 24 hours a day. In terms of sales, Samsung began to try a direct supply model, which reduced the supply chain level between telephone manufacturers and consumers, it is beneficial to Samsung itself

Samsung’s subsidiaries provide majority components for the company’s mobile phones and other digital products. For Samsung Semiconductor, the proportion of self-produced semiconductors has reached 50% and was increasing year by year. Samsung Motor manufactures chips and camera modules; Samsung SDI manufactures liquid crystal displays and batteries; Samsung Corning manufactures display-dedicated glasses. The core components of the mobile phone are produced by Samsung itself. Any innovation can be integrated on the Samsung mobile phone. This is a vertically integrated production system. The vertical production system not only ensures Samsung's freedom in product function design, assembly, and appearance, but also enables Samsung to design and manage the supply chain within a group, improving its product innovation capability and production speed.

Samsung not only holds the core technology of mobile phones, but also has the R&D and production capabilities of most of its spare parts. Samsung's subsidiaries are closely related to each other and have sales and exchanges with each other. They have achieved a large degree of vertical integration in the supply chain and economies of scale within the whole group, acquired technical efficiency, and reduced production costs. According to the double helix structure of industrial evolution, the mobile phone industry with a high degree of product modularity and a horizontal structure will evolve into a vertical industrial structure. Samsung’s self-control strategy is exactly in line with this pattern; at the same time, each business is mutually reinforcing and formed independence cycles.

3.2.2 The Advantages and Impact on Inventory: Amazon.com

Amazon.com achieved highest ranking in Inventory Management performance. It is the first company in the related industry to use big data, artificial intelligence and cloud technology for inventory management. It innovatively launched services such as predictive allocation, cross-regional distribution, and cross-border distribution

Big data-driven warehouse order operations are very efficient, and the entire order processing can be completed within 30 minutes at the Amazon's operations center in China. That means orders can be processed and shipped out within 30 minutes after placing. From order processing, quick picking, rapid packaging to sorting, everything is driven by big data and is fully visualized. Because Amazon's back-office system analysis capability is very powerful, it can quickly resolve and process orders. In the rush hour, Amazon can accurately forecast inventory requirements through big data analysis. It can prepare from the aspects of distribution planning, capacity allocation, and end-to-end distribution, balance the order operation ability, and greatly reduce the risk of overstock.

Amazon's Cubi Scan instrument will measure the height, width, height, and volume of new small-to-medium sized goods and optimize the storage according to this commodity information such as shoes, clothes and other goods, which can be sent directly to Cubi for storage. This provided great convenience for suppliers. At the same time, the database of Amazon can store these data and share them nationwide so that other warehouses can directly use the background data. Putting these data into suitable goods can collect information and facilitate subsequent optimization, design, and regional planning.

In 2012, Amazon spent $775 million to acquire robot manufacturer Kiva Systems to upgrade Amazon's logistics system. By 2015, Amazon has increased the number of robots to 10,000 for use in major operational centers in North America. The efficiency of the Kiva system is 2-4 times higher than that of the traditional logistics operations. The robot can run 30 miles per hour with an accuracy of 99.99%. In the operational mode, Kiva robotic operation subverts the traditional mode “Stuff look for goods and place”. In the e-commerce logistics center, mobilizes the robot through the operation plan, and realizes the mode of “looking for goods, locating goods”. The reservoir area is uninhabited, and each location is automatically

sorted into jobs by the Kiva robot.

3.2.3 The Advantages and Impact on Demand: Apple and Huawei

1) Apple

Apple's product demand shaping strategy is mainly focus on product innovation, new product lines, and improvement of existing products. Apple continues to innovate the functionality and appearance design of existing products, while also prudently expanding new product lines.

Apple has also adopted special marketing methods for iPhone's selling. First, they only tell the market that new iPhones will be available. However, after a long time, there is almost no information for new iPhone. After the market is extremely eager to obtain product's information from various sources, they briefly introduce the new iPhone. It makes the popularity of the iPhone's discussions have continued to maintain, and successfully using the power of the consumer to help iPhone do free advertising. After the new iPhone was officially launched, its overwhelming advertisements were seen every day and everywhere through various ways. This extreme contrast makes consumers suddenly had a great interest in new iPhone.

2) Huawei

Huawei's early positioning in the low-end market in the smart phone market has attracted consumers with low price advantages. With the continuous development of the company's smart phone business and the accumulation of technology and skills, the company began to introduce products to the high-end market, attracting consumers through excellent design and good camera quality. An excellent example is Huawei's cooperation with Leica to continuously improve the quality of the company's high-end mobile camera to achieve the best shooting performance. At present, Huawei's mobile phone camera imaging quality is the best among all smart phones. The company has effectively promoted consumer demand for company products by vigorously promoting the quality of its own products and inviting famous international stars to advertise.

3.2.4 The Advantages and Impact on Customer Relationship: Amazon and IBM

1) Amazon.com

Amazon.com has an excellent IT business system and web system to manage customer data. After registering through the company's web system, customers can perform order management, payment setup, personalization, tracking of product purchase records, logistics information, return records, etc. in the future shopping process. At the same time, the web page will provide product recommendation information based on the customer's purchase record. Amazon's IT business system can handle a lot of information in time, such as the number of customers, customer account information, purchase information, customer preferences and evaluation system, mail service, etc.

