

# Impact of blockchain technology on supply chain collaboration: a case study of JD Chain

Zhirui Chen\*

Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, 999077, Hong Kong, China

**Abstract.** This study uses JD.com as a case study to explore blockchain technology's application in supply chain management. By leveraging distributed ledgers, consensus mechanisms, smart contracts, and cryptographic techniques, blockchain effectively tackles problems related to privacy protection, information traceability, and authenticity within traditional supply chains. This paper examines JD's blockchain framework and its impact on various supply chain functions, revealing that blockchain technology has markedly improved procurement efficiency, reduced costs, enhanced customer trust and sales revenue, optimized logistics operations, and streamlined management processes. Through its JD Chain platform, JD.com has boosted operational performance and economic value and offered valuable insights for smaller enterprises. Given the technical and financial constraints faced by smaller firms, it is recommended that they engage in open source blockchain communities hosted by larger organizations to lower information acquisition costs and share resources. This paper provides practical advice for enterprises considering the integration of blockchain technology into their supply chain management.

## 1 Introduction

For now, the hot spot of blockchain technology in China is still in finance. Relatively vicious, the information transparency requirements are extremely high, but there is a lack of attention to the supply chain area where some data transmission is not smooth, data distortion, and other problems. Blockchain technology fundamentally solves the problems of privacy protection, information traceability, information authenticity, and other problems existing in the traditional supply chain. However, because the application of blockchain technology in the supply chain is still in the early stage, many enterprises are still in the wait-and-see stage of "hesitating" for blockchain technology.

Blockchain technology first appeared in the Bitcoin exchange platform, the principle is to connect the transaction location of each bitcoin through a trusted chain, thus forming the blockchain. The blockchain created by Satoshi Nakamoto is one of the earliest blockchains in the world, also known as the Genesis block. This means that no matter which block, if the chain traces the past, it will return to the original Genesis block [1]. The main core technologies of blockchain technology include distributed ledger, consensus mechanism,

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\* Corresponding author: [21099481d@connect.polyu.hk](mailto:21099481d@connect.polyu.hk)

smart contract, and cryptography technology [2-4]. In essence, blockchain is to apply the intelligence of its distributed structure to enterprise transactions and build mutual trust. Each block contains a batch of transactions, which are packaged into a block after verification, and the block relates to the previous block through the hash function to form a chain structure composed of multiple blocks.

Supply chain management relies on collaboration and mutual benefit. Based on mutual trust, benefit, and long-term development, supply chain members convert consumer demand into collective actions, maximizing overall benefits through cooperation and coordination. This collaborative partnership replaces traditional competition [5]. The motivations for supply chain collaboration are threefold: First, the need to respond quickly to customer demand. Improving product quality, production efficiency, and information sharing requires overall cooperation to shorten cycles and enhance flexibility [6]. Second, reducing transaction costs among members. Coordination mechanisms promote collaboration, lower transaction costs, and improve the overall cost advantage [7]. Third, the need for specialization through division of labor. Collaboration enables firms to focus on their strengths, create specialized products and services, and ensure quality and delivery through joint management [8].

Effective performance evaluation of supply chain collaboration can promote communication among supply chain members, strengthen information feedback, and reasonably evaluate the effect of supply chain collaborative operation, which is an important part of the effective planning, control, and decision-making of the supply chain [9, 10]. Supply chain collaborative performance is a direct reflection of the level of supply chain collaborative operation. However, so far, the indicators for evaluating supply chain collaboration are not comprehensive and accurate.

Given this, this paper takes Jingdong's supply chain technology, as the research object, and discusses the operation characteristics, influence mechanism, and supply chain collaboration effect of its introduction of blockchain technology, to provide effective suggestions for other enterprises to apply blockchain technology and promote the application and development of blockchain technology.

## 2 Research setting and method

The goal is to explore the performance of blockchain in the field of supply chain. This study chose Jingdong, a representative enterprise, as a case, and developed a set of performance evaluation criteria based on supply chain collaboration theory.

JD Chain, a professional brand of blockchain technology and services under JD Digital Technology, focuses on creating trustworthy enterprise-level blockchain services for enterprise needs. Based on the underlying blockchain technology, JD Chain provides all-round and life-cycle enterprise-level blockchain application solutions. The JD Chain engine can process more than 20,000 transactions per second, which can reach 1 billion level of account storage and 100 billion level of transaction storage, support the verification and execution of cross-chain contracts, multi-chain collaboration TPS can reach 1 million level, and has strong security and privacy features, supporting both national secret and international cryptosystem standards. It will also achieve higher performance through the optimization of storage, consensus, contract execution, and other modules, and parallel processing design of transactions and check-ups. Typical cases are as follows.

Second-hand mobile phones. The tracing process involves three roles: sellers, testers, and sales platforms. Sellers send phones to the inspection authority for testing. The system generates inspection orders for sales merchants and sends phones to testing institutions. These institutions confirm and test phones according to Paipai standards and submit results to the traceability platform. The results, including indicators and final grading, are returned

to sales merchants, who list and sell the phones based on these grades. Consumers can verify the phone's test results via the blockchain by checking the unique code (IMEI or traceability code) on the delivery order or QR code on the phone.

