

MINISTRY OF SCIENCE AND HIGHER EDUCATION
OF THE RUSSIAN FEDERATION

Federal State Budgetary Educational Institution of Higher Education

PENZA STATE UNIVERSITY

Institute of Economics and
Administration
Field of study
Master's degree programme

Department of Economic Theory and
International Relations
38.04.01 Economics
International Economics

GRADUATION THESIS

on

Development of e-commerce in G20 countries

Master's degree student

Zhang Kangxiong

signature, date

Academic adviser

Rozhkova L.V.

signature, date

Compliance supervisor

Vlazneva S.A.

signature, date

Reviewer

Bondarenko V.V.

Doctor of Economic Sciences, Director of the
Penza Branch of the Financial University under
the Government of the Russian Federation

signature, date

The thesis was approved for defence (record of the department meeting dated _____
no. _____)

Head of the Department

Rozhkova L.V.

signature, date

The thesis was defended and marked _____ (record of the State Examination Board
dated _____ no. _____)

Secretary of the SEB

Rasskazova N. V.

signature, date

Penza, 2021

FSBEI HE Penza State University
Institute of Economics and Administration
Department of Economic Theory and International Relations
Field of study 38.04.01 Economics,
Master's degree programme International Economics

APPROVED BY:
Head of the Department
Doctor of Social Sciences,
Associate Professor
Rozhkova L.V.

«_____» _____ 20__

ASSIGNMENT
FOR THE GRADUATION THESIS OF

Master's degree student Zhang Kangxiong, group 19ЭЭМ3(a), full-time mode of study

1 The topic of the graduation thesis: "Development of e-commerce in G20 countries" was approved by the university order

dated «___» _____ 20__ no. _____

2 The deadline for the Master's degree student to complete the graduation thesis is 11.06.2021.

3 The input data for the graduation thesis is the regulatory and legal framework, scientific literature and reference books, and Internet data.

4 The list of issues to be studied includes theory of e-commerce development; measurement and analysis of e-commerce development in G20 countries; present situation of e-commerce development in G20 countries.

5 The list of visuals contains tables and figures.

6 The date of setting the assignment is 29.11.2019.

Academic adviser _____ / Rozhkova L.V. /
(signature) (full name)

The assignment was accepted by Master's degree student _____ / Zhang Kangxiong /
(signature) (full name)

Schedule for completing the graduation thesis

No.	Content of the thesis	Deadline for completion	Due date, signature of the academic adviser
First year of study			
1	Analysis of scientific literature, choice and updating of the research topic	01.09.2019 – 28.11.2019	
2	Framing the scientific concept of research	29.11.2019 – 12.01.2020	
3	Devising the detailed plan of the first chapter and draft of the thesis	13.01.2020 – 23.02.2020	
4	Conducting theoretical research within the first chapter of the thesis	24.02.2020– 30.04.2020	
5	Preparing the first chapter of the thesis	1.05.2020– 30.06.2020	
Second year of study			
6	Collection of statistical data and material for the thesis	01.09.2020 – 30.09.2020	
7	Studying new literature sources within the topic of the thesis	01.10.2020 – 31.10.2020	
8	Conducting research within the first and the second chapters of the thesis	01.11.2020 – 31.12.2020	
9	Preparing the second chapter of the thesis	1.01.2021 – 1.03.2021	
10	Preparing the third chapter of the thesis	2.03.2021 – 2.05.2021	
11	Preparing the introduction and conclusion	3.05.2021 – 16.05.2021	
12	Completing the graduation thesis	17.05.2021 – 30.05.2021	
13	Handing in the thesis for compliance control and antiplagiat	31.05.2021 – 9.06.2021	
14	Getting acquainted with the feedback and review	10.06.2021	
15	Presenting the written thesis	11.06.2021	

Academic adviser _____ / Rozhkova L.V. /
(signature) (full name)

The assignment was accepted by Master's degree student _____ / Zhang Kangxiong /
(signature) (full name)

Summary

The graduation thesis comprises 68 pages, 3 chapters, 2 figures, 18 tables, 62 sources, 1 annexe.

E-COMMERCE, G20 COUNTRIES, INDICATORS SYSTEM, FACTOR ANALYSIS, MEASUREMENT OF E-COMMERCE, ENVIRONMENT OF E-COMMERCE.

The target of research is analysis of development of e-commerce in G20 countries.

The goal of work is to study to build an indicator system of the development level of e-commerce in G20 countries based on the typical e-commerce measurement theory, and calculate and analyze the development e-commerce of each country, so as to put forward concrete and feasible policy suggestions for G20 countries to promote the development of e-commerce

The methodological framework of the paper is formed by the complex of theoretical and practical methods such as literature research method, induction and deduction, empirical analysis, factor analysis.

The results of research include: empirical analysis of G20 countries' e-commerce development index calculation model, and analyzes the development level and problems of G20 countries' e-commerce with data, definition and specific classification of e-commerce applications and e-commerce services, current situation and prospect of e-commerce development in G20 countries are analyzed.

The theoretical relevance of the thesis is established by using the rich resources of the network and the library, reviewing a large number of research literature and materials on e-commerce, and forming the definition, measurement theory and method of e-commerce respectively through careful study and analysis, which provides sufficient theoretical reference for further study and analysis below.

There are four main novelties in this research: make a new definition of e-commerce with induction and deduction, which adopted to research in paper; the establishment of index system of e-commerce development to measure development of e-commerce in G20 countries; measurement of e-commerce development in G20 countries based on indicators system; analysis of current situation in G20 countries from various aspects.

Contents

Introduction	3
Chapter 1 Theory of e-commerce development	6
1.1 The types of e-commerce	6
1.2 Theory of measuring e-commerce development	14
Chapter 2 Measurement and analysis of e-commerce development in G20 countries.	23
2.1 The establishment of index system of e-commerce development	23
2.2 Measurement of e-commerce development in G20 countries	29
Chapter 3 Present situation of e-commerce development in G20 countries	39
3.1 Transaction of e-commerce in G20 countries	39
3.2 Environment of e-commerce in G20 countries	43
3.3 Prospect of e-commerce development in the future in G20 countries	49
Conclusion	56
References	62
Appendix A	68

Introduction

Since the 1990s, e-commerce has developed rapidly in most countries in the world, and it is rapidly changing the operation mode of traditional commerce and the current economic and social structure. On the one hand, e-commerce changes the traditional business model, breaks the boundaries of time and space, and makes the traditional business process electronic and digital. On the other hand, the value of e-commerce is far more than a new way of trade. It will not only change the production, operation and management activities of enterprises, but also affect the consumption pattern of the whole consumer group and even the economic operation structure of the whole society. As an important driving force to promote economic transformation and industrial structure upgrading, e-commerce has attracted more and more people's attention. Governments and enterprises all over the world attach great importance to it, and it has also become a research focus in academic circles. How to accurately define e-commerce, how to measure the development level of e-commerce and understand its impact on economic development, these problems need to be studied and solved.

G20 countries are members of the G20 which is the international economic forum that brings together the world's major economies. These countries account for more than 80 % of world GDP, 75 % of global trade and 60 % of the population of the planet. According to the Estimates of Global E-Commerce 2018 released by the United Nations Conference on Trade and Development (UNCTAD) [50], total global e-commerce sales in 2018 increased by 8 % over 2017 to reach 25.63 trillion dollars, among which e-commerce transactions in G20 countries reached 24.17 trillion dollars, accounting for 94.3 % of total global e-commerce transactions. Due to the different levels of economic development of G20 countries, there are also gaps in the level of e-commerce development. Through the comprehensive measurement of e-commerce development level of G20 countries, this paper understands the differences of e-commerce development level of each country and the actuality of e-commerce development of G20 countries. Meanwhile, it is importantly significant for G20 countries to develop the e-commerce better to promote each country's economic development healthily and continuously.

The research purpose of this paper is to build an indicator system of the development level of e-commerce in G20 countries based on the typical e-commerce measurement theory, and calculate and analyze the development e-commerce of each country, so as to put forward concrete and feasible policy suggestions for G20 countries to promote the development of e-commerce. The paper contains the following main contents:

The introduction firstly elaborates the background and research significance of this paper, then introduces the main content and structure of this paper, and major methods of research and analysis, finally points out the main innovation points of this paper.

The first chapter mainly describes the related theories of e-commerce. Firstly, it briefly introduces the definition, development, classification and application of electronic commerce, and then it narrates the main theory of measuring the development of e-commerce from the international organization aspect and the national aspect.

The second chapter firstly build the evaluation index system of e-commerce development in G20 countries. Then make a empirical analysis to it. The method of factor analysis is used to measure the e-commerce development of G20 countries in 2018, and the final result is comprehensively and deeply analyzed.

The third chapter mainly introduces current situation and trend of e-commerce development in G20 countries. The chapter are divided into two parts, the first part describes scale of e-commerce transaction and environment of e-commerce in G20 countries, and second part is concerning trend of future development of e-commerce in G20 countries.

The conclusion summarizes the research conclusions of this paper, then put forward the shortcomings of this study are analyzed, and the future research directions are prospected.

For the main research content of this paper, we will adopt the following research methods: One is the literature research method. By using the rich resources of the network and the library, we have reviewed and sorted out a large number of research literature and materials on e-commerce, and formed the definition, measurement theory and method of e-commerce respectively through careful study and analysis, which provides sufficient theoretical reference for further study and analysis below.

The second method is induction and deduction. In the definition of e-commerce, the definition of e-commerce in various studies is summarized, and then a definition suitable for this study is given based on specific problems. At the same time, using inductive deductive method, summed up the definition and specific classification of e-commerce applications and e-commerce services.

The third is the empirical analysis. This paper uses factor analysis method to make an empirical analysis of G20 countries' e-commerce development index calculation model, and analyzes the development level and problems of G20 countries' e-commerce with data.

Current academic research on electronic commerce is more of a focus on local or surrounding areas of e-commerce development model, influence factors, the economic impact and so on, it lacks of research on e-commerce in a number of countries, some scholars also carries on the analysis comparison to country under the electronic commerce, but the research scope is small, and mainly quantitative analysis, there is little empirical analysis. In this paper, the research target scope is set as 20 major countries distributed in various continents, and the evaluation system of e-commerce development level of each country is constructed from the aspects of e-commerce infrastructure, e-commerce application, and contribution to GDP. Factor analysis method is used to measure and evaluate the development level of e-commerce of G20 countries. Explore the gap between the development level of e-commerce in different countries, and break through the malformation that e-commerce scholars focus on the narration but less on the demonstration.

There are four main novelties in this paper: make a new definition of e-commerce with induction and deduction, which adopted to research in paper; the establishment of index system of e-commerce development to measure development of e-commerce in G20 countries; measurement of e-commerce development in G20 countries based on indicators system; analysis of current situation in G20 countries from various aspects.

Chapter 1 Theory of e-commerce development

1.1 The types of e-commerce

Governments, international organizations, enterprises, and scholars have given many different definitions based on their status and participation in e-commerce. There are some definitions of e-commerce from international organizations and governments.

Global Information Infrastructure Commission (GIIC) defines e-commerce as an economic activity that uses information technology as a means of communication. People can publicize, purchase and settle products and services with economic value through alternative ways. This mode of transaction is not affected by geographical location, capital and distribution channels. All enterprises, companies, government organizations, ordinary citizens, social groups or organizations can participate in economic activities, including agriculture, forestry, fisheries, industry and service industry.

The United Nations Working Group on the Simplification of International Trade Procedures defines e-commerce as: Use electronic form to carry out business activities, including suppliers, customers, between the government and stakeholders through any form of electronic tools, such as electronic data interchange (EDI), Web technologies, such as E-mail or unstructured business information sharing structure, and management, and complete the management activities, business and consumer activities in various trades.

The definition of electronic commerce in the European Parliament's "Electronic Commerce for Europe Initiative" is that electronic commerce is a business activity carried out by electronic means. It processes and transmits data, including text, sound and images, electronically. It involves many aspects, including electronic trade and services in goods, online data transfer, electronic fund transfer, electronic securities trading, electronic waybills, commercial auctions, collaborative design and engineering, online information, and access to public goods.

The definition of electronic commerce proposed by the International Organization for Standardization (ISO) is a general term for the exchange of information content and requirements between enterprises and between enterprises and consumers. In the Special

Report on Electronic Commerce, WTO believes that electronic commerce is the production, marketing, sales and circulation activities carried out through the telecommunications network. It includes not only Internet-based transactions, but also all business activities that use telecommunications technology to solve problems, reduce costs, increase value and create business opportunities.

Meanwhile, there are some definitions of e-commerce from transnational companies. IBM's statement on e-commerce: e-commerce = IT + Web + business.

That is, he believes that e-commerce is a dynamic business activity developed on the Internet under the background of the combination of Internet and traditional information technology system. At the same time, the IBM company believes that e-commerce is divided into broad e-commerce and narrow e-commerce. In the narrow sense, e-commerce is also called electronic transaction, which is mainly based on the Internet. In the broad sense, e-commerce includes not only electronic transaction, but also all other business activities using the Internet, such as financial accounting, production planning and arrangement, customer contact, material allocation, etc. Therefore, in a broad sense, the definition of IBM emphasizes the commercial application under the network environment (Internet, corporate Intranet, corporate extranet), and it is the application that combines buyers and sellers, manufacturers and their partners.

HP believes that e-commerce generally refers to the realization of electronic and automation of all links from pre-sales service to after-sales support. Its definition includes three concepts: E-business in the broad sense, e-commerce in the narrow sense and e-consumer in the narrow sense: E-consumer refers to commercial trade activities carried out through electronic means, centered on the sale of goods. It includes e-commerce between merchants and e-commerce between merchants and final consumers. E-business mainly refers to various electronic businesses, including not only online commodity trading, but also services to customers and cooperation between business partners. E-consumer can be understood as the use of information technology to study, work, shop, entertainment and a series of other activities.

Intel Corporation's definition of e-commerce: e-commerce = electronic market + electronic transactions + electronic services. Sun believes that e-commerce refers to the use of the Internet for business transactions.

In academic community, Lefebvre Louisa et al. (2005) [36, p. 1444] defined e-commerce as two types when they studied enterprise e-commerce activities and their business processes. In a narrow sense, e-commerce refers to buying and selling through the Internet; in a broad sense, e-commerce refers to the use of the Internet and related technologies to support the organization of all necessary functional activities. Kaefer Frederick et al. [34, p. 530] Proposed 10 components of business benefits, mainly focusing on the business performance obtained by using B2B e-commerce, and measured and analyzed the impact of organizational constraints on the success of B2B e-commerce work. Zhu Kevin(2004) [61, p. 167] explored the complementarity of IT infrastructure and e-commerce capability based on resource assessment of enterprise value. Leonard Lori et al. (2003) [37, p. 315] analyzed the impact of e-commerce on the financial status of enterprises by using the e-commerce survey data of retail enterprises. Ewton Stacey E.(2004) [22, p. 198] adopted Delphi and AHP to measure the impact of e-commerce technology on the whole business process.