For major commodities, Amazon's built an after-sales product warranty maintenance system to provide quality assurance quotas and a convenient solution for problem product compensate. This strategy can quickly resolve customer after-sales products issue, improve customer satisfaction as well as customer relationship management system.

2) IBM

IBM has accumulated years of experience in customer service development strategy. When assisting enterprises in formulating solutions, IBM is willing to share successful experiences with customers, analyze all customer behaviors, predict customer demand for products and services, and conduct one-on-one personalized services according to requirements. The company uses data mining technology or databases to analyze customer behaviors, expectations, needs, history, and it has a comprehensive customer concept and customer loyalty measurement standards.

3.2.5 The Advantages and Impact on Supply Chain Network Design: Amazon

Through more than 20 years of accumulation, Amazon has built a global network that can reach 185 countries and regions through 109 operations centers around the world. In China, Amazon has 13 operations centers and nearly 300 trunk lines. It can provide daily and next-day services to consumers in more than 1400 districts and counties.

In the logistic nodes design field of the supply chain network, Amazon will select a central city in a large area to build warehouse. Orders placed by any consumer in the country will be automatically matched to warehouses with the lowest delivery costs and highest efficiency. In

terms of transportation, Amazon uses "combined packaging" technology to expand shipments. In addition, Amazon will also provide delivery efficiency through the assistance of the post office. The method is to use company’s trucks or independent carriers to deliver the ordered goods from Amazon's warehouse to the the local post office, and then the post office delivers goods to the customers. In this way, the processing procedures of the post office for goods can be shortened, thus the post office can deliver goods to customers more conveniently, and it also saves expenses for Amazon.

In the field of information network design, Amazon is doing logistics and distribution by itself, considering that a self-built logistics in major cities with a relatively concentrated delivery volume can save costs. By using big data and logistics information systems, it can send and track goods in a timely way. In other regions, Amazon will choose to cooperate with different logistics companies by establishing a stable communication mechanism with them, and assess these logistics companies annually according to the delivery speed, accuracy rate, and customer complaint rate.

Conclusion

A comprehensive framework of IT companies' influence on SCP assessment was developed and applied in IT industry in this thesis. Chapter 1 introduced the definition of IT Company, how this research selected IT companies for further study, and some basic information about the chosen IT companies. Chapter 2 starts from the construction of criteria tree for the measurement of IT companies' influence on SCP. This construction is a hierarchical system of criteria based on huge amounts of literature and novels, it also received some suggestions from supply chain experts. The next section of this chapter is methodology, it was described as well as various methods that thought to be applicable in the context of solving the problem of SCP assessment. The method for the analysis of information was chosen to be DSS APIs, because the author believes that this method is the most suitable for the current problem as it has a unique combination of characteristics. Chapter 3 is survey data analysis based on 11 supply chain experts scores. The result of this thesis can be summarized as:

- The criteria tree for assessment of IT companies' influence on SCP were developed on the basis of scientific literature and supply chain experts' suggestions.
- The framework of the assessment for IT companies' influence on SCP was constructed and formulated on the basis of selected criteria and quantitative evaluation of the questionnaire results (see appendix A2)
- The framework was applied on the selected IT companies in order to test the framework and provide evidence of its applicability

As a result of the framework application, each of the IT company's influence on SCP were given a snapshot of the current situation, all the weak and strong influence on the SCP were identified and then the recommendations were formulated based on the analysis of the calculations.

The theoretical contribution of this work is primarily the development of a universal framework of multinational IT company's influence on SCP, and additionally is the development of the hierarchic system of criteria of the influence on SCP assessment, which will be valid for the comparison of any set of IT companies of comparable size and employee count. Additionally, the theoretical contribution is the weights that the experts assigned to each

of the criteria; these may be also used for the repetition of the framework application in IT context. Moreover, it was shown that the framework can be straightforwardly and successfully applied, therefore showing that the developed framework works in the specified context.

The practical contribution of this work is the development of the framework of IT company's influence on SCP assessment, which is important for managers because currently there is no widely accepted framework of this kind of assessment for large IT companies. The developed framework allows to identify which company has better advantages in SC and which company has lower influence on SCP. Not only it allows to compare large IT companies' SCP, but also it allows to identify the weak and the strong points in order to know which elements to focus on when developing the program for the improvement of IT company's SC. To summarize, the contribution of this thesis is:

- Development of the list of criteria (universal in IT company field)
- Formation of the hierarchic system of criteria (for large IT company field)
- Assessment of the weights of each criteria (universal in IT context)
- Development of the important and relevant framework of large IT company's influence on SCP assessment (currently there is no widely accepted framework)
- Illustration of the framework's applicability