The definition of electronic commerce adopted in this paper. Considering the different views from various aspects, the paper believes that although the content of e-commerce is very complex, a concise definition is still needed to facilitate the promotion and statistics of e-commerce. The author summarizes the concept of e-commerce as follows: E-commerce refers to all business activities conducted by both parties through information technology and computer network, including trade in goods, trade in services and trade in intellectual property rights. Namely, the transfer of ownership of material goods (such as clothing, household appliances, etc.) occurs through transactions, or the paid consumption of service goods (such as financial services, network information consulting services, etc.) is realized (provided). In essence, it is the electronization and networking of all links of trade activities, namely the use of electronic information technology and computer networks to solve the problems of expanding publicity, reducing costs, adding value, creating business opportunities, selling products and providing services.

In accordance with different classification standards, e-commerce can be divided into different types.

According to the type of network used, e-commerce can be divided into internet-based e-commerce, EDI based e-commerce, Intranet based e-commerce, and extranet based e-commerce. EDI is to format and standardize commercial documents according to the protocol, and conduct data processing and data exchange between the computer network and the computer network system of the business partner.

EDI includes Internet EDI and non-Internet EDI; Internet-based e-commerce involves a wide range, including the initial email, to the later development of information release, information sharing, purchase or sale of products and services, no doubt does not reflect the powerful functions of the Internet and the rapid development of e-commerce technology; Intranet is the virtual network within an enterprise.

Many large enterprises use the Intranet to establish enterprise resource planning system, fund allocation, production, management as a whole, so as to conduct internal e-commerce activities, not only improve the work efficiency, but also greatly reduce the management cost and various expenses; An enterprise extranet is a network that connects the intranets of enterprises from all walks of life together. The electronic commerce based on this network mainly refers to the business activities that enterprises carry out with goods suppliers, product sellers and other enterprises by using the external network.

According to the transaction objects, e-commerce can be divided into five categories:

- B2B (business-to-business),
- B2C (business-to-consumer),
- B2G (business-to-government),
- C2C (consumer to consumer),
- C2G (consumer to government).

B2B refers to the information exchange and transmission between enterprises through the Internet or other private networks to carry out online business activities. It is the main form of e-commerce, the main driving force of its development, and the main way for enterprises to gain competitive advantage and market position. B2B e-commerce is

characterized by a small number of transactions and a large volume of transactions. It is generally used for large transactions between enterprises and suppliers and sellers.

B2C refers to the business activities in which enterprises provide products and services to consumers through the online retail model. This is the type we are most familiar with. Various virtual businesses appear on the Internet and online stores, such as Tmall mall, Fanke, Amazon online bookstore, Dangdang, etc., all belong to this type. They provide a wide variety of consumer goods and services. B2G refers to the e-commerce activities between government departments and enterprises through the network. For example, the U.S. government publishes the purchase list on the Internet, and enterprises respond to it in an electronic way. The government uses electronic tools to collect taxes from businesses online. The delivery of samples can improve the efficiency, openness and transparency of government offices.

C2C refers to the transaction mode in which consumers provide products or services to other consumers through the Internet. Both buyers and sellers need to attach themselves to the trading platform of Party H, the most common of which is the online stores of Taobao. C2G refers to all kinds of business activities between the government and citizens, such as online distribution of personal taxation and social welfare funds, etc. This kind of e-commerce has not been developed in China, but with the development of the economy in the future, the government will provide people with more perfect online services.

According to the transaction scope, e-commerce can be divided into three categories: Global e-commerce, long-distance domestic e-commerce, local e-commerce. Global e-commerce refers to the global trade activities carried out by both parties through the network; Long-distance domestic e-commerce refers to the transaction activities based on the network within the national standard. Local e-commerce refers to the e-commerce carried out on the basis of the local communication network.

E-commerce originated from the computer electronic data processing (EDP) technology in the 1960s, and has experienced three stages of development.

The first stage: Electronic commerce based on EDI. The period is from the 1960s to the 1990s. Electronic data interchange (EDI) is an electronic transmission method that transmits business documents from one computer to another computer according to a

uniform standard format. EDI gradually began to rise in the United States in the late 1960s, greatly reducing the waste of paper bills and duplication of labor. At the beginning, EDI could only realize the electronic service of a single item, but with the emergence of the third party service, it gradually developed into the electronic service of multiple items, forming a business system based on data standard, computer and local area network. EDI is the primary stage of electronic commerce.

The second stage: Internet-based e-commerce. This stage is after 1990s of 20 century. EDI has a high cost and is generally only used by large enterprises, which limits the promotion of EDI e-commerce applications. In the middle and late 1990s, the rapid popularity of Internet, gradually from scientific research institutions, universities to enterprises and families, its function from a simple information sharing into a popular tool of information dissemination. Electronic information exchange system based on the Internet, low cost, wider coverage, and better realization of information sharing, greatly promoted the popularity of enterprise e-commerce activities - e-commerce, based on the Internet e-commerce gradually formed.

The third stage: E-concept e-commerce. Since 2000, e-commerce has been rapidly popularized around the world by virtue of its advantages in time and space, speed, cost and personalization, and people's understanding of e-commerce has gradually expanded from e-commerce to the height of E-concept. E-commerce can not only be combined with business activities to form e-commerce, but also can be combined with government, military, medical, education and other fields to open up a broader application space, thus forming e-commerce of the concept of E.

E-commerce application refers to the use of electronic means by organizations or individuals to obtain business information and achieve the sale and purchase of goods and services, common concepts include enterprise e-commerce application, personal e-commerce application and government e-commerce application.

The application of e-commerce in enterprises is embodied in constructing a self-owned website or a third-party e-commerce trading platform to carry out business activities. The enterprise's portal website from the initial only provides network access and search engine, to now mainly provides network access, search engine, chat room, electronic

bulletin board, free mailbox, video and audio information, e-commerce, network community, network games, free web space and other more rich business.

Third-party e-commerce trading platform refers to the sum of information network systems that provide trading matchmaking and related services for both or more parties in e-commerce activities. It is established and provided by a third party other than the two parties in the transaction. If this trading platform is established by an enterprise, it is often difficult to distinguish whether an enterprise has an independent website or a website equipped with a third-party platform when counting the number of account websites established by an enterprise. In view of this situation, we regard all platforms equipped by an enterprise as third-party trading platforms.

Personal e-commerce application refers to the business activities carried out by natural persons using e-commerce trading platform. In the B2B and B2C transaction modes, the identity of the network provider is an enterprise, but in the C2C mode, the identity of the network provider is mostly an individual. With the rapid development of C2C e-commerce, and considering the feasibility and statistical significance of the statistical scheme, the behavior of personal online store is classified into the category of enterprise e-commerce, and the definition of personal e-commerce application is defined: refers to the behavior of online shopping by individual consumers using electronic means. Three statistical indicators related to it are the number of Internet users, the number of Internet users shopping online and the total amount of online shopping, while the total amount of online shopping and the online transaction volume of enterprises are repeated data, which can be counted as one of the two.

Government e-commerce application generally refers to e - government, the first to promote and carry out e-government is the United States government. The OECD points out that the application of new information and communication technologies to government functions can change the way governments operate and are structured. The World Bank defines e-government as: e-government refers to the use of information and communication technology by government agencies to improve the relationship between government and enterprises, the public and other government agencies, and achieve business-efficient government management.

According to the transaction and service objects, e-government can be divided into three modes: G2B (governmental activities between the government and enterprises), G2C (governmental activities between the government and citizens) and G2G (governmental activities between the government and the government).

Advantages of time and space. Traditional business is limited by fixed sales time and place. For example, consumers have to go shopping in shopping malls during the business hours of shopping malls, while e-commerce activities are mainly carried out on the Internet. Its activity space expands with the expansion of the network system and is no longer restricted by the region. The transaction subject of e-commerce can carry out business activities at any time, anywhere and at will through the computer and network. Therefore, e-commerce has a brand-new space-time advantage over traditional commerce.

Efficiency advantage. E-commerce has great speed and efficiency advantages. E-commerce makes the enterprise and cooperation between enterprises is more convenient, more open and transparent information, to save the cost, a lot of time and greatly improve the speed of information transmission, the speed of product from production to distribution, so as to improve the efficiency of the whole business. Through e-commerce, enterprises can provide consumers with more convenient services. Consumers can easily obtain product information just by browsing the web, which breaks through the limitation of time and space of traditional business. Its speed advantage is not comparable to traditional business.

Cost advantage: First, online stores do not need to exist too much physical infrastructure, such as office space, sales stores, etc., which reduces the investment cost of such infrastructure to a certain extent. Secondly, the application of enterprise Intranet and Internet in e-commerce makes "paperless trade" more and more become a reality, which also saves the cost of document processing and communication. Thirdly, compared with the traditional way of trade, e-commerce reduces a large number of intermediate links, so that buyers and sellers can conduct business activities directly through the network, which reduces the transaction cost and management cost.

To take a simple example, if we directly buy the iPhone 6 from the official website or Apple stores, the price is only 5288 yuan, but if we buy the iPhone 6 from the dealer stores, the price will be increased to 5688 yuan or higher, and the extra 400 yuan in the

middle is the "intermediate link" cost. Fourth, the supplier can determine the production and purchase plan of a product according to the market demand anytime and anywhere, and can adjust it at any time, so as to reduce the inventory and also reduce the cost of storage and operation.

Personalized Advantages. E-commerce has created new conditions for consumers to provide personalized services. Consumers can evaluate their satisfaction with goods and services more conveniently through the Internet and give feedback to enterprises. Enterprises can also analyze consumers' needs and preferences by tracking consumers' shopping habits, so as to have a more thorough understanding of consumers' internal requirements, and then provide better personalized services. For example, when buying Gree air conditioners online, consumers can make the color and function of air conditioners according to their own requirements. By providing personalized products and services, enterprises can improve the loyalty and satisfaction of consumers and increase their competitiveness. Personalized products and services are gradually becoming the future trend of e-commerce development.

1.2 Theory of measuring e-commerce development

As a new and rapidly developing economic activity, e-commerce has attracted more and more people's attention. The main concerns include the development and application of e-commerce, the degree of impact on social economy and how to develop e-commerce. Therefore, in order to solve these problems, the government, research institutions and academic circles have studied the measurement of e-commerce from different angles. On the whole, domestic and foreign research on the statistical measure of e-commerce is mainly divided into the official, research institutions, professional consulting companies and academic research, in addition to mutual cooperation between the research.

In the middle and late 1990s, some developed countries and international organizations began to conduct research on e-commerce statistics at the earliest, such as OECD, APEC, EU, the United States and the United Kingdom. This section gives a basic introduction to the typical and influential statistical measurement theories of e-commerce.

E-commerce measurement theory of international organizations. Organization for Economic Co-operation and Development (OECD). In July 1997, the OECD established the Committee for Information, Computer and Communication Policy (ICCP) Statistical Expert Group, and held the first meeting of information social indicators, the purpose is to establish a set of definitions and methods, to promote the information society, information economy and electronic commerce all aspects of the preparation of internationally comparable data. In July 1998, ICCP held the second meeting, and set up a working group on information society index (hereinafter referred to as WPIIS), the main work is to build internationally comparable indicators and related statistics, the information society, the working group is committed to gauge the ICT infrastructure, services, content and index system, especially the electronic commerce applications. The OECD has contributed significantly to the definition of e-business, the template questionnaire, the prioritization of indicators and the collection of data [2, p. 65].

In April 2000, the WPIIS proposed two definitions of e-business transactions, namely e-business in the broad sense and e-business in the narrow sense, which were endorsed by the OECD. Based on this definition, OECD puts forward a life cycle model to measure the development of e-commerce, which adopts the S-shaped curve of innovation diffusion, that is, the statistics of e-commerce development should be divided into three modules from the beginning to the maturity. The first is the electronic commerce preparation module, that is to support the electronic commerce development of the necessary technology, infrastructure.

Secondly, it is the use intensity module of e-commerce, that is, the scale and application degree of e-commerce development, including enterprise e-commerce application, personal application, e-commerce transaction scale, etc. Thirdly, it is the influence and function module of e-commerce, that is, to discover the added value and multiplier effect of e-commerce, and to evaluate the special contribution of e-commerce in improving the efficiency of economic and social activities. Due to the difficulty of measurement, advanced line first two dimensions (readiness and intensity) indicators of measurement. Considering the differences in economic development level and data collection ability of different countries, this paper gives suggestions on the priority of e-commerce measurement on the basis of international comparison.

Table 1.1 – The priority degree of e-commerce dimensions and departments

Content	Priority measures	The sub-priority aspects of measurement
Indicators	E-commerce readiness and application	Its impact on society and economy
Department	The business sector, the household sector	The government department
Qualitative or quantitative	Mainly qualitative	Many quantitative indicators
Transaction or process	E-commerce transaction	The business process of e-commerce

Table 1.2 – Priority measurement indicators of e-commerce

Readiness index	Application index
Computer availability	The degree to which a computer is used
Access to WWW	site usage
Internet access	The extent of Internet use
ICT technology	The amount of sales by using the Internet
Barriers to the adoption of ICT	the amount of money paid online in e-commerce
Recognize the benefits of ICT applications	The type of products purchased/sold on the Internet
	A place to buy products on the Internet

European Union (EU). As an influential regional economic cooperation organization in the world, Europe is a political entity and an economic entity, and its member states are closely connected. In order to achieve the goal of making Europe the most competitive economy by 2010, the European Council launched the Electronic Europe Action Plan 2002 in 2000. The plan covers three areas: building a cheaper, safer and faster Internet; Investing more in people and skills; Promote the widespread use of the Internet. The EU member states jointly studied and developed a series of 23 indicators, which became an official document, which was adopted by the European Council in 2000. Using these 23 indicators, the Commission collects relevant data for 15 Member States and 18 countries (Iceland, Norway and Switzerland) and assesses the implementation of the Data Assessment Programme. The 2002 electronic European assessment report provides a comprehensive

overview of the results of indicator development and compares policy progress in light of market developments [42, p. 72].

In 2002, the Council of Europe launched the E-Europe Action Plan 2005, which shifted its focus to the efficient use and availability of the Internet, in an attempt to develop modern public services and a dynamic e-business environment by providing broad broadband access and secure information infrastructure at competitive prices. The plan aims to bring the benefits of the information society to all Europeans.

To that end, the European Union conducted an online survey of 20 public services, 12 of which are available to citizens and eight to businesses. The survey aims to enable participating countries to analyse the development of online public services and to compare them from country to country. In 2005, in order to promote the development of the digital economy, the European Commission launched the five-year strategy i2010 for 2006-2010, and its benchmark framework is shown in table 1.3 [21, p. 32].

Table 1.3 – I2010 topics and their contents

Priority policy	Themes	Content
European Information Space	Development of Broadband	Broadband coverage
		Broadband order
		Speed and price
		Multiple platforms to access the Internet
	Advanced services	Availability of advanced online services
		Use of advanced online services
	Security	Security in the use of ICT
	Impact	Development of the ICT sector
Monitoring research and business innovation	Investment in ICT research	Percentage of ICT research funding
	ICT adoption for business	Connectivity and ICT adoption
	The impact of ICT adoption for business	ICT investment and consumption by businesses, households and governments
		Impact on productivity
		Career and Skills
Monitoring the connotation of the information society, public services and quality of life	Connotation of information society	Household connectivity was calculated and two different indices were used
		e-accessibility
		Measure number culture
	The public service	e-government

Asia-Pacific Economic Cooperation(APEC). APEC was one of the first regional forums to put e-commerce statistics high on the agenda. As its member countries are in different stages of economic development, each country faces different challenges in the development of e-commerce. APEC has formulated the Guidelines for Assessment of E-commerce Readiness [1], with the purpose of helping member countries to measure and understand their respective e-commerce readiness, so as to form e-commerce development plans in line with their national conditions and promote the rapid and healthy development of e-commerce in each country.

The guidelines provide a system of indicators to measure the state of e-business readiness, including six broad categories of indicators: basic architecture and technology, necessary service connectivity, skills and human resources, the state of the digital economy, the current level and type of Internet use and promotion activities, each of which contains a series of specific issues and indicators. The guide adopts qualitative assessment method, and the assessment results are only the development level and changing trend of countries or regions, excluding comparison of e-commerce readiness between countries or regions. Different from the assessment framework proposed by OECD, APEC is mainly an assessment of e-business readiness, which is mainly related to the stage of e-business development and assessment needs of APEC member countries.

E-commerce measurement theory of developed countries. The United States is one of the first countries in the world to carry out e-commerce activities and e-commerce statistics, and its e-commerce application is also ahead of many countries. Its lead agency in charge of e-commerce statistics is the U.S. Census Bureau.

In 1999, the U.S. Census Bureau began to collect data on e-commerce sales for the first time, adding two survey questions about e-commerce sales (whether online sales are conducted and how much is the total online sales) to the existing monthly sample survey of retail sales, and finally publishing quarterly estimates of e-commerce retail sales. The Census Bureau then obtained 1999 data on e-commerce by adding questions about e-commerce sales to its annual 1999 sample of industries, including retail, wholesale and some service industries under the North American Industrial Classification System. The specific survey is shown in table 1.4.

Table 1.4 – Annual statistical survey of US e-commerce

Name	Frequency	Method	Research purpose	Investigation way
Annual manufacturing sample survey	once a year	stratified sampling survey	Enterprise production and sales, e-commerce activities and e-commerce processes, etc	Supplementary questionnaires were added
Annual trade sample survey	once a year	stratified sampling survey	Sales volume of wholesale enterprises, e-commerce sales volume and other related economic activities	The existing questionnaire included questions about e-commerce
Annual sample survey of garment industry	once a year	stratified sampling survey	The annual income, expenditure and e-commerce income of service enterprises	The existing questionnaire included questions about e-commerce
Annual retail trade sample survey	once a year	stratified sampling survey	Sales, e-commerce sales and other retail business indicators	The existing questionnaire included questions about e-commerce

For the manufacturing sector, the Census Bureau not only gets data on e-commerce sales in its annual sample survey, but also captures the entire business process of e-commerce activities of manufacturing firms. To this end, the Census Bureau has designed a supplementary questionnaire for the collection of manufacturing e-commerce data. In summary, according to the characteristics of different sectors of economy and e-commerce activities, the US Census Bureau uses different survey indicators to measure e-commerce activities [2, p. 56].

United Kingdom. The Office for National Statistics of the United Kingdom uses the life cycle model theory of e-commerce development proposed by the OECD to measure the e-commerce in the United Kingdom, and analyzes the preparation, use and impact of e-commerce on social economy in detail. According to the specific measure of electronic commerce, the office for national statistics released some related files, the file is mainly summarized the office for national statistics (ONS), electronic envoy office (OEE) and the trade and industry (DTI) research, puts forward the research framework, measurement

method, variable, and its source, data quality, and other needs to be done, This paper constructs a measurement system containing 80 indicators, carries out an investigation on 9 economic powers, and gives the survey results. However, due to the difficulty of the survey and data sources, the survey only used 49 indicators, covering all aspects of e-commerce preparation, use and influence of the market, individuals, enterprises and the government.

"China E-commerce Development Index Report" is an authoritative research report on the measurement of e-commerce in China. The report is compiled based on objective and reliable data and released regularly every year. The concept of China E-commerce Development Index was put forward in the report. The index is based on presenting the general situation, characteristics, advantages and potential of e-commerce development in different provinces and cities in China, aiming to provide a reliable decision-making basis for promoting e-commerce development to drive economic development [14].

"China E-commerce Development Index Report" comprehensively examines the development of e-commerce from four aspects of development scale, development trend, application and industrial support. Under the overall e-commerce development index, there are four secondary sub-indexes, namely scale index, growth index, penetration index and support index. The key point of the scale index is to evaluate the current structure of domestic electricity in the commercial market, including the number of enterprises in each province, the number of online shoppers, transaction scale and so on in the national e-commerce market. The growth index is mainly aimed at the assessment of the development ability of e-commerce in each province, which can predict the growth trend and development potential of e-commerce, including the growth rate of the number of e-commerce enterprises, transaction size, online shopping number and so on.

The penetration index focuses on measuring the penetration of e-commerce within the province, including the number of e-commerce enterprises, the proportion of online shopping and transaction volume in the province. The supporting index examines the supporting effects of network infrastructure environment, logistics environment and human capital on the development of e-commerce.

Table 1.5 – Index system of China's e-commerce development

First-level indicator	Second-level indicator
The index of the scale	Enterprises with e-commerce activities in various provinces account for the proportion of enterprises with e-commerce activities in China
	The e-commerce transaction volume of each province accounts for the proportion of the national e-commerce transaction volume
	The online retail sales of each province accounted for the proportion of the national online retail sales
	The number of online shoppers in each province accounted for the proportion of the national online shoppers
The Growth index	The growth rate of businesses with e-commerce activity
	Growth rate of e-commerce transaction volume
	Growth rate of online retail sales
	Growth rate of online shoppers
The Penetration index	The proportion of enterprises with e-commerce activities in each province in the total number of enterprises in the province
	The number of online shoppers in each province accounted for the proportion of the number of Internet users in the province
	The online retail sales of each province accounted for the proportion of the social retail sales of consumer goods
The Support index	Based on the environment
	Logistics environment

The above 6 representative e-commerce measurement index systems from views of international organizations and countries have their own characteristics and limitations in terms of application scope or index selection, so they cannot be copied into the index system for the evaluation of e-commerce development in G20 countries, but they have certain theoretical reference significance for the selection of indicators in this paper. There are several implications as follows:

In terms of the hierarchy of the index system, specific theories or typical studies in the field of e-commerce are taken as the guidance to select the research perspectives. The selection of the hierarchy indicators should highlight the classification characteristics and

priorities of different dimensions, and adhere to the scientific and systematic principles of accurate hierarchy to reflect the different levels of e-commerce development.

In terms of the selection of specific indicators, the availability of data from G20 countries should be taken into consideration comprehensively, and the source of index data should be reliable at the same time. By fully consulting and searching the index data of various countries, we should pay attention to whether their statistical caliber is uniform, and try our best to obtain scientific and reasonable index data, so as to ensure the comparability of empirical results.

In terms of evaluation methods, quantitative evaluation methods should be selected as much as possible. With objective data as the support, statistical means should be used to analyze and process the data to form a quantitative development index, which can objectively and truly measure the development level of e-commerce in G20 countries.

Chapter 2 Measurement and analysis of e-commerce development in G20 countries

2.1 The establishment of index system of e-commerce development

Build a scientific and reasonable evaluation index system and measure model is the premise of accurate evaluation work, in order to accurately quantify the G20 countries e-commerce development level, find the deep-seated problems existing in the development process, this chapter before the analysis of international organizations (country) of several typical measuring system for the theory basis for electronic commerce development, and on the basis of the design principle of index system, This paper constructs a measurement index system of E-commerce Development Index of G20 countries from three aspects of readiness, application and influence, and determines an appropriate and effective measurement system to lay a foundation for empirical analysis.

The principle of index system construction. The index system is composed of multiple indexes that represent the characteristics of the evaluation object, and each index shows different characteristics of the evaluation object. Therefore, only by integrating multiple indexes can the research object be fully measured. Meanwhile, the scientific rationality of the measurement index system determines the objective authenticity of the measurement results. Therefore, the index system in this paper follows the following construction principles [60, p. 38]:

Systemic principle. Systemic principle requirements from the perspective of system theory, considering the electronic commerce development, e-commerce industry is regarded as the electronic commerce itself and the external environment of the social system, the index should not only have strong logical relationship between, also want to independent, starting from the development of electronic commerce each link, subsystem points dimension comprehensive consideration all the indicators, The final formation of a top-down, layers of in-depth unified system.

Scientific principle. Index system of the design and selection of index entries must be based on principles of scientific nature, can objectively reflect the e-commerce industry law

of development and various support conditions, as far as possible fully reflect the real relationship between indicators, establish e-commerce infrastructure, application level, development environment and other aspects of the evaluation index system, It can objectively and practically reflect the relationship and development of various indicators of electronic commerce.

Representativeness principle. When determining index items, to ensure that its has some typical representative, can maximum limit reflect the characteristics of the development of electronic commerce, do not blindly pursue index number, it is to be kept in a reasonable scope, and to be a reliable source of statistics is based, provide reliable data support for the empirical analysis, to facilitate subsequent data calculation and scientific analysis.

Operational principles. On the one hand, the index system should be reasonably structured and well-organized, and the index must have a clear definition and be easy to understand and collect data. On the other hand, the modularization of the index system ensures its stability, and the change of the local index does not affect the overall measure, which is convenient for the subsequent revision and improvement of the index system.

Principle of comparability. On the one hand, it refers to the internal comparability, the comparability among all kinds of indicators reflected in the index system, and the time and space comparability of the same indicator. On the other hand, it refers to external comparability, which reflects that the index system constructed has the characteristics of standardization, has a wide range of applicability, and can be used for international or regional comparison [48, p. 27].

Establishment of evaluation index system. In this paper, the establishment of the index system of e-commerce development measurement is based on the e-commerce life cycle model proposed by OECD. In other words, the index system is constructed from the three dimensions of e-commerce readiness, application and influence. Developed countries generally take the OECD index framework as the standard to design their own index system, which shows that it is very scientific and operable. So this paper preliminarily takes the first-level index of establishing the e-commerce development measurement index system from

three levels of readiness, application and influence, including 7 second-level indicators and 23 third-level indicators in total, as shown in table 2.1.

Table 2.1 – Evaluation Index system of e-commerce development [48, p. 28]

First-level indicators	Second-level indicators	Third-level indicators
Readiness	User readiness	Fixed-telephone subscriptions
		Fixed broadband subscriptions s
		International bandwidth(in Mbit/s)
		Mobile-cellular subscriptions
		Mobile-broadband subscriptions
		Computer penetration rate
	The logistics level	Logistics performance index
		Quality of port infrastructure
		Air cargo volume
Application	User usage	Online shopping penetration rate
		Percentage of businesses that have a website
		Proportion of online sales enterprises
	Deal size	E-commerce transaction
		Online retail sales
	Growth rate of transaction	Growth rate of e-commerce transaction
		Growth rate of online retail sales
Impact	Impact on the economy	The percentage of e-commerce transaction in GDP
		The percentage of Online retail in total retail sales of consumer goods
	Development potential	Gross domestic spending on R&D
		Information society index
		GDP per capita (current US \$)
		Input degree of informatization
		Number of patent applications
Total	7	23

On the basis of reviewing relevant literature and following the principle of index design, this paper aims to design a reasonable, objective and comprehensive evaluation

index system for e-commerce, so as to accurately measure the development index and dynamic trend of e-commerce in G20 countries.

At present, but there is no denying that part of the G20 countries started development of e-commerce is still in the bud, in view of the electronic commerce the statistics of the planning department also has not yet been established, statistical system and statistical data is not yet perfect, a lot of statistical data is difficult to obtain, while the index system can measure the electronic commerce development level in an all-round way, but there are still lack of operation. At the same time, the statistical systems of different countries have certain differences, which increases the difficulty of data acquisition.

In order to ensure the comparability of the empirical analysis and comprehensively investigate the development level of e-commerce in G20 countries, we draw on the practice of OECD, UK and other countries in the study of e-commerce measurement. Under the premise of keeping the measurement target unchanged, we can make appropriate adjustments to the indicators in practice. Therefore, some indicators were appropriately revised in this measurement to meet the data requirements. The basic index layer was revised from 23 to 14. The adjusted index system is shown in table 2.2.

Description of evaluation index system. Readiness of e-commerce development. Readiness index reflects the readiness of e-commerce development, including the construction of network infrastructure and logistics system. Electronic commerce is developed based on the network, which provides online channels for e-commerce activities, and network infrastructure promotes the development of business trade by reducing the cost of information searching and communication.

Therefore, to measure the development level of a country's e-commerce, it is necessary to examine the construction level of network infrastructure. The network infrastructure of e-commerce development mainly includes the construction of ICT access and ICT use. Specific indicators include fixed-telephone subscriptions, fixed broadband subscriptions, international bandwidth and computer penetration rate.

Logistics system is the transport channel of e-commerce transactions, and the construction of logistics system provides an important support for the development of e-commerce. Different from the traditional logistics industry, e-commerce logistics industry

is a brand new service operation mode which connects the e-commerce platform with the traditional logistics module.