List of References

1) Amy Zuckerman. Supply Chain Management. Express Exec. 2002
2) Anna Nagurney. Supply Chain Network Economics: Dynamics of Prices, Flows and Profits. Edward Elgar Publishing. 2006
3) Analysis of Sony's Mobile Supply Chain Management Model, Foreign Economic and Trade University
4) Apple’s Marketing Analysis, Nanjing University of Finance and Economics. 2016
5) Bennet P. Lientz. Manage IT as a Business: How to Achieve Alignment and Add Value to the Company. Taylor and Francis. 2004
6) Cheng Xiaohua. Manufacturing Inventory Control Techniques. China Material Publishing House. 2007
7) Daintith John. "IT", A Dictionary of Physics. Oxford University Press. 2012
8) David Blanchard. Supply Chain Management Best Practice. John Wiley & Sons. 2007
9) David Frederick Ross. Introduction to Supply Chain Management Technologies, Second Edition. Auerbach Publications. 2011
10) Ding Yongqi. Logistics. Metallurgical Industry Press. 2008
11) Ely Laureano Paiva, Iuri Gavronski, Livia Castro D'Avila. The Relationship between Manufacturing Integration and Performance from an Activity-Oriented Perspective. Brazilian Administration Review. 2011
12) Fang Na, Huang Lei. A Summary of Conceptual Research on Supply Chain Management. Contemporary Economy. 2008
13) Gao Benhe, Tang Yulan. Introduction to Logistics. Central Radio and TV University Press. 2015
14) Geoff Relph and Catherine Milner. Inventory Management: Advanced Methods for Managing Inventory within Business Systems. Kogan Page. 2015
15) Gwynne Richards. Warehouse Management: A Complete Guide to Improving Efficiency and Minimizing Costs in the Modern Warehouse, 2nd edition. Kogan Page. 2014
16) Hau L. Lee, and Corey Billington. The Evolution of Supply Chain Management Models and Practice. Hewlett-Packard. 1995
17) How Demand Planning Can Improve the Supply Chain. Bisk Education. 2018
18) Huang Wei, Zhu Pengwei. Supply Chain Management Analysis of Huawei. Zhejiang University Ningbo Institute of Technology. 2014

19) Hua Xiling, Zhang Guorong, Liu Yunqin. Logistics System & Logistics Management Foundation. Beijing Institute of Technology Press. 2010
20) Huang Gang. Amazon's Big 10 Logistics Technology Not Known to the Outside World. Logistic Information. 2015
21) Huo Bofeng, Cao Zhi, Li Siyu, Zhao Xiande. Research on the Matching between Internal and External Integration in Supply Chain. System Engineering Theory and Practice. 2016
22) James Womack, Daniel Jones. Lean Thinking: Banish Waste and Create Wealth in Your Corporation. Simon and Schuster. 1996
23) Janyashankar M. Swaminathan, Stephen F. Smith, Norman M. Sadeh. A Multi Agent Framework for Modeling Supply Chain Dynamics. Technical Report, The Robotics Institute. Carnegie Mellon University. 1996
24) John Dudovskiy. Apple Value Chain Analysis. Research Methodology. 2018
25) John Gattorna. Dynamic Supply Chain Alignment: A New Business Model for Peak Performance in Enterprise Supply Chains Across All Geographies. Gower Publishing Limited. 2009
26) John Shank, V.Govindarajan. Value Chain Strategic Cost Management. Cost of Management.1993
27) Karl Marx. Political Economics Critique Introduction, Anthology of Marx and Engels (Chinese version), Vol.2, p16. People's Publishing House, 1995
28) Li Yanfeng, Xie Kun. Lean logistics, p146. China Fortune Press. 2012
29) Li Zhao. The Impact of Supply Chain Risk on Supply Chain Integration and Company Performance: A Global Investigation. Xi'an Jiaotong University. Supply Chain Management: An International Journal. 2013
30) Martin Christopher. Logistic and Supply Chain Management 5th edition. Pearson Education. 2016
31) Ma Shihua. New Supply Chain Management. China Renmin University Press. 2008.
32) Ma Tianshan. Transport Economy (Highway) Professional Knowledge and Practice. China Personnel Publishing House. 2009
33) Michael Porter. Competitive Strategy (Chinese version). Huaxia Publishing House. 1997
34) Nathalie Fabbe-Costes, Marianne Jahre. Supply Chain Integration and Performance: A Review of the Evidence. Emeraldingsight. 2010
35) Ronan McIvor. Integrated Manufacturing Systems: The International Journal of Manufacturing Technology Management: Enabling Supply Chain Integration Using Internet Technologies. Volume

13, p8, 2002

36) Slack Nigel, Chambers Stuart, Johnston Robert. Operations and Process Management: Principles and Practice for Strategic Impact. Prentice Hall/Financial Times. 2009

37) Sunil Chopra, Peter Maiinder. Supply Chain Management (Chinese version), China Renmin University Press. 2010

38) Sun Yefang. Introduction to Circulation. Finance and Trade Economy. 1981

39) Tan Miller. How to Measure Supply Chain Performance. Material Handing & Logistics. 2017

40) Tony Wild. Best Practice in Inventory Management, Second Edition. Taylor and Francis. 2002

41) Vivek Sehgal. Supply Chain Sphere of Influence. Supply Chain Musings. 2010

42) Wang Wei, Research on the Origin and Development of Supply Chain Concept. Lunwenwang. 2012

43) Wang Jinsheng. Evolution of Supply Chain and Supply Chain Management Theory. Finance and Trade Research. 2003

44) Wei Yin. The Study of the Supply Chain Management in Foxconn Technology Group. Guilin University of Electronic Technology. 2015.