Table 2.2 – Revised index system e-commerce development in G20 countries [30, p. 100]

First-level indicators	Second-level indicators	Third-level indicators	Number
Readiness	Network infrastructure	Fixed-telephone subscriptions	X ₁
		Fixed broadband subscriptions	X ₂
		International bandwidth(in Mbit/s)	X ₃
		Computer penetration rate	X ₄
	The logistics level	Logistics performance index	X ₅
Application	User usage	Online shopping penetration rate	X ₆
	Transaction size	E-commerce transaction	X ₇
		Online retail sales	X ₈
	Growth rate of deal	Growth rate of e-commerce transaction	X ₉
		Growth rate of online retail sales	X ₁₀
Impact	Impact on the economy	The percentage of e-commerce transaction in GDP	X ₁₁
	Development potential	Gross domestic spending on R&D	X ₁₂
		Information society index	X ₁₃
		GDP per capita (current US \$)	X ₁₄

E-commerce transaction activities show the characteristics of universality of space, which also determines the expansion of the logistics and transportation scope, which also shows the important role of a perfect transportation network and logistics system in improving the logistics and transportation service capacity of e-commerce. Therefore, improving logistics operation efficiency and service capacity plays an important role in the development of a country's e-commerce. This paper directly uses the World Bank statistics to measure the comprehensive development level of logistics index. The index is a weighted average of six indicators: The ease of arranging competitively priced freight, the efficiency of customs clearance procedures, the ability and quality of logistics services, the frequency with which goods arrive at the consignee within a predetermined or expected time, the quality of trade and transport-related infrastructure, the ability to track and trace cargo

Specific indicators include the quality of port infrastructure, the quality and capacity of logistics services and air cargo volume.

Application degree is mainly used to measure the application of e-commerce in a country or region. It can directly reflect the application level of e-commerce and is one of the most direct indicators to reflect the development level of e-commerce. This paper mainly evaluates the application degree of e-commerce from three aspects, including user usage degree, transaction size and transaction growth rate. In recent years, with the development and application of ICT, the mobile phone shopping industry has developed rapidly. The development of e-commerce has also spawned a large number of service groups relying on e-commerce, such as online payment.

The transaction scale mainly investigates the transaction situation of two major trading markets of e-commerce, including the e-commerce market of a country and the online retail market. The total transaction amount of these two markets basically covers the transaction situation of the entire e-commerce market, reflecting the development scale of e-commerce. The growth rate of transactions is measured by the growth rate of e-commerce transactions and the growth rate of online retail respectively [23, p. 40].

The impact, namely the electronic commerce on the impact of national economic and social development. The index contains two secondary indicators, namely the impact on the economy and the development potential. The influence of e-commerce on the national economy reflects the position and role of e-commerce in the national economy, as well as its promoting role in operation, management, consumption and circulation. Due to the difficulty of data collection, eliminate some smaller correlation index, this paper use e-commerce transactions as a share of GDP to roughly measure of the impact of electronic commerce on one country's economy. The development potential of e-commerce is a long-term indicator of the growth of e-commerce, which can reflect the growth trend of e-commerce development. The index mainly examines the future development space and capacity of e-commerce in G20 countries, including the proportion of R&D expenditure in GDP, GDP per capita and information society index.

2.2 Measurement of E-commerce Development in G20 Countries

The methods selected by international scholars to measure the development level of e-commerce mainly include Delphi, AHP, factor analysis, linear regression and so on. Considering that the two measurement methods of Delphi and AHP are subjective relatively, and the regression analysis method is mainly aimed at a few variables. The existing studies have shown the effectiveness of factor analysis method, this paper selects factor analysis method to measure and evaluate the development level of e-commerce in G20 countries.

Factor analysis method was proposed by the British psychologist C.E. Spearman in 1904. It is to reduce a large number of variables or sample indicators to a few common factors, and classify the variables according to different factors, and feedback most of the original data with a small number of factors. Its analysis idea is to classify each variable according to the strength of the correlation. In order to facilitate the high correlation of variables within each group, a comprehensive variable is usually used to represent a group of variables, and is called a common factor.

First use $F_1, F_2, \dots, F_n$ stands for the common factor, $X_1, X_2, \dots, X_p$ represents the observable random variable, let $X=(X_1, X_2, \dots, X_p)$ is a random variable of $p \times 1$ dimension, $F=(F_1, F_2, \dots, F_n)$ is a normalized common factor vector of $m \times 1$ dimension, and $m < p$, $\varepsilon=(\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p)$ is the vector of a special factor of $p \times 1$, independent of and unrelated to F , and the mean value is 0. The covariance matrix is a diagonal matrix, so as to ensure the independence of each ε_i with different variances. Under the above assumption, the matrix form of factor analysis is [30, p. 102]:

$$\left\{ \begin{array}{l} X = A * F + \varepsilon \text{ or} \\ X_1 = a_{11}F_1 + a_{12}F_2 + \dots + a_{1m}F_m + \varepsilon_1 \\ X_2 = a_{21}F_1 + a_{22}F_2 + \dots + a_{2m}F_m + \varepsilon_2 \\ \vdots \\ X_p = a_{p1}F_1 + a_{p2}F_2 + \dots + a_{pm}F_m + \varepsilon_p \end{array} \right.$$

Where, $A=(a_{ij})(p \times m)$ is called the factor load matrix, a_{ij} reflects the load of the i th variable X_i on the j th factor F_j , and the factor load a_{ij} represents the correlation coefficient

between the i th variable and the j th common factor, that is, the proportion of X_i dependence on F_j .

The contribution rate of all common factors to the total variance is measured by the sum of the squares of the elements in the i th row in matrix A , namely h_i^2 . It is denoted as $\text{var}(\varepsilon_i) = \sigma_i^2$, so $\text{var}(x_i) = h_i^2 + \sigma_i^2$, which indicates the complementary relationship between the common degree and the residual variance σ_i^2 , and also indicates that the variance of the variable X_i is composed of two parts. The former part is that h_i^2 represents the contribution rate of the common factor to the total variance. It is generally believed that the higher the value of h_i^2 is, the more representative and explanatory the common factor is. The latter part is the variance generated by some specific variables. The sum of squares of each column element in matrix A is denoted as g_j^2 to represent the contribution of the common factor F_j to X , that is, the sum of variance contribution capabilities provided by the common factor F_j to all variables, which is an indicator reflecting the importance degree of the common factor F_j .

Process and results of measurement. Source of data. G20 countries are separately Argentina, Australia, Brazil, Canada, China, France, Germany, Japan, India, Indonesia, Italy, Mexico, Russia, South Africa, Saudi Arabia, South Korea, Turkey, the United Kingdom, the United States, and the European Union. Because the European is a special economy which contains many countries, so this paper eliminated the European in the following empirical analysis. Thus the paper eventually selected 19 countries in total in data analysis [48, p. 30].

In this paper, we selected the data of each country in 2018 to measuring the e-commerce development. The data is from national statistical bureau of G20 countries. At the same time, considering some datum which are not easily obtained, it will be used data of some international organizations, such as Organization for Economic Cooperation and Development (OECD), International Telecommunication Union (ITU), European Union.

Standardized processing of data. Due to the degree of inconsistency between each index in terms of magnitude and dimension, it is necessary to conduct dimensionless processing on the data of the 14 indexes to eliminate the influence caused by the difference in dimension and magnitude of the indexes. The dimensionless processing of indicators is

also known as the standardization processing of indicators, which is a method to eliminate the difference of magnitude of original data by using some mathematical ideas and methods. In this paper, the mean method is adopted for the data standardization processing, and the matrix formed by the indexes processed by the mean method can more accurately reflect the difference of each index in the initial data. It also includes the difference information of each index's influence degree. The dimensionless quantitative calculation formula is as follows:

$$x_1 = X_i / \bar{X}$$

In the formula, x_1 is the dimensionless value of the index, and X_i and $\bar{X}$ are the statistical value of the index and the average value of each province of an index respectively. The standardized data are shown in Appendix table A.1.

Factor analysis. Factor analysis is a process of reconstructing a few representative factor variables from a large number of original variables. The potential requirement is that there should be strong correlation between the original variables. The first step is to verify whether the original data is suitable for factor analysis. KMO and Bartlett spherical tests were used in this paper. KMO statistics test the partial correlation of variables. The stronger the partial correlation, the more suitable it is for factor analysis. KMO test coefficient more than 0.5, it is considered that the factor test can be done. The original hypothesis of Bartlett's spherical test is that the correlation coefficient matrix is the identity matrix. Rejecting the null hypothesis indicates that factor analysis can be performed.

In this paper, SPSS-24 software, a effective tool to make analysis and management of data, was used to conduct factor analysis on the development of e-commerce in G20 countries, and KMO and Bartlett's reliability tests were obtained from the data, as shown in table 2.3.

Table 2.3 – K MO and Bartlett's reliability tests

KMO and Bartlett's tests		
KMO sampling fitness measure.		0.612
Bartlett's sphericity test	Approximates chi-square	267.570
	Degrees of freedom	91
	Significant	0.000

As can be seen from table 2.3, the significance value is 0, so the null hypothesis that the correlation coefficient is 0 (variables are independent of each other) is rejected, indicating that there is correlation between variables. Secondly, the KMO value is 0.612, greater than 0.5, indicating that each indicator data is suitable for factor analysis [60, p. 38].

A common factor was extracted for 14 e-commerce indicators of G20 countries in 2018. According to the explanation of the total variance. The cumulative contribution rate of the three selected common factors is 81.113 %. These three common factors contain most of the original information of the evaluation index system, and the contribution rates of each factor after rotation are 33.98 %, 28.968 % and 18.166 % respectively. Therefore, it can be concluded that the first common factor has the strongest explanatory power to the variable. The explanatory power of the second and third common factors came next.

After extracting common factors, the initial factor model and factor loading matrix obtained are often complex, which is not conducive to the interpretation of factors. By means of factor rotation, the value of each element in the load matrix is differentiated towards 0 and 1, and the load of each variable on the factor is more obvious, which is conducive to the explanation of each common factor.

In the rotation component matrix table, the factor load of the first common factor(F_1) is relatively large on 7 variables, including computer penetration rate, information society index, online shopping penetration rate, Growth rate of e-commerce transaction, fixed broadband subscriptions, GDP per capita and fixed-telephone subscriptions.

The second common factor(F_2) in the growth rate of the online retail sales, gross domestic spending on R&D, logistics performance index and the percentage of e-commerce transaction in GDP have relatively large factor loads . The third common factor(F_3) has relatively large factor loads on 3 variables, they are separately international bandwidth, online retail sales and e-commerce transactions.

Therefore, we can find apparently that the first common factor(F_1) mainly reflect the readiness of e-commerce, it can be named readiness factor for e-commerce; The second common factor(F_2) reflects the effect of electronic commerce, it can be named as impact factor of e-commerce; The third common factor(F_3) reflects the application situation of electronic commerce, it can be named the application factor of e-commerce.

Table 2.4 – Interpreted total variance

Total variance interpretation									
	Initial eigenvalue			The sum of squares of the extraction load			Sum of the squares of the rotating loads		
	Total	Percentage of variance	Cumulative %	Total	Percentage of variance	Cumulative %	Total	Percentage of variance	Cumulative %
1	7.49	53.496	53.496	7.49	53.496	53.496	4.757	33.98	33.98
2	2.433	17.376	70.872	2.433	17.376	70.872	4.055	28.968	62.947
3	1.434	10.241	81.113	1.434	10.241	81.113	2.543	18.166	81.113
4	0.739	5.279	86.392						
5	0.606	4.33	90.722						
6	0.413	2.95	93.672						
7	0.351	2.509	96.182						
8	0.213	1.524	97.705						
9	0.115	0.823	98.528						
10	0.078	0.559	99.088						
11	0.068	0.486	99.573						
12	0.037	0.266	99.84						
13	0.019	0.137	99.977						
14	0.003	0.023	100						

Table 2.5 – The rotated component matrix

The component matrix after rotation			
Indicators	Component		
	1	2	3
Computer penetration rate	0.905	0.244	0.209
Information society index	0.898	0.31	0.053
Online shopping penetration rate (%)	0.874	0.283	-0.025
Fixed broadband subscriptions	0.774	0.547	0.123
Growth rate of online retail sales	-0.708	0.171	-0.026
GDP per capita (current US\$)	0.699	0.553	0.143
Fixed-telephone subscriptions	0.697	0.653	-0.08
Gross domestic spending on R&D	0.161	0.852	0.214
Growth rate of e-commerce transaction	-0.032	-0.798	-0.107
Logistics performance index	0.357	0.789	0.225
The percentage of e-commerce transaction in GDP	0.336	0.785	0.269
International bandwidth;in Mbit/s	0.084	0.058	0.905
Online retail sales	-0.024	0.156	0.881
E-commerce transaction	0.142	0.358	0.823
Rotation method: Kaiser normalized maximum variance method.			
The rotations converge after 5 iterations.			

According to the component score coefficient matrix, we can get the score expression of each common factor.

Table 2.6 – Component score coefficient matrix

Component score coefficient matrix				
Number	Indicators	Component		
		1	2	3
X ₁	Fixed-telephone subscriptions	0.085	0.147	-0.132
X ₂	Fixed broadband subscriptions	0.137	0.051	-0.018
X ₃	International bandwidth; in Mbit/s	0.028	-0.137	0.417
X ₄	Computer penetration rate	0.249	-0.125	0.072
X ₅	Logistics performance index	-0.053	0.234	-0.015
X ₆	Online shopping penetration rate	0.226	-0.064	-0.045
X ₇	E-commerce transaction	-0.02	-0.004	0.332
X ₈	Online retail sales	-0.03	-0.066	0.389
X ₉	Growth rate of e-commerce transaction	0.164	-0.328	0.076
X ₁₀	Growth rate of online retail sales	-0.273	0.236	-0.049
X ₁₁	The percentage of e-commerce transaction in GDP	-0.058	0.23	0.007
X ₁₂	Gross domestic spending on R&D	-0.132	0.307	-0.033
X ₁₃	Information society index	0.23	-0.07	-0.012
X ₁₄	GDP per capita (current US\$)	0.111	0.067	-0.011
Extraction method: principal component analysis.				
Rotation method: Kaiser normalized maximum variance method.				
Component score.				