45) William T. Walker. Supply Chain Construction: Building Networks to Flow Material, Information, and Cash. CRC Press. 2016

46) Xu Zhangyi. Five Areas of Enterprise Supply Chain Optimization: Chapter 5. Enterprise Supply Chain Optimization. Tsinghua University Press. 2006

47) Yingli Wang, Stephen Pettit. E-Logistics: Managing Your Digital Supply Chains for Competitive Advantage. Kogan Page. 2016

48) Zahra Lotfi, Muriati mukhtar, Shahnorbanun Sahran, Ali Taei Zadeh. Information Sharing in Supply Chain Management. ScienceDirect. 2013

Appendixes

A1. Questionnaire for Supply Chain Performance Experts

Questionnaire for Supply Chain Performance Experts

针对供应链绩效专家的调查问卷

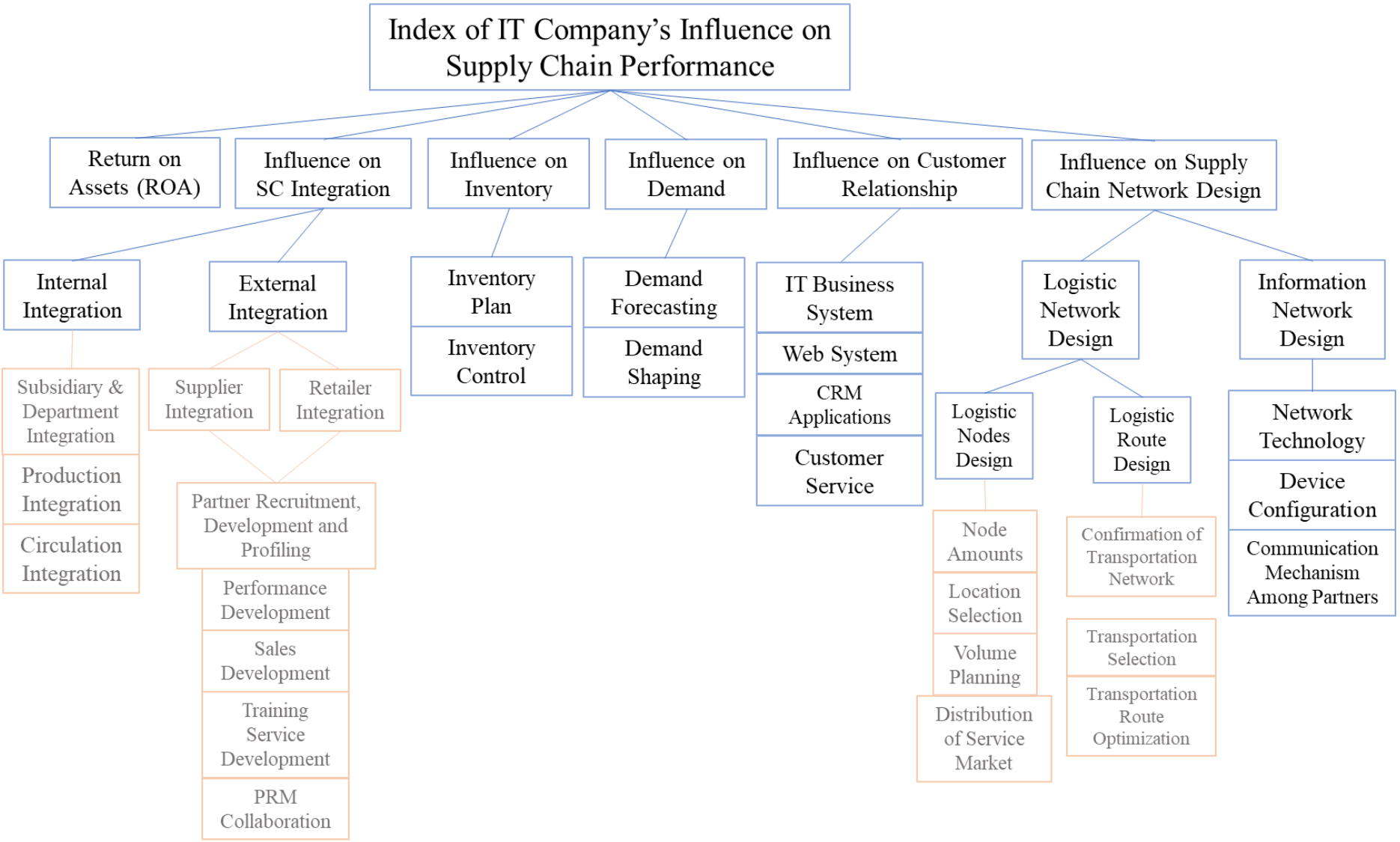
Dear respondent!
This questionnaire is one important component of master thesis project for the Graduate School of Management. The purpose is to compare the supply chain performance of famous IT companies and what kind of impacts they have in supply chain.