The factor score expression of the three common factors can be obtained through the factor score coefficient matrix, and its calculation formula is as follows:

$$\begin{aligned}
 F_1 &= 0.085x_1 + 0.137x_2 + 0.028x_3 + 0.249x_4 - 0.053x_5 + 0.226x_6 - 0.02x_7 - 0.03x_8 \\
 &\quad + 0.164x_9 - 0.273x_{10} - 0.058x_{11} - 0.132x_{12} + 0.23x_{13} + 0.111x_{14} \\
 F_2 &= 0.147x_1 + 0.051x_2 - 0.137x_3 - 0.125x_4 + 0.234x_5 - 0.064x_6 - 0.004x_7 - 0.06x_8 \\
 &\quad - 0.328x_9 + 0.236x_{10} + 0.23x_{11} + 0.307x_{12} - 0.07x_{13} + 0.067x_{14}
 \end{aligned}$$

$$F_3 = -0.132x_1 - 0.018x_2 + 0.417x_3 + 0.072x_4 - 0.015x_5 - 0.045x_6 + 0.332x_7 \\ + 0.39x_8 + 0.076x_9 - 0.049x_{10} + 0.007x_{11} - 0.033x_{12} - 0.012x_{13} \\ - 0.011x_{14}$$

where $x_1, x_2, \dots, x_{14}$ is the normalized data corresponding to the original data. The factor score of each common factor can be obtained by the factor score function, so as to reflect the development of e-commerce in different countries from different angles. The variance contribution rate corresponding to the three common factors can also be used as the weight base to calculate the comprehensive score of e-commerce development in various countries. The formula is as follows:

$$F = (0.3389 * F_1 + 0.28968 * F_2 + 0.18166 * F_3) / 0.81113$$

Therefore, we can calculate the factor scores and aggregate scores for 20 countries separately. The high comprehensive score indicates that the country has a high level of e-commerce. Because SPSS-24 standardized the original data with the factor analysis, the comprehensive score can be negative, but it does not mean that a country's e-commerce level is negative, it indicates that one country's e-commerce development level is below the average level of G20 countries. The final factor scores of each country are shown in table 2.7.

By means of factor analysis, this paper takes G20 countries as research objects, calculates and analyzes the comprehensive score and ranking of the development of e-commerce in G20 countries, which can reflect the differences in the development level of e-commerce in different countries vertically.

According to the results calculated in Table 2.7, the level of e-commerce development in G20 countries has obvious differentiation characteristics from the perspective of comprehensive scores and ranking. Economically developed countries have a relatively high level of e-commerce development, ranking at the top, while some relatively backward developing countries, whose e-commerce development is slow, rank at the bottom. Secondly, the overall score of the United States with the highest level of e-commerce

development is 1.703, while that of India with the lowest score is only 0.136, which is a big gap between the two. Specifically, the top five countries in e-commerce development of G20 countries in 2018 are the United States, China, the United Kingdom, Japan and South Korea, and their comprehensive scores are all above 1.

Table 2.7 – Scores and rankings of e-commerce development of G20 countries

Country	Score of readiness factor(F ₁)	Ranking	Score of impact factor(F ₂)	Ranking	Score of application factor (F ₃)	Ranking	Final score	Final ranking
United States	0.736	10	0.474	8	5.471	2	1.703	1
China	0.163	18	-0.082	15	5.824	1	1.343	2
U.K	1.134	1	0.335	11	2.335	3	1.117	3
Japan	0.588	13	1.553	2	1.147	4	1.058	4
Korea	0.599	12	1.883	1	0.437	8	1.021	5
Germany	0.941	7	1.216	3	0.672	5	0.979	6
France	0.994	5	1.011	4	0.360	9	0.858	7
Canada	0.986	6	0.809	5	0.333	10	0.777	8
Australia	1.091	3	0.756	6	-0.015	17	0.724	9
Italy	0.913	8	0.422	10	-0.023	18	0.528	10
Saudi Arabia	1.093	2	-0.293	18	0.309	11	0.423	11
Argentina	0.650	11	0.428	9	-0.011	16	0.421	12
Russia	1.069	4	-0.492	19	0.522	7	0.409	13
Turkey	0.575	14	0.129	14	0.201	12	0.332	14
Brazil	0.739	9	-0.104	16	0.222	13	0.322	15
Mexico	0.380	15	0.201	13	0.094	15	0.252	16
South Africa	0.198	17	0.247	12	-0.036	19	0.163	17
Indonesia	0.328	16	-0.105	17	0.196	14	0.144	18
India	-0.554	19	0.691	7	0.543	6	0.136	19

As economically developed countries, the five countries have good economic conditions, relatively good network infrastructure and perfect logistics system. Meanwhile, we also see that South Africa, India and Indonesia ranked low in overall e-commerce, with

a combined e-commerce score of less than 0.2 in all three countries, due to poor network development and infrastructure conditions.

From the perspective of readiness, there are still large differences in e-commerce development among G20 countries in 2018. As can be seen from the table, the United Kingdom ranks the first in e-commerce readiness factor F1 with a score of 1.134, much higher than the average level. Specifically, developed countries represented by the United Kingdom have a high degree of readiness for e-commerce, while developing countries have a low degree of development for e-commerce.

In other words, based on their strong economic conditions and developed scientific and technological strength, developed countries have relatively perfect information network construction, good infrastructure, and generally high income, which leads to their higher penetration rate of mobile phones and computers than developing countries. However, due to the large population base and relatively low per capita income in developing countries such as India, China and Brazil, their Internet penetration rate and mobile phone utilization rate are generally lower than those in developed countries.

From the perspective of impact factor (F_2), the top five countries in the e-commerce development of G20 countries in 2018 are South Korea, Japan, Germany, France and Canada. Except Canada, the scores of the other four countries are all above 1, especially South Korea and Japan, whose e-commerce impact factor scores are all above 1.55. Lower-scoring countries include Indonesia, Russia and Saudi Arabia. The impact mainly reflect the electronic commerce on the impact of national economic and social development. The index includes two secondary indicators: the impact on the economy and the development potential. Data show that South Korea, Japan and Germany have a greater impact on the economy of e-commerce. Countries with low scores have less impact on the economy from e-commerce.

From the perspective of application factor F_3 , China and the United States take an absolute advantage in the e-commerce application index, and the transaction size is far larger than that of other G20 countries. The application of e-commerce mainly reflects the transaction scale of e-commerce in a country, or the market scale of e-commerce. In 2018, the total volume of e-commerce transactions between China and the United States reached

145,700 dollars, accounting for more than half of the total volume of e-commerce transactions among G20 countries, accounted for 60.81%. Australia, Italy, South Africa and other countries ranked the last in the list of e-commerce application factors, mainly because these countries have a small population. For example, Australia's population is only 24.99 million, so it is difficult to form a large-scale e-commerce market.

Chapter 3 Present situation and trend of e-commerce development in G20 countries

3.1 Transaction of e-commerce in G20 countries

Scale of e-commerce transaction in G20 countries. Consumption patterns have gradually changed with the improvement of science and technology, and e-commerce has shown a trend of diversified and innovative development in application fields, which has injected impetus into the development of e-commerce in G20 countries. In recent years, the volume of e-commerce transactions in G20 countries has shown a fast growth rate, and the scale of e-commerce transactions has continued to expand.

The Global E-commerce Data Report makes a statistical analysis of the e-commerce transaction volume of 27 countries in the world. Due to the limitation of data, this paper selects the e-commerce transaction volume of 16 countries in G20 countries from 27 countries during 2014–2020 to analyze the dynamic changes of e-commerce scale, at the same time, some part of data are derived from national bureau of statistics.

Among these countries, the United States, China and Japan have high transaction volume of e-commerce. In the United States, in particular, e-commerce transactions reached 10738 billion dollars in 2020, much higher than other G20 countries and equivalent to the combined value of China, Japan and Germany. The three countries have mature e-commerce markets with huge development potential and are becoming new engines to drive the rapid and sustainable growth of their national economy.

South Africa, Turkey and Saudi Arabia e-commerce transactions of less than other countries, the reason is mainly because of this a few countries with less land area and population, the number of consumer e-commerce is also can be less, but from the point of development trend, the growing e-commerce transactions, e-commerce is gradually accepted by consumers, and infiltrate into the daily consumption behavior.

Table 3.1 – E-commerce transaction of G20 countries, 100 million dollars [26]

Country	2014	2016	2018	2020
United States	62680	79350	97760	107380
China	19432	33386	47311	57406
Japan	22650	27470	32400	37358
Germany	9200	12650	16210	20243
Korea(Rep.of)	10500	12500	14740	16690
United Kingdom	7920	8890	10800	11960
France	5751	7520	9570	11435
Canada	4000	5500	7300	8925
Australia	1950	2430	2980	3508
India	372	680	980	1312
Italy	280	365	460	552
Russia	106	151	255	311
Brazil	113	178	228	289
Mexico	108	164	210	265
Turkey	52	83	112	145
South Africa	21	29	41	58

Online retail sales in G20 countries. With the rapid improvement of network communication, electronic payment, modern logistics and other technologies, the original development model of e-commerce has been gradually broken, and many emerging business forms have been derived. The transformation from the initial information sharing platform to a convenient trading platform has been completed, and many new development models have emerged. All industries are actively building the integration of offline and online development, such as the emergence of new e-commerce models such as O2O, e-commerce service industry is also actively realizing the full integration with traditional industries, at the same time, the transaction content is developing towards diversification, mobile e-commerce and network retail and other modes of e-commerce transaction scale is continuously expanding. Online retail sales by countries are shown in table 3.2.

Table 3.2 – Online retail sales in G20 countries, 100 million dollars [26]

Country	2014	2016	2018	2020
China	4277	7500	13095	19246
United States	2970	3900	5200	7193
United Kingdom	1720	2300	2910	4065
Japan	1025	1340	1790	2469
Germany	840	1040	1306	1835
France	613	797	1039	1445
Canada	400	590	820	1119
Korea(Rep.of)	400	570	750	1036
India	55	152	334	420
Italy	146	203	260	361
Russia	113	146	207	284
Brazil	93	142	163	233
Australia	75	96	116	164
Mexico	8	12	98	118
Turkey	31	49	67	91
South Africa	18	23	33	45

From the perspective of online retail transaction size, online retail sales in all G20 countries showed a trend of growth from 2014 to 2020, and the top three countries, China, the United States and the United Kingdom, remained faster growth in online retail sales. China, in particular, has an absolute advantage among G20 countries, with a net increase of about 615 billion dollars in online retail sales in 2020 compared with 2018. Turkey, South Africa and Mexico accounted for the least amount of online retail transactions, with South Africa accounting for just 4.5 billion dollars.

As a developing country, South Africa and Turkey, relatively backward economic development, the network technology is not developed, accordingly network business platform and infrastructure construction is not perfect, which leads to their online retail sales is low, but overall, along with the continuous development of economy and information technology is mature, the future national e-commerce has the very big development space.

The growth rate of e-commerce transaction. The growth rate of e-commerce transaction reflects growth speed of e-commerce transaction in G20 countries in this year compared with the former year. It also illustrates development potential of one country's e-commerce to the extent.

The under table indicates changes of growth of e-commerce transaction from 2017 to 2020. From the point of data, e-commerce transactions of the G20 countries is growing rapidly. In 2020, for example, the average growth rate of e-commerce transaction volume in G20 countries was 14.23 %. In Russia in particular, the growth rate of e-commerce transaction in 2020 was as high as 27.8, much higher than other countries. Secondly, countries with high growth rates are India, Brazil and Mexico. We find that these countries with fast growth of e-commerce transactions are all developing countries. Although these developing countries are growing faster, their volume of transactions is low and they are at the primary stage of development of e-commerce.

Table 3.3 – Growth rate of e-commerce transaction in G20 countries [26]

Country	2017	2018	2019	2020
United States	12.5	12.6	11.9	10.1
China	55.7	10.3	24.8	13.6
Japan	10.2	10.1	8.3	8.9
Germany	12.7	22.0	17.5	9.0
Korea(Rep.of)	10.6	7.7	8.0	9.2
United Kingdom	6.7	5.2	6.4	14.2
France	14.9	13.8	12.5	13.1
Canada	17.5	17.0	16.4	14.1
Australia	10.8	12.5	11.9	9.6
India	34.4	36.0	23.5	16.7
Italy	13.6	14.8	12.3	12.2
Russia	24.5	14.4	22.5	27.8
Brazil	29.2	21.9	10.1	16.3
Mexico	25.0	21.5	10.4	16.0
Turkey	25.0	27.7	19.3	13.1
South Africa	9.5	26.1	24.1	13.9

Product structure of e-commerce transaction. The figure 3.1 indicates structure of main products of e-commerce in G20 countries in 2020, we can find apparently that clothes, shoes and hats were the main commodities in e-commerce transactions of G20 countries in 2020, accounting for 68 %.

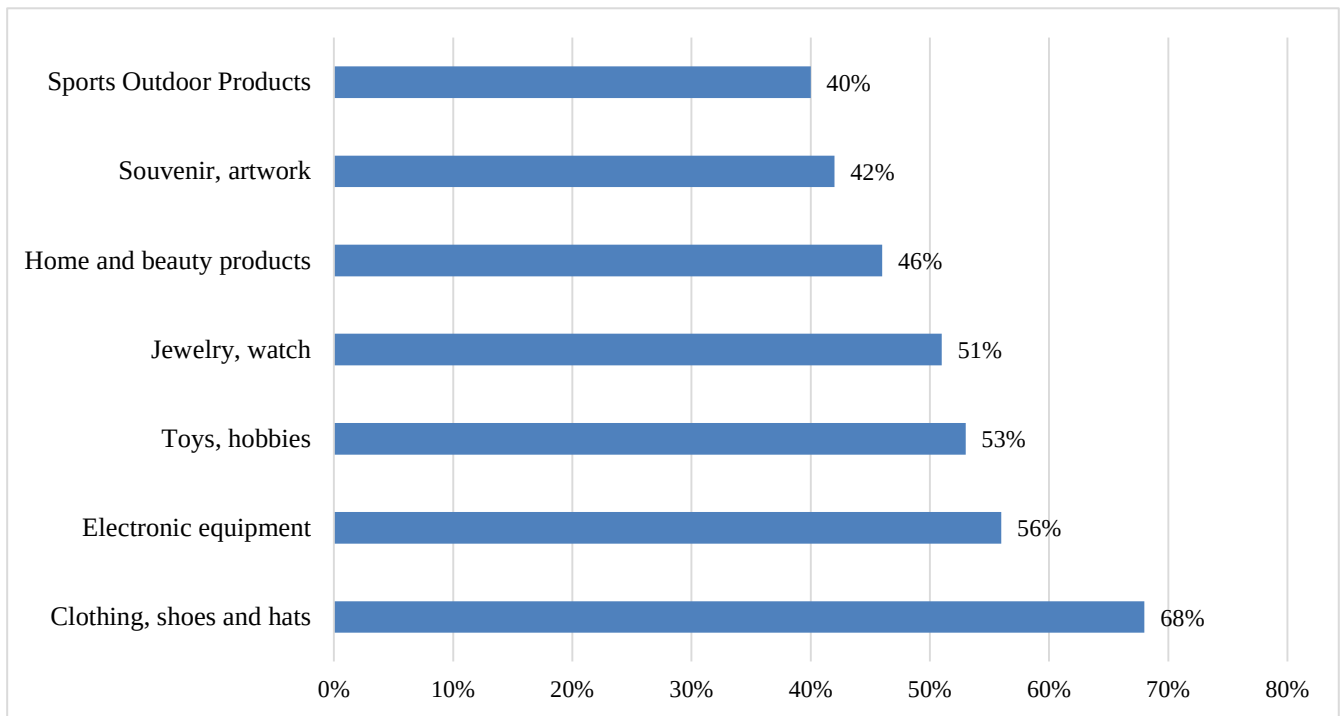


Figure 3.4 – Product structure of e-commerce transaction in G20 countries

At the same time, electronic devices came in second with 56 percent, followed by toys and hobbies – 53 %, Jewelry and watch – 51%, home and beauty products – 46%, souvenir and artwork – 42%, sports outdoor products – 40%. In the future, with the development of information technology and the popularity of mobile phones, the proportion of electronic devices will be higher and higher.