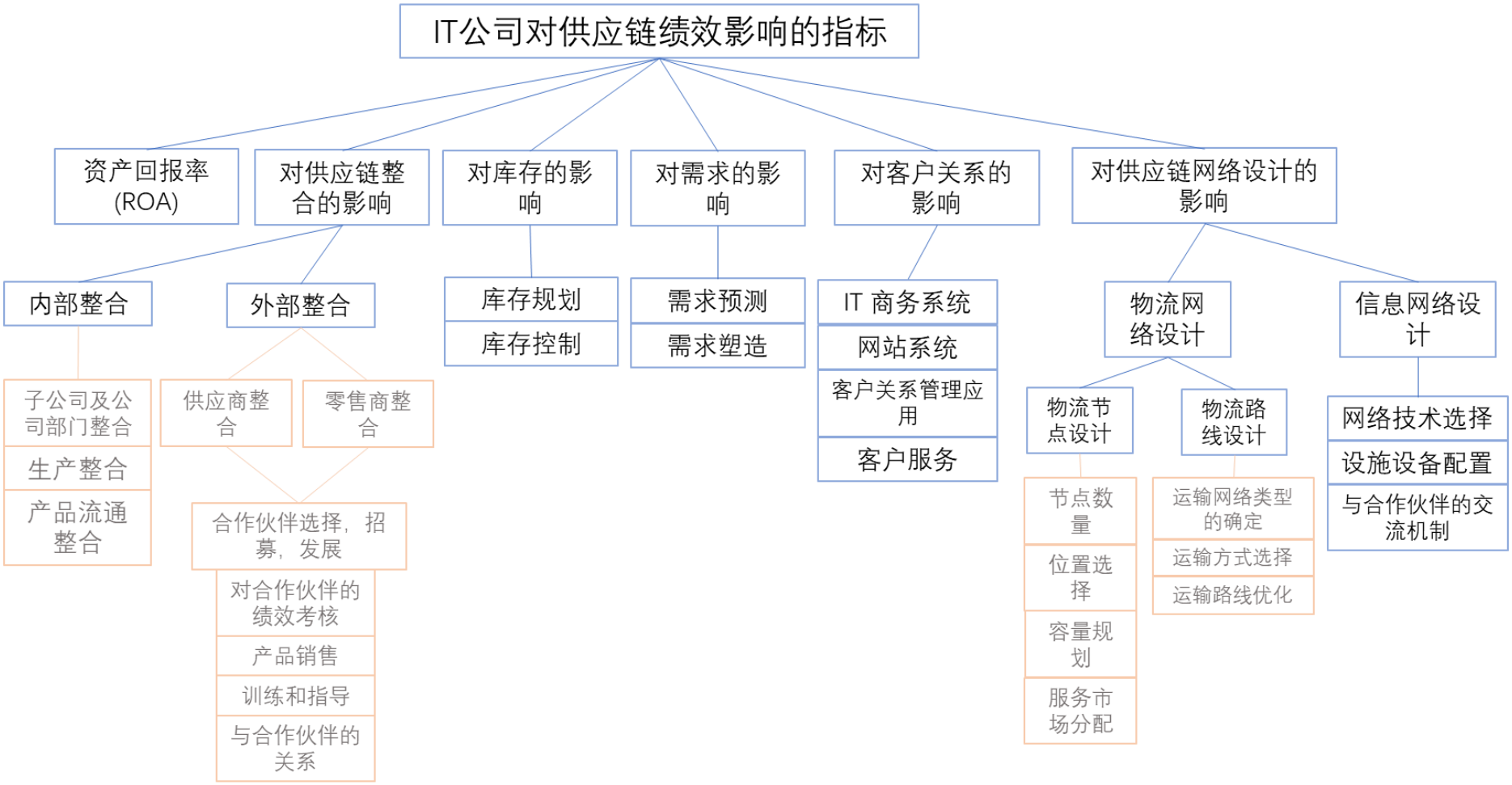
The data will be collected for the purpose of developing a balanced and comprehensive method to evaluate the supply chain performance in twelve major famous IT companies.
The arranger of this research ensures confidentiality of the information you will provide as the results of this survey will be used in cumulative form only.

Please read the instructions carefully and follow them in order to ensure proper filling of the survey and further acceptance of the results obtained into processing stage.

On next page there is a Supply Chain Performance Index for your reference. The index tree has three layers, the criteria with blue frames will be used in the survey for evaluation, the sub-criteria with light orange frames are only the explanation of upper criteria but not for evaluation. You will be asked to allocate points (from 1 to 10) to each criterion in the diagram. 1 represents it has little or terrible performance and 10 represents great performance in this field.
尊敬的问卷参与者：
这份调查问卷是圣彼得堡大学硕士论文的一个重要组成部分，其目的是比较著名 IT 公司供应链的绩效水平以及对供应链带来的影响。
问卷参与者的个人信息将严格保密，问卷内容仅作学术分析
请仔细阅读问题说明以保证问卷填写的准确性