3.2 Environment of e-commerce in G20 countries

Logistics performance index. The efficiency of logistics transportation affects the scope of e-commerce. The level of logistics service is crucial for a country to enhance its foreign trade competitiveness, and it is also the basic support for the construction of e-commerce supply chain. Based on the World Bank's Global Logistics Performance Index,

this paper analyzes the logistics service level of G20 countries. Logistics Performance Index overall score reflects perceptions of a country's logistics based on efficiency of customs clearance process, quality of trade- and transport-related infrastructure, ease of arranging competitively priced shipments, quality of logistics services, ability to track and trace consignments, and frequency with which shipments reach the consignee within the scheduled time. The index ranges from 1 to 5, with a higher score representing better performance.

Table 3.4 – Logistics performance index of G20 countries [45]

Country	2016	2018	2020
Germany	4.12	4.23	4.20
Japan	3.91	3.97	4.03
United Kingdom	4.01	4.07	3.99
United States	3.92	3.99	3.89
France	3.85	3.90	3.84
Australia	3.81	3.79	3.75
Italy	3.69	3.76	3.74
Canada	3.86	3.93	3.73
China	3.53	3.66	3.61
Korea, Rep.	3.67	3.72	3.61
South Africa	3.43	3.78	3.38
India	3.08	3.42	3.18
Indonesia	3.08	2.98	3.15
Turkey	3.50	3.42	3.15
Mexico	3.13	3.11	3.05
Saudi Arabia	3.15	3.16	3.01
Brazil	2.94	3.09	2.99
Argentina	2.99	2.96	2.89
Russian Federation	2.69	2.57	2.76

Based on the comprehensive data of three years, the logistics performance index of most G20 countries is higher than 3. However, at the same time, developed countries in G20

countries generally have a higher score in logistics index with a relatively developed level of logistics development, while most of the developing countries have a lower score in logistics index and a relatively backward level of logistics service. In terms of specific countries, both Germany and Japan scored higher than 4 in the logistics index in 2020, showing an obvious advantage among G20 countries. The third to fifth countries in the logistics performance index were the UK, the US and France. Brazil, Argentina and Russia logistics performance index scores poorly, at the same time, the three logistics performance index score lower than 3.

Internet penetrate rate. Internet penetration rate reflects the proportion of people who regularly use the Internet in a country or a region. It is usually used to measure the informationization developed degree of a country or region internationally.

Table 3.5 – Internet penetrate rate of G20 countries, % [27]

Country	2016	2017	2018	2019	2020
Japan	85	90	92	94	95
U.S	78	86	88	91	95
Australia	90	92	93	94	95
U.K	85	90	91	92	94
Korea	78	85	90	91	93
Germany	78	82	87	91	93
Canada	86	89	91	92	93
France	83	85	87	88	91
Russia	62	66	70	76	82
Mexico	61	64	67	72	78
Brazil	56	58	66	70	73
Italy	62	65	69	70	72
Turkey	55	55	60	66	71
China	47	49	53	56	60
South Africa	35	37	38	40	41
India	25	28	34	35	37

Table 3.5 shows the changes of Internet penetration rate in G20 countries from 2016 to 2020. Generally speaking, the Internet penetration rate in G20 countries is relatively different. Developed countries have higher Internet penetration rate and more advanced informatization degree. However, most developing countries have a low Internet penetration rate and their informatization development is relatively backward. According to the comprehensive five-year data, Japan has the highest Internet penetration rate, with an average of 91 %.

According to the latest data, the top three countries in the G20 in 2020 were Japan, the United States and Australia, with an Internet penetration rate of 95 %, far higher than the level of developing countries. At the bottom of the list are China, South Africa and India, all developing countries, particularly South Africa and India, which had less than 50 % Internet penetration in 2020, less than half of Japan's. Despite the large number of Internet users in China and India, 828 million population and 478 million people respectively, but the huge population base, the two countries led to low Internet penetration.

Information society index. Information society is a social state in which information technology is applied to a certain extent in the fields of economy, society, politics and life. It is also an inevitable result of the quantitative change to qualitative change caused by the deepening and accumulation of information technology application.

The society can be divided into different stages of development according to the level of development. The development level of the information society can be measured by the Information Society Index (ISI). The value range of ISI is between 0 and 1, and the higher the value of ISI is, the higher the development level of the information society is. Based on the phase information society index standards, the development of the information society can be divided into two stages, namely the preparation of the information society ($0 < \text{ISI} < 0.6$) and the development of information society stage ($0.6 < \text{ISI} < 1$).

Figure 3.7 shows the level of information society development in G20 countries in 2020. The information society development index of G20 countries is differentiated. Specifically, the information society index of developed countries led by the United States and Japan is relatively high, with an average of about 0.8, while the information society

index of most developing countries such as India, Indonesia and China is relatively low in 2020, with an average score below 0.6.

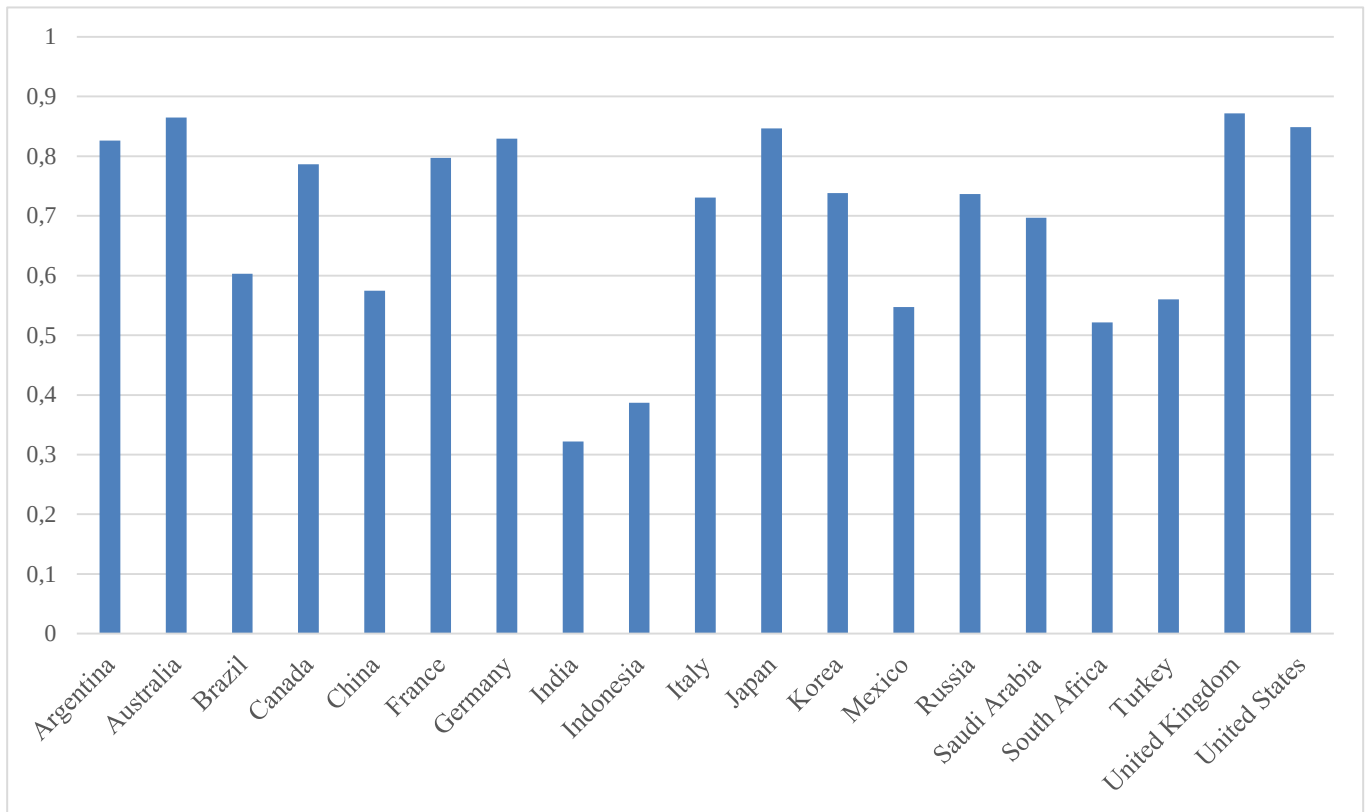


Figure 3.2 – Information society index of G20 countries in 2020 [17]

It is not difficult to see that the developed countries among the G20 countries are in the development stage of information society on the whole. In the development stage of the information society, with the popularization of the application of information technology, the characteristics of industrial society gradually fade, networking and intelligence have reached a higher level, social management and public services have basically realized networking. And most of the developing countries are in the preparation stage of information society. In the preparatory stage of information society, information technology is constantly applied in various fields of a country's economy, society, life and politics, and the informatization process is promoted. Therefore, it is also a long period of accumulation.

G20 countries overall information society development faster basically has the following reasons: one is the mobile Internet, intelligent manufacturing, big data, such as artificial intelligence move forward, a new generation of information technology, the

industrial structure adjustment and economic development mode, the omni-directional impact on social life style and so on various aspects, reduce the production cost, improve the original people's quality of life; Second, countries all over the world pay more and more attention to the innovation and application of information technology, information society construction as an important gripper international competitiveness in the new period, has launched a series of strategies and policies, such as the "Internet", Germany "4.0", Japan "advanced robot manufacturing plan", China "Internet +" and "made in China 2025", etc.

Percentage of individuals using computer and mobile phone. The percentage of individuals using computer and mobile phone reflects population of persons use mobile phone and computer in all individuals in a country. Meanwhile, we can find which way of online shopping do people prefer to the extent.

Table 3.6 – Percentage of individuals using computer and mobile phone, % [32]

Country	Percentage of individuals using a	
	Computer	Mobile phone
Argentina	44.8	65.4
Australia	82.4	82.9
Brazil	31.2	54.7
Canada	79.8	71.3
China	26.4	69.4
France	77.5	62.8
Germany	88.8	81.6
India	11.3	22.3
Indonesia	14.5	27.6
Italy	67.5	67.5
Japan	75.5	62.9
Korea (Rep. of)	83.0	94.9
Mexico	43.0	45.1
Russian Federation	72.0	58.2
Saudi Arabia	67.8	76.2
South Africa	21.9	51.3
Turkey	45.5	65.3
United Kingdom	87.5	74.8
United States	83.1	77.8

From the perspective of percentage of individuals using a mobile phone, the average percentage of individuals using a mobile phone in G20 countries is 62.8 %, but it has differentiation among countries. The proportion of individuals using a mobile phone in developed countries is higher than the average. The share of individuals using a mobile phone in developing countries is lower than the average. In terms of countries alone, South Korea tops the list with 94.9 % of personal mobile phone use, followed by Australia (82.9 %) and Germany (81.6 %).

From the perspective of percentage of individuals using a computer, the differentiation between G20 countries are even more apparent. For example, Germany ranks first with 88.8% of individuals using a computer. India, a developing country, accounts for only 11.3%. Meanwhile, the gap of individuals using a mobile phone and computer embodies which way of online shopping do people prefer to the extent. For instance, the percentage of individuals using a computer in United States is 83.1%, which higher than percentage of individuals using a mobile phone, American prefer to online shopping with computer, and the mobile phone is only a electronic equipment to communicate.

3.3 Prospect of e-commerce development in the future in G20 countries

In recent years, e-commerce in G20 countries has fully covered all aspects of the commercial economy: whether it is the manufacturing sector of the national economy or the circulation sector of the service sector. Whether it's enterprise applications, personal applications, or government procurement. More and more large and small enterprises have finally seen the benefits of e-commerce. Whether they set up independent official e-commerce platforms or use third-party e-commerce platforms, the penetration rate of e-commerce has maintained a sustained and rapid growth.

In the future, with the gradual maturity of online payment and logistics distribution, e-commerce in various countries will certainly form a large scale economy, and through the practical combination with the real economy, inject impetus to the social and economic development, showing a trend of high popularization and normalization.

The center of gravity of the e-commerce market will begin to shift to the Asia-Pacific. On the one hand, China replaced the US as the world's largest e-commerce market as early as 2015. China's e-commerce sales grew more than 30 % in 2019 to nearly 2 trillion dollars, accounting for more than half of all global online retail sales. The U.S. market followed closely at 60.63 billion dollars, accounting for nearly 15 % [50].

On the other hand, the European and American e-commerce market has been very mature, the e-commerce market has gradually become a red sea, the absolute growth rate of e-commerce is gradually slowing down; At the same time, Southeast Asia, the Middle East, India, Russia and other emerging e-commerce markets began to rise rapidly, with the growth rate of e-commerce transactions greater than 10%, becoming the hot areas of e-commerce entrepreneurship. For e-commerce entrepreneurs, it means that the layout and focus of e-commerce need to be adjusted in time.

In the boom of e-commerce, the short board of industrial chain has already emerged, namely the logistics supply chain, which is also the hot spot of G20 countries in the future development. At present, the main combination of e-commerce and logistics is: the customer orders online, and then the buyer recommends the logistics company for the buyer to choose. However, the combination of e-commerce and logistics is much more than that. As e-commerce is accepted and become a habit by more and more consumers, they also put forward higher requirements for logistics. In addition, consumers will attach more importance to the logistics services and other value-added service capabilities of online merchants, while the richness of product categories and the depth of a product are slightly less important.

Therefore, in the future, only those enterprises that regard logistics as a part of their core value and have mastered the tricks of the trade can win in the world e-commerce market competition. These companies will take the logistics supply chain network as part of the overall e-commerce solution, the logistics channel, the business flow channel and the information flow channel are bundled, is the real integration, penetration into each link of the e-commerce enterprise.

With the increasingly fierce competition in e-commerce, business intelligence will play an increasingly important role in e-commerce operation, which can be seen from the

mature foreign e-commerce websites. In G20 countries, especially developed countries, e-commerce companies generally have people who are specifically responsible for data analysis and other business intelligence work as a kind of strategic investment. However, there are not many enterprises in developing countries that really focus on data analytics and business intelligence, and the main reason for this is the lack of investment.