在下一页您将看到一张供应链绩效评价标准以供参考。该评价标准分为三个层次，在蓝色方框内的指标将被用于给 IT 公司做评估，而橙色方框内的子指标仅作为对上一层指标的解释说明，不用于评估。 您将根据这些指标进行评分，分数由低到高为 1 至 10。1 分表示该公司在这一指标内的绩效糟糕，10 分则为非常好。


Index of IT Company's Influence on Supply Chain Performance
Return on Assets (ROA)
Influence on SC Integration
Influence on Inventory
Influence on Demand
Influence on Customer Relationship
Influence on Supply Chain Network Design
Internal Integration
External Integration
Inventory Plan
Inventory Control
Demand Forecasting
Demand Shaping
IT Business System
Web System
CRM Applications
Customer Service
Logistic Network Design
Information Network Design
Subsidiary & Department Integration
Production Integration
Circulation Integration
Supplier Integration
Retailer Integration
Partner Recruitment, Development and Profiling
Performance Development
Sales Development
Training Service Development
PRM Collaboration
Logistic Nodes Design
Logistic Route Design
Node Amounts
Location Selection
Volume Planning
Distribution of Service Market
Confirmation of Transportation Network
Transportation Selection
Transportation Route Optimization
Network Technology
Device Configuration
Communication Mechanism Among Partners


IT公司对供应链绩效影响的指标
资产回报率(ROA)
对供应链整合的影响
对库存的影响
对需求的影响
对客户关系的影响
对供应链网络设计的影响
内部整合
外部整合
库存规划
库存控制
需求预测
需求塑造
IT 商务系统
网站系统
客户关系管理应用
客户服务
物流网络设计
信息网络设计
子公司及公司部门整合
生产整合
产品流通整合
供应商整合
零售商整合
合作伙伴选择，招募，发展
对合作伙伴的绩效考核
产品销售
训练和指导
与合作伙伴的关系
物流节点设计
物流路线设计
节点数量
位置选择
容量规划
服务市场分配
运输网络类型的确定
运输方式选择
运输路线优化
网络技术选择
设施设备配置
与合作伙伴的交流机制

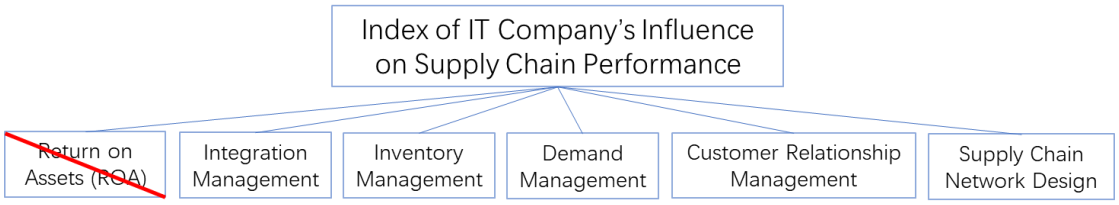
The IT companies that have been chosen in this research survey will be evaluated by these criteria. They are:
这些评价标准将被用于评估选入该问卷的 IT 公司。它们包括：

- Apple Inc.　苹果
- Samsung Electronics　三星电子
- Foxconn　富士康
- Amazon.com　亚马逊
- Hitachi　日立
- IBM
- Huawei　华为
- Dell Technologies　戴尔科技
- Sony　索尼
- Lenovo　联想

The questions will follow the order of these criteria level by level from top to bottom.
问题将根据这些评价标准从上到下一步步进行

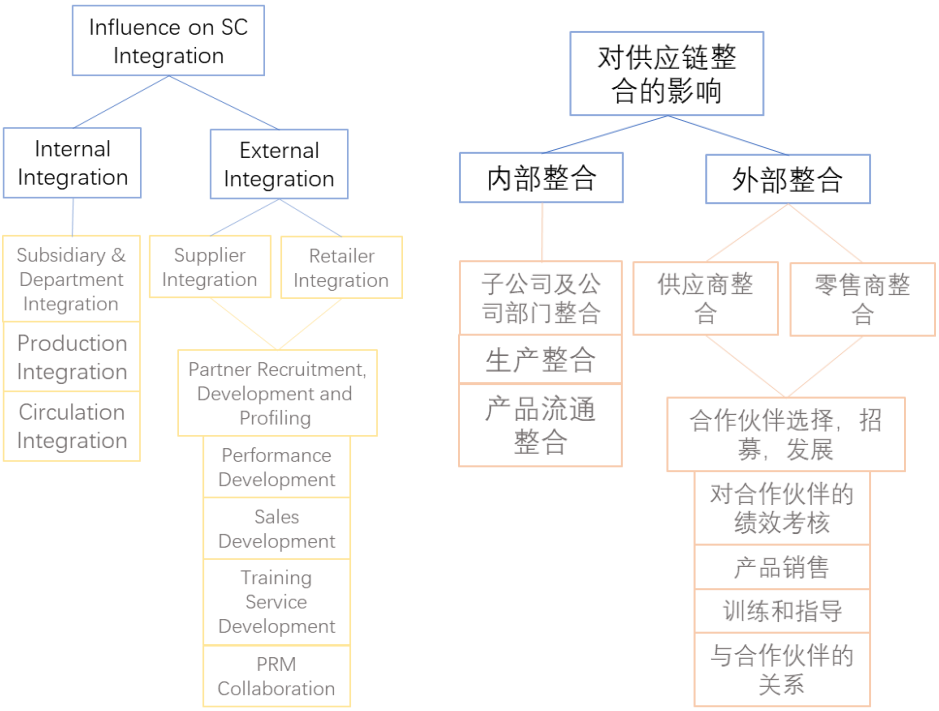
At the highest layer, there are six criteria, however we only use five of them without Return on Assets (ROA), due to the fact that it has a special mathematical formula to compute. The five first-layer criteria are identified as:
最高一层有六类评价标准，但我们仅用除开资产回报率（ROA）的其余五类，因为资产回报率有专门的公式进行计算。这五类标准是：

- Integration Management 整合管理
- Inventory Management 库存管理
- Demand Management 需求管理
- Customer Relationship Management 客户关系管理
- Supply Chain Network Design 供应链网络设计



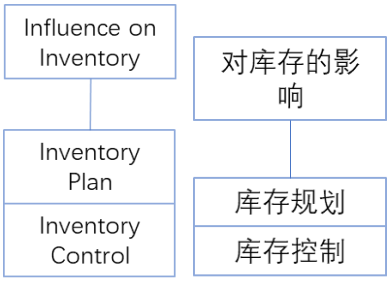
Please answer the following questions:
请回答以下问题

1. The first criterion is the influence on SC Integration, which is made up by two sub-criteria: Internal Integration and External Integration. Please read the explanatory components with light orange frame under these two sub-criteria and set your scores from 1 to 10.
   第一类标准是对供应链整合的影响，由内部整合与外部整合两个子标准组成。请通过橙色方框内的组成要素对这两个子标准进行理解并给 IT 公司评分，由低到高为 1 至 10 分



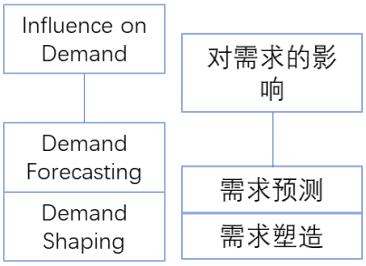
IT Company	Internal Integration	External Integration
Apple Inc.		
Samsung Electronics		
Foxconn		
Amazon.com		
Hitachi		
IBM		
Huawei		
Dell Technologies		
Sony		
Lenovo		

2. The second criterion is the influence on Inventory. It is composed by Inventory Plan and Inventory Control. Please give your scores for the IT companies from 1 to 10.
第二类标准是对库存的影响，包括库存规划和库存控制。请为以下 IT 公司评分，由 1 到 10



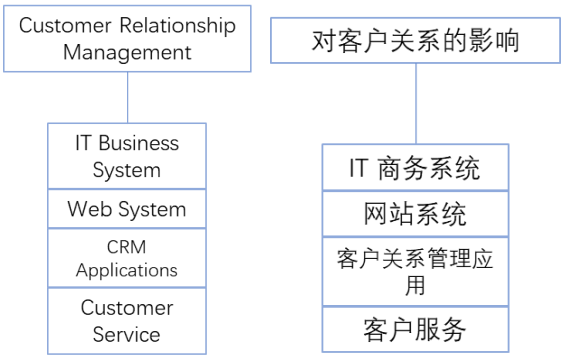
IT Company	Inventory Plan	Inventory Control
Apple Inc.		
Samsung Electronics		
Foxconn		
Amazon.com		
Hitachi		
IBM		
Huawei		
Dell Technologies		
Sony		
Lenovo		

3. The third criterion is the influence on Demand. It has two sub-criteria: Demand Forecasting and Demand Shaping. Please give your scores for the IT companies from 1 to 10.
第三类标准是对需求的影响，包括需求预测和需求塑造。请为以下 IT 公司评分，由 1 到 10



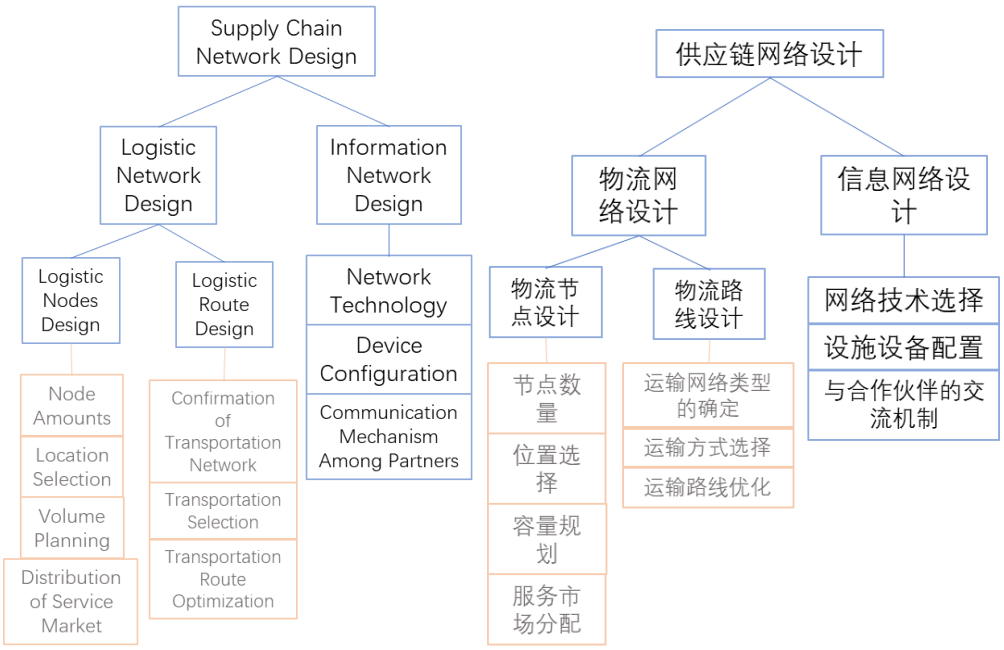
IT Company	Demand Forecasting	Demand Shaping
Apple Inc.		
Samsung Electronics		
Foxconn		
Amazon.com		
Hitachi		
IBM		
Huawei		
Dell Technologies		
Sony		
Lenovo		