In the future, one of the competitive factors for e-commerce will be whether you have a set of business intelligence systems in place, whether you have a strong data analytics team, they are the brain trust of the e-commerce enterprise.

As the result of researches, we can form the most important trends of e-commerce [20]:

1 New generation of retail stores. Sellers have to combine formats. Online retailers are increasingly breaking into the offline market. Despite the progress, customers love to pick up goods in a real store, as it can be felt and seen.

2 B2b-ecommerce change. CEOs of b2b-companies put the main focus on e-commerce. Instead of taking orders by phone in companies will be engaged in online orders.

3 Product Visualization. This year, technology will allow buyers to try products by using smartphones. But a couple of years ago it seemed fantastic. Now you can see how everything will look in the house: from pillowcases to refrigerators. This will help to significantly reduce returns.

4 Change Conversion. Retailers will now know how much they will get offline profits thanks to online advertising. This became possible after the introduction of the new indicator ROPO Ratios (“Research Online, Purchase Offline” – search online, buy offline). 82 % of mobile phone users are looking for stores close to home and about 20 % of requests lead to buying during the day. Interconnecting modern technology, retailers can calculate the entire conversion.

5 The increase in the number of purchases from a smartphone. Smartphones are entering our life more and more firmly, and making purchases from a phone is easy to do - you don't even need a physical card, as there is Google Pay and Apple Pay.

6 Artificial Intelligence in e-commerce. The more brands learn about customers, the more accurately they can set up a target. The time is not far off when it will be possible to set up advertising that is suitable in all respects - even according to your favorite color.

7 Amazon development as a marketplace. Admittedly, this year, Amazon will finally become part of every online strategy. In the West, for sure – 55 % of Americans initially look for products on Amazon, whose sales account for 44 % of total online sales and 4 % of US retail sales.

8 Voice as a way of communication. Already, in the Domino's network, users can order pizza and control delivery only by voice, and Lyft taxi customers can call the driver through Alexa's smart assistant.

9 Search by image. For the first time, instead of searching by words, this year users will massively switch to searching by images. By the photo you can find exactly the product that interested.

10 The browser will cease to be the only way to find a product. Users left from "browser addiction". Now you can buy and order everything you need in applications, social networks and even using marks on Google-maps.

11 Full personalization. Positive experience - a guarantee that the buyer will return to you again. And an important role here plays an individual approach. Suggestions, recommendations and tips will be modeled for each client.

12 Video conferencing. Video content is becoming more attractive for the buyer - the text should be read, and listen to the audio, without being distracted. This is too disadvantageously now. Therefore, we reduce the time of submission using video.

13 Storytelling. Not everyone is interested in how good your product is, but it's interesting to everyone, what is the story behind it. Products should provide real human value.

Nowadays, customers hold the power in the market, as they have a vast number of offers to pick from. Thus, it is not solely your product that allows you to stand out from competitors; it is a customer-centric shopping experience built around your brand to keep customers. Everything from an intuitive order process and payment possibilities to fast delivery has an impact. This augmented service is intangible and requires a lot of effort. It

is here that new e-commerce technologies and applications offer software development solutions.

Today, all well-known brands are represented online by an e-commerce store, shopping apps, marketplaces or even all of these things simultaneously. Every effort is made to acquire more clients online. Here are the trends currently shaping the e-commerce industry.

Personalized Product Recommendations. Recognizing your visitors and making personalized product recommendations will create a unique shopping experience and make an impression with your potential customers. Let's take Segmentify as an example. It is an intelligent product recommendation engine that promises its customers at least 10% revenue increase. Through various implementations of different campaigns you can increase conversion rates, revenue, repeat customers and purchases, reduce bounce rates and abandoned carts. When making product recommendations, it is important that you continue to analyze your performance and adapt based on the behavior of your customers.

Social-commerce, a Subset of E-commerce. Naturally, social commerce is the use of social networks for online shopping transactions.

Social media is embedded in our daily activities. This fact effectively changes the buyer-seller landscape. Brands stay in touch with their clients via popular social networks to create a personal relationship. More advanced technical features are integrated into social media that are directed to shorten the buying cycle. In the future, the one-click “Buy” button will likely be adopted by most social networks.

The combination of e-retail and social media has resulted in evolving P2P marketplaces. Facebook and Instagram are the greatest examples. At last, the fact: the social e-commerce growth rate is on track to increase by 25 % over the next 5 years, to make up more than a quarter of the total e-commerce market [14].

M-commerce. Using applications on smartphones and tablets to buy and sell products is known as mobile-commerce or, more simply, m-commerce. Today, the percentage of consumers using mobile devices constitutes a half of all internet traffic, meaning it is of high importance that e-commerce shops adapt to mobile screens and, in some cases, even build

a separate app for the specific purpose of reaching these buyers and following mobile e-commerce trends.

Solely the presence of a website or mobile app does not guarantee tremendous success. It is important to make sure that you create the best online shopping experience. Client engagement and retention are key indicators to focus on.

Mobile shoppers are particular, so even the slightest issue can change their mind and lead them to buy from a competitor. Meanwhile, the more advanced functionality embedded into mobile apps sets up some new game rules. The invention of the devices such as Beacons and Dash Buttons actually showed the value of having a branded e-commerce mobile app. These gadgets trigger interest and engagement on the mobile app, which in the end increases sales.

1 One-Click Checkouts. This technique offers a completely new e-commerce experience formed from an analysis of former purchases and buyer behavior. Research shows that mobile users expect to have as easy of an e-commerce shopping cart process as possible. This advancement in the mobile cart, along with a growing interest in digital coupons, will be responsible for almost half of sales in e-retail.

E-wallets and New Payment Integrations. Electronic wallets simplify the payment process. Online services like Apple Pay, PayPal, Stripe, and Google Wallet allow for easy electronic transactions. Moreover, digital wallets can be synchronized with your bank account. This data, along with your driver ID, health card, etc, can be stored in the phone. As well, with the universal acceptance of NFC (near field communication) technology, we wirelessly connect to terminals for in-store payments using our smartphones.

Beacons. Beacons drive retail sales while, at the same time, providing a personalized mobile shopping experience. According to a presentation by Apple in 2013, beacons are heavily used by top retail stores. Urban Outfitters, Macy's, Target, and CVS all use them to build personalized content strategies. The device transmits Bluetooth signals to nearby smartphones that have the correct branded app. This increases the chances to use the app more often and actually complete the purchase. Sephora utilizes beacons to gather consumer information and send personalized promotions [4, p. 653].

Dash Buttons. This appliance from Amazon offers easy order-placement of the most regularly purchased goods. These button devices are tagged to a place where these goods are often used. Then, using the Amazon app, a user can preliminarily set up the orders. This new technology trend in e-commerce will likely soon be imitated by other top players like Costco and Walmart.

These are the trendsetting processes at the present time. However, merchants should understand that as technology progresses, there will continue to be transformations in how we interact with and buy goods. The tech adoption curve helps to evaluate the risks of employing new technologies used in e-commerce. It illustrates the most prominent e-commerce innovations influencing the industry and their level of acceptance by the public. Naturally, it takes some time before being adopted by the majority in the e-commerce system, but keeping an eye on the technological advancements is more than necessary.

Conclusion

This paper mainly analyzes the status quo of e-commerce development in G20 countries, and measures and evaluates the level of e-commerce development in G20 countries. First of all, this paper introduces the relevant theories of e-commerce measurement, and then uses factor analysis method to measure the development level of e-commerce in G20 countries. Finally, the paper quantitatively analyzes the current situation and prospect of development of e-commerce in G20 countries in the future. The main conclusions are as follows:

Based on the e-commerce development measurement theory of international organizations and countries such as APEC, EU, the United States and China, and based on the development of e-commerce in G20 countries, an evaluation index system of e-commerce development in G20 countries is constructed. The system contains three first-level indicators, namely readiness, application and influence, and is subdivided into e-commerce transaction volume, Internet penetration rate and other 14 specific indicators to measure the development of e-commerce in G20 countries.

Based on the constructed indicator system of e-commerce development in G20 countries, this paper calculates and analyzes the e-commerce development in G20 countries in 2018 by using the software SPSS-24 and factor analysis. In general, among G20 countries, economically developed countries have a relatively high level of e-commerce development and rank at the top, while some economically backward developing countries have a slow development of e-commerce and rank at the bottom. In 2018, the top five countries in the e-commerce development of G20 countries are the United States, China, the United Kingdom, Japan and South Korea, and their comprehensive scores are all above 1. Meanwhile, we also see that South Africa, India and Indonesia rank low in the overall e-commerce rankings, and their comprehensive scores are all below 0.2.

From the perspective of readiness, there are still large differences in the development of e-commerce among G20 countries in 2018. Developed countries represented by the UK have a high degree of readiness for e-commerce, while developing countries have a low degree of development for e-commerce. The UK ranks first in e-commerce readiness factor

with a score of 1.134, much higher than the average level; From the view of impact factor, the top five countries in the e-commerce development of G20 countries in 2018 are South Korea, Japan, Germany, France and Canada. Except Canada, the scores of the other four countries are all above 1, especially South Korea and Japan, whose e-commerce impact factor scores are all above 1.55. This indicates that South Korea, In Japan and Japan, e-commerce contributes more to the economy.

From the point of application factors, China and the United States have an absolute advantage in the e-commerce application index, and the transaction size is far larger than that of other G20 countries. In 2018, e-commerce transactions between China and the United States totaled \$145,700. Accounting for more than half of e-commerce transactions in G20 countries, reaching 60.81%. Countries with low scores in the e-commerce application factor include Australia, Italy and South Africa, mainly because these countries have small populations and it is difficult to form a large-scale e-commerce market.

Starting from two aspects of e-commerce transaction scale and e-commerce development environment, this paper analyzes the current situation of e-commerce development in G20 countries, and analyzes the future development trend of e-commerce in G20 countries based on the current situation. The results show that the development of e-commerce in G20 countries has a good development trend and great development potential, especially in developing countries. However, in general, there are obvious differences in the development of e-commerce in G20 countries. E-commerce in developed countries is relatively mature, while e-commerce in developing countries is at the initial stage and relatively low in maturity.

In the future, with the gradual maturity of online payment and logistics distribution, e-commerce in G20 countries will certainly form a large scale economy, and through the practical combination with the real economy, inject impetus to the social and economic development, showing a trend of high popularization and normalization; The shift of the center of gravity of the e-commerce market; With the increasingly fierce competition in e-commerce, business intelligence will play an increasingly important role in e-commerce operation.

Due to the problem of data acquisition, the relevant indicators of e-commerce transactions in G20 countries were not included in the empirical analysis. In the future research, I hope to gradually improve the indicator system by reading a lot of literature and paying close attention to the development trends of e-commerce. At the same time, in the future research, the e-commerce development measurement model should be updated and selected according to the development stage and construction requirements of e-commerce in G20 countries, so as to achieve the accuracy and comprehensiveness of e-commerce development index measurement.

Collecting relevant data is one of the main difficulties in this paper. This research needs a large amount of data in the current situation analysis and empirical part, and the index data are obtained from major international official data websites and statistical reports. Due to the lag of international data, in order to maintain the consistency and comparability of data of G20 countries in the empirical analysis, the research time of this paper can only be updated to 2018. Therefore, in terms of data collection, future research should constantly expand data collection approaches, constantly update and improve relevant data and literature materials, so as to make the research more contemporary.

E-commerce is one of the industries being changed by the revolutionary use of blockchain technology.

With future of e-commerce growth, some side effects are bound to occur. There are issues with trust, slow transactions, higher fees and policies, and digital data ownership. With its concept of a distributed, genuine ledger of all digital transactions, blockchain helps to build trust in online payments. It also excludes frauds and provides a new payment method with the help of cryptocurrency (Bitcoin, Ethereum, Ripple, etc).

As a real-life example, Amazon has policies for its listed retailers. They reduce contact with their customers, as they can just send one follow-up email. Amazon employs its own customer support that is not acquainted with the merchants' products. As a consequence, this reduces the credibility of the retailers and results in a higher cost to the customer.

At present, experts are working on the future of e-commerce marketplace. It is called ECoinmerce and will be blockchain-driven to solve the aforementioned issues.

The notion of transactions using digital assets eliminates the need for a third-party. Additionally, these transactions are faster and fees are decreased both for buyers and sellers. All data entered into a blockchain is stored there indefinitely. This means that no matter how many times a good is sold or repurchased, the transaction history always remains. This can go a long way toward eliminating fraud and boosting transparency.

The tendency for robots to replace human activity has been observed over the last century. In the past, automated machines started working on car assembly lines and food production. As artificial intelligence and machine learning evolves, it limits people into the process, e.g. in a delivery system. Currently, automated vehicles require human operation. However, it is more than possible that drones and droids will eliminate even this participation.

The future of automation lies in drones embracing the sky and droids on the ground. Despite many obstacles in drone delivery, the benefits of its adoption are great for retailers. This will considerably cut costs in logistics operations. Amazon is in the first line with its testing of a new, fast drone delivery system - Amazon Prime. As well, a famous example in the food industry, Domino's delivered a pizza with the help of a drone in 2016 in New Zealand. Once drone airports become a reality, shipping time will be shortened to even a few hours. This is sure to boost online purchases.

The future of the e-commerce delivery system is expected to be focused not on a specific address, but on an individual person and their expected location and time. Pinpoint shipping, as this is referred to, would embed sophisticated AI.

G20 members agree on the following common principles to promote the development of and cooperation in the digital economy:

Innovation. Technological innovation in ICTs as well as innovation in ICT-driven economic activities is among the key driving forces of inclusive economic growth and development.

Partnership. In order to improve cooperation, address common challenges, and advance the global digital economy, closer partnership among G20 members can help share knowledge, information and experiences, so that differences can be narrowed and various interests can be advanced through constructive dialogues. The G20 recognizes

the Internet is an important part of modern information network that sustain digital economy. Internet governance should continue to follow the provisions set forth in outcomes of World Summit on the Information Society(WSIS). In particular, we affirm our commitment to a multistakeholder approach to Internet governance, which includes full and active participation by governments, private sector, civil society, the technical community, and international organizations, in their respective roles and responsibilities. We support multistakeholder processes and initiatives which are inclusive, transparent and accountable to all stakeholders in achieving the digitally connected world.

Synergy. Since the digital economy touches almost all economic and social sectors and is closely related to other topics in the G20, particularly innovation and the new industrial revolution, it is the common aspiration of G20 members to create synergy among discussions of these topics in order to avoid duplication and ensure consistency.

Flexibility. The G20 recognizes the importance of flexibility given the different concerns and priorities of members.