4. The fourth criterion is the influence on Customer Relationship, which is made up by four sub-criteria. Please give your scores for the IT companies from 1 to 10.
第四类标准是对客户关系的影响，包括四点：IT 商务系统，网站系统，客户关系管理应用，客户服务。请为以下 IT 公司评分，由 1 到 10



IT Company	IT Business System	Web System	CRM Applications	Customer Service
Apple Inc.				
Samsung Electronics				
Foxconn				
Amazon.com				
Hitachi				
IBM				
Huawei				
Dell Technologies				
Sony				
Lenovo				

5. The final criterion is Supply Chain Network Design. It has two sub-criteria with several branches.
最后一类标准是供应链网络设计。它由两个子标准和一系列子分类组成



First, let us start from the left part — Logistic Network Design. It has two sub-criteria. Please read the explanatory components with light orange frame under these two sub-criteria and set

your scores from 1 to 10.
首先我们从左半部分——物流网络设计开始。它由两个子标准构成。请通过橙色方框内的组成要素对这两个子标准进行理解并给 IT 公司评分，由低到高为 1 至 10 分

IT Company	Logistic Nodes Design	Logistic Route Design
Apple Inc.		
Samsung Electronics		
Foxconn		
Amazon.com		
Hitachi		
IBM		
Huawei		
Dell Technologies		
Sony		
Lenovo		

Next, let us continue with the right part — Information Network Design. It is composed by three sub-criteria. Please give your scores for the IT companies from 1 to 10.
接下来请看右半部分——信息网络设计。它由三个子标准组成。请为以下 IT 公司评分，由 1 到 10

IT Company	Network Technology	Device Configuration	Communication Mechanism Among Partners
Apple Inc.			
Samsung Electronics			
Foxconn			
Amazon.com			
Hitachi			
IBM			
Huawei			
Dell Technologies			
Sony			
Lenovo			

A2. Questionnaire Result

The Average Scores of Questionnaire Result from 11 SC Experts										
	Apple	Samsun	Foxcon	Amazon.co	Hitachi	IBM	Huawe	Dell	Sony	Lenov
SC Integration										
Internal Integration	9.0	9.1	6.5	8.0	7.2	8.0	6.0	7.6	5.7	7.0
External Integration	8.6	8.3	6.0	8.4	7.6	8.2	5.8	8.0	7.3	7.9
Inventory										
Inventory Plan	8.8	8.5	8.0	9.2	7.2	7.4	6.4	8.1	7.0	73.0
Inventory Control	9.0	8.8	8.2	9.5	7.5	7.8	7.2	8.5	7.2	8.7
Demand										
Demand Forecasting	8.5	7.5	9.0	7.3	8.0	7.3	8.2	8.8	7.0	8.2
Demand Shaping	9.4	8.7	5.4	5.9	5.7	6.7	8.6	7.2	7.4	8.5
Customer Relationship										
IT Business System	7.5	7.4	6.5	8.6	7.8	8.8	7.3	7.5	6.8	7.4
Web System	8.3	8.5	5.1	9.0	7.0	7.0	8.4	5.4	7.7	8.4
CRM Applications	7.5	7.4	7.8	8.3	7.8	7.9	7.1	7.2	7.4	7.9
Customer Service	7.0	5.3	7.8	8.8	7.6	8.1	7.0	6.9	8.0	7.4
Supply Chain Network										
1. Logistic Network										
Logistic Nodes Design	8.0	7.6	6.8	9.0	7.1	8.2	7.3	7.0	7.0	7.8
Logistic Route Design	8.6	8.2	7.5	9.1	7.0	8.4	7.6	7.5	6.6	8.4
2. Information Network										
Network Technology	8.5	7.4	8.4	9.0	7.6	8.6	7.5	8.0	6.7	7.8
Device Configuration	8.4	7.8	8.6	8.7	7.8	8.4	7.0	7.5	7.0	8.4
Communication Mechanism among Partners	8.8	7.3	8.4	8.9	8.2	8.2	7.2	7.8	7.8	8.0