Inclusion. The G20 members should work together with all stakeholders, to bridge all manner of digital divide and foster entrepreneurship, innovation, and economic activity, including further development of content and services in a variety of languages and formats that are accessible to all people, who also need the capabilities and capacities, including media, information and digital literacy skills, to make use of and further develop information and communications technologies. Accordingly, we recognize the vital importance of the principles of multilingualism to ensure the linguistic, cultural and historical diversity of all nations. Digital inclusion and the use of digital technology to enhance inclusion should remain key elements in promoting the digital economy to ensure that no one is left behind, regardless of their gender, region, age, disability or economic status. The G20 members recognize the potential of the digital economy to facilitate the implementation of the 2030 Agenda for Sustainable Development.

Open and enabling business environment. The G20 recognizes the critical importance of private sector on digital economy as well as of enabling and transparent legal, regulatory, and policy environments, and fostering open, competitive markets. Recognize the importance of enforcing competition and consumer protection laws

in the digital economy, which are conducive to market access, technological innovation in ICTs and the growth of the digital economy.

G20 members recognize that freedom of expression and the free flow of information, ideas, and knowledge, are essential for the digital economy and beneficial to development, ICT policies that preserve the global nature of the Internet, promote the flow of information across borders and allow Internet users to lawfully access online information, knowledge and services of their choice. At the same time, the G20 recognizes that applicable frameworks for privacy and personal data protection, as well as intellectual property rights, have to be respected as they are essential to strengthening confidence and trust in the digital economy.

References

- 1 APEC E-Commerce Readiness Initiative. URL : www.ecommerce.gov/apec/ (access date: 01.05.2021).
- 2 Atrostic B.K., Gates J., Jarmin A. Measuring the Electronic Economy: Current States and Next Steps. US : Press. 2002. 284 p.
- 3 Benchmarking indicators. Commission of the European Communities. Brussels : COM. 2002. 665 p.
- 4 Bhardwaj, A. Transforming Business: Integrating ERP with E-business. // International Journal of Advanced Research in Computer Science and Software Engineering. 2018. № 7. P. 653–656.
- 5 Bourdeau L., Chebat J.C., Couturier C. Internet Consumer Value of University students // Journal of Retailing and Consumer Services. 2002 № 9. P. 34–38.
- 6 Cabral L., Hortacsu A. The Dynamics of Seller Reputation : Evidence from eBay // The Journal of Industrial Economics. 2010. № 58. P. 54–78.
- 7 Cao Z., Lu H.. Introduction to E-commerce. Hangzhou : Zhejiang University Press. 2015. 175 p.
- 8 Chen F. The Development of E-commerce and the Government's Countermeasures // Business Economics. 2011. № 30(11). P. 138–140.
- 9 Chen Sh. The Application and Comparison of the Third Party Electronic Payment Platform at Home and Alive // Journal of Jinhua College of Technology. 2018. № 8 P. 45–50.
- 10 Chen X., Sun Y. Analysis on the Difference of Regional E-commerce Development Levels in China // Science and Technology Management Research. 2018. № 4. P. 197–202.
- 11 Chen Y., Cao L. Evaluation of the development performance of e-commerce in China: Based on the macro data of 31 provinces // Journal of Business Economics. 2018. № 2. P. 60–63.
- 12 Chinese e-commerce statistics and its application (part 1). Research Group of E-commerce Statistics and Its Application // China Statistics. 2017. № 12. P. 16–18.

13 Chinese e-commerce statistics and its application (part 2). Research Group of E-commerce Statistics and Its Application // China Statistics. 2019. № 1. P. 21–24.

14 Clayton T. Towards a measurement framework for international e-commerce benchmarking. URL : <https://docplayer.net/12163876-Towards-a-measurement-framework-for-international-e-commerce-benchmarking.html> (access date: 01.05.2021).

15 Dai Zh. Research on the Selection of Logistics Distribution Mode of Excellence Amazon. Tianjin: Tianjin University. 2012. 158 p.

16 Deak E. J. The Economics of E-Commerce and The Internet. US : Published South–Western. 2014. 98 p.

17 Digital society index 2019: Human needs in digital world. URL : <https://www.oxfordeconomics.com/recent-releases/digital-society-index-2019-human-needs-in-a-digital-world>. (access date: 03.05.2021).

18 E-commerce statistics – Statistics Explained. URL : https://ec.europa.eu/eurostat/statistics-explained/index.php?title=E-commerce_statistics. (access date: 03.05.2021).

19 E-commerce worldwide – Statistics & Facts. URL : <https://www.statista.com/topics/871/online-shopping/>. (access date: 01.05.2021).

20 Estimates of Global E-Commerce 2018. URL: https://unctad.org/system/files/official-document/tn_unctad_ict4d15_en.pdf. (access date: 01.05.2021).

21 European information society for growth and employment i2010-A. Brussels : COM. 2005. 229 p.

22 Ewton S. E. Assessment of the impacts of e-commerce technologies on overall business processes: An analytic Delphi process // Technology Management for Reshaping the World. 2013. № 1. P. 197– 207.

23 Fan Y., Zhuo D. An Empirical Study on the Effect of E-commerce on Economic Growth in China // Industrial Technology Economics. 2020. № 29(8). P. 40–44.

24 Frecknail J., Glaister K. Electronic Commerce and International Taxation: A Square Peg in a Round Hole? // European Management Journal. 2011. № 19 P. 651–658.

25 Global and regional ICT data. URL : <https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx> (access date: 03.05.2021).

- 26 Global ecommerce market report: ecommerce sales trends and growth statistics for 2021. URL : <https://www.businessinsider.com/global-ecommerce-2020-report>. (access date: 03.05.2021).
- 27 Global Ecommerce Update 2021. URL : <https://www.emarketer.com/content/global-ecommerce-update-2021>. (access date: 01.05.2021).
- 28 He H. A Preliminary Analysis on the Development and Regional Differences of E-commerce in China. Lanzhou : Lanzhou University. 2015. 103 p.
- 29 Hong H. Research on E-commerce in South Korea and Its Enlightenment to China. Shanghai : Shanghai Jiao Tong University. 2019. 97 p.
- 30 Huang J., Chai W. E-commerce readiness level model and empirical research // Statistical Forecasting and Decision. 2017. № 18. P. 100–103.
- 31 Hwang W., Pietroforte R. Internationalization of e-commerce: A comparison of online shopping preferences among Korean, Turkish and US populations // Behavior and information Technology. 2016. № 25(1). P. 3–18.
- 32 iMedia Reporting Center about e-commerce. URL : <https://www.iimedia.cn/c880/79484.html>. (access date: 03.05.2021).
- 33 Jia H., Wang H. Reflections on the establishment of e-commerce statistics in China // China Statistics. 2008. № 8. P. 47–49
- 34 Kaefer F., Bendoly E. Measuring the impact of organizational constraints on the success of business-to-business e-commerce efforts: A transactional focus // Information and Management. 2014. № 41(5). P. 529–541.
- 35 Kumar S., Petersen P. Impact of e-commerce in lowering operational costs and raising customer satisfaction // Journal of Manufacturing Technology Management. 2016. № 17(3). P. 283–302.
- 36 Lefebvre L. A., Lefebvre E., Elia E. Exploring B-to-B e-commerce adoption trajectories in manufacturing SMEs // Technovation. 2015. № 25(12). P. 1443–1456.
- 37 Leonard L., Manly T. S. Does e-commerce affect the financial results of large retail companies? // Proceedings of Annual Meeting of the Decision Science Institute. 2013. № 2. P. 315–320.

- 38 Li B. Research on the development status and prospect of e-commerce in China // Research World. 2015. № 1. P. 15–18.
- 39 Li X., Lu J., Liu L. Analysis of the current situation, problems and strategies of the electronic commerce credit system // Modern Economic Information. 2019. № 8. P. 132
- 40 Li X., Lu Zh., Wencan S. Cross-border e-commerce evaluation system and empirical research // E-commerce. 2016. № 7. P. 25–27.
- 41 Lin J. Research on statistical indicators and accounting methods of e-commerce. China : South China University of Technology. 2015. 117 p.
- 42 List of e-Europe benchmarking indicators. Brussels : COM. 2000. 338 p.
- 43 Liu H., Song J. Research on the problems and countermeasures of China's e-commerce development // China Information Industry. 2019. № 10. P. 17–20.
- 44 Liu Y., Wang W. The reconstruction and empirical analysis of regional e-commerce development index // Science of Science and Management of Science and Technology. 2019. № 7. P. 144–147.
- 45 Logistics performance index. URL : <https://databank.worldbank.org/source/>. (access date: 03.05.2021).
- 46 Luo H., Jiang R., Ye Y. Evaluation of Rural E-commerce Competitiveness in Anhui Province // Jo2, urnal of Northwest Normal University (Natural Science Edition). 2019. № 55(1). P. 129–134.
- 47 Ren J. Research and Empirical Study on Measuring the Development Level of Regional E-commerce // Journal of Lanzhou Institute of Education. 2013. № 29(10). P. 48–51.
- 48 Research on the measurement of e-commerce level. Research Group of E-commerce Index Research and Measurement // Statistical Research. 2017. № 12. P. 26–31.
- 49 Tang E. The development level and spatial differentiation of e-commerce in China // Economic Geography. 2015. № 35(5). P. 9–14.
- 50 UNCTAD Estimates of Global E-Commerce 2019. URL : https://unctad.org/system/files/official-document/tn_unctad_ict4d15_en.pdf. (access date: 01.05.2021).

51 Wang H., Tan J. An empirical study on the development level of cross-border e-commerce in the Yangtze River Delta: Based on factor analysis // Contemporary Economics. 2019. № 12. P. 78–82.

52 Wang J., Qin W. Research on the New Normal Mode of E-commerce in One Belt And One Road Strategy Area // China Circulation Economy. 2015. № 29(5). P. 46–54.

53 Wang K. Exploration on the Development and Innovation Mode of E-commerce under the Background of "One Belt And One Road" // Chinese Journal of Management Informatization. 2019. № 22(08). P. 159–160.

54 Weltevreden J. W. J., Boschma R. A. Internet strategies and performance of Dutch retailers // Journal of Retailing and Consumer Services. 2018. № 15(3). P. 163–178.

55 Wresch W. Initial e-commerce efforts in nine least developed countries: A review of national infrastructure, business approaches and product selection // Journal Global Information Management. 2018. № 11(2). P. 67–78.

56 Yang J., Zheng B., Yang L. Research on cross-border e-commerce evaluation index system based on factor analysis // Finance and Trade Economics. 2014. № 9. P. 94–102.

57 Yao G., Chen F., Zhao G. Research on the Status, Problems and Countermeasures of the Development of E-commerce Industrial Park // China Business and Commerce. 2014. № 21. P. 116–118.

58 Zhang H., Hao T. Evaluation of China's regional e-commerce development level based on entropy method // Journal of Xi'an University of Posts and Telecommunications. 2016. № 21(5). P. 88–94.

59 Zhang Y. Analysis of Cross-border E-commerce Evaluation Index System Factors // Science and Technology Information. 2016. № 14(30). P. 74–75.

60 Zhao L., Gai Sh. The construction of enterprise informatization level measurement index system // Information Journal. 2018. № 12. P. 38–39.

61 Zhu K. The complementarity of information technology infrastructure and e-commerce capability: A resource-based assessment of their business value // Journal of Management Information Systems. 2014. № 21(1). P. 167–202.

62 Zhu N., Wu L. Analysis on the Development Potential and Trend of Cross-border E-commerce in China under the Background of "One Belt And One Road" Strategy // Reform and Strategy. 2015. № 31(12). P. 134–137.

Appendix A

Table A.1 – Standardized data of indicators in G20 countries

Country	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇
Argentina	0.793	0.765	0.195	1.027	0.766	1.018	0.011
Australia	1.187	1.356	0.202	1.317	1.117	1.186	0.234
Brazil	0.659	0.597	0.578	0.630	0.806	0.924	0.018
Canada	1.346	1.561	0.353	1.344	1.107	1.270	0.574
China	0.485	1.143	3.017	1.096	1.057	0.744	3.719
France	2.115	1.794	0.402	1.238	1.154	1.103	0.752
Germany	1.843	1.647	0.529	1.408	1.257	1.156	1.274
India	0.058	0.054	1.376	0.171	0.883	0.438	0.077
Indonesia	0.112	0.133	0.367	0.300	0.873	0.443	0.009
Italy	1.213	1.127	0.183	1.058	1.112	0.864	0.036
Japan	1.798	1.307	0.409	1.192	1.228	1.257	2.547
Korea(Rep.of)	1.825	1.667	0.478	1.146	1.060	1.302	1.159
Mexico	0.618	0.583	0.423	0.708	0.833	0.875	0.017
Russia	0.745	0.881	1.061	1.109	0.713	1.041	0.020
Saudi Arabia	0.576	0.811	0.716	1.377	0.816	1.290	0.007
South Africa	0.209	0.077	0.047	0.350	0.964	0.769	0.003
Turkey	0.509	0.652	0.623	0.833	0.871	0.886	0.009
United Kingdom	1.691	1.587	3.724	1.398	1.212	1.239	0.849
United States	1.217	1.258	4.316	1.328	1.171	1.196	7.685
	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄
Argentina	0.058	0.834	1.179	1.155	0.329	1.199	0.439
Australia	0.078	0.635	0.638	0.876	1.057	1.255	2.166
Brazil	0.109	1.079	0.395	0.051	0.300	0.876	0.340
Canada	0.550	0.933	1.039	1.434	0.987	1.142	1.749
China	8.784	0.768	0.942	1.791	1.251	0.834	0.377
France	0.696	0.887	0.857	1.446	1.303	1.157	1.572
Germany	0.875	0.609	0.687	1.722	1.814	1.204	1.806
India	0.211	1.105	3.008	0.152	1.207	0.468	0.076
Indonesia	0.016	1.562	0.589	0.046	0.577	0.562	0.147
Italy	0.174	0.807	0.559	0.093	0.810	1.061	1.307
Japan	1.201	0.589	1.161	2.754	1.897	1.229	1.479
Korea(Rep.of)	0.503	0.609	0.826	3.599	2.538	1.072	1.262
Mexico	0.065	1.072	1.689	0.072	0.194	0.795	0.366
Russia	0.139	2.502	0.832	0.064	0.656	1.069	0.429
Saudi Arabia	0.034	1.767	0.899	0.048	0.370	1.011	0.881
South Africa	0.021	0.999	1.240	0.047	0.484	0.757	0.241
Turkey	0.045	0.867	0.826	0.061	0.568	0.813	0.357
United Kingdom	1.952	0.708	0.674	1.590	0.993	1.265	1.626
United States	3.488	0.668	0.960	2.000	1.663	1.232	2.379