Fresh food. With rising living standards, the quality requirements for fresh food increase, and market competition becomes fiercer. For instance, Xiyu Sea Cucumber uses JD Chain's anti-counterfeiting traceability platform to manage quality across the supply chain. The platform displays the entire production process via video and provides real-time growth information. It also incorporates marketing activities like member management, red envelope marketing, lotteries, and surveys, helping brands enhance consumer trust, boost sales, and achieve a brand premium.

### **3 JD Chain technical framework**

#### **3.1 Blockchain architecture**

The flexibility, scalability of the system, and the diversity of business support are the basic capabilities of JD to realize the underlying framework of a general blockchain for enterprises. Therefore, the design of the JD Chain on key components such as consensus, ledger, contract, storage, and password Service is pluggable, and the standard SPI (Service Provider Interface) is defined. Users can customize the implementation according to the requirements of different business scenarios or different participants in the same business scenario. So that the whole system can be assembled like building blocks.

JD Chain is divided into three parts according to the functional level, namely gateway service, consensus service, and data ledger.

Gateway service is an application access layer, which provides device access, private key management, security and confidentiality, protocol conversion, and other functions. The key management system can save the key in the form of ciphertext in the gateway but also can provide users with key query, signature generation, and other functions. Security and privacy means that the encryption algorithm with private characteristics is adopted on the gateway to desensitize the data information so that it is only displayed by the authorized nodes, to ensure that the information cannot be tampered with and privacy.

Consensus service, as an important implementation method, provides an effective method for communication between nodes, identity management, security authentication, transaction processing, smart contracts, data queries, etc., to ensure that the account information between nodes is consistent. JD Chain system changes the internal data of the company by changing the status information of the account books and accounts. The corresponding contract engine is also introduced into the JD Chain to ensure the security and effectiveness of the contract and reduce the development and expansion of the system.

Digital ledger provides basic blockchain services such as block, account, configuration, and storage for all parties. The toolkit is a toolkit that runs through the entire blockchain system, and users can get the corresponding tools as long as they call a certain interface.

#### **3.2 Anti-counterfeiting traceability platform**

##### *3.2.1 Full process traceability*

JD Chain anti-counterfeiting traceability platform involves several subjects, this chain has to provide product manufacturers, suppliers, as well as product testing authority testing institutions, retailers selling products, as well as transport products logistics enterprises, and finally have product of the product. The blockchain links these links in series, and the

information is recorded through the blockchain. First, the production enterprise will produce and process the goods, including the selection of raw materials, the optimization of processing technology, quality inspection, etc., and send the goods to a professional testing institution for testing to ensure that the quality of the goods meets the prescribed standards; Then, the testing agency will send the product inspection batch, traceability code and other digital labels, as well as the product test results to the JD Chain anti-counterfeiting traceability platform, so that consumers can effectively track the source, quality and safety of the product. Finally, the testing agency will conduct more accurate testing on the products according to the requirements of consumers to ensure that the products meet the relevant standards. The test results require the participation of multiple parties, including brands, retailers, and regulatory authorities, to ensure the authenticity of the data, and can be quickly held accountable if problems occur. By scanning the QR code or RFID, consumers can directly obtain the traceability information of the whole process of the product, creating a secure and reliable shopping environment.

### *3.2.2 Anti-counterfeiting traceability*

The JD Chain anti-counterfeiting traceability platform writes the data uploaded by the alliance entities into the blockchain network and combines physical anti-counterfeiting labels, RFID, AI identification, and other methods to form a complete anti-counterfeiting traceability system. Apply for a traceability code on the JD Chain anti-counterfeiting traceability platform, assign a traceability code to each product, combine physical goods with digital codes, and conduct counterfeit identification and early warning through traceability code query times, chip comparison, AI identification verification, and other ways, while displaying traceability information recorded in the blockchain to consumers. Let consumers simply complete the authenticity verification of goods, while obtaining the process information of the whole life cycle of the goods from the raw material, to achieve real anti-counterfeiting traceability.

## **3.3 Digital depository platform**

### *3.3.1 Blockchain value-added special invoice*

Jingdong introduced blockchain technology to reduce the cost of paper invoices. Using blockchain decentralization, full process traceability, non-tamper, and other technologies, can reduce problems such as false invoices and repeated reimbursement of VAT special invoices, and the data is transmitted to the recipient, who can query the invoice information that cannot be tampered with, improve transaction efficiency, reduce transaction costs, and improve financial operation efficiency. Then through cryptography technology, each relevant enterprise can intelligently consult its relevant information to ensure data security and privacy.

The invoice system of Jingdong transmits the invoice information to the third-party billing service company, and the billing service company provides the linked data. The billing company will sign and endorse the linked information, and use smart contracts to confirm the billing information, generate PDF electronic value-added invoices, and send them to Jingdong, and Jingdong will input them into Jingdong key customer system. The enterprise receiving the invoice obtains the electronic value-added invoice from the interface and uses the hash algorithm to accurately match it, to realize the accurate verification of the invoice information, and to ensure the correctness and consistency of the data.

### **3.3.2 Logistics documents lactonization**

By applying blockchain technology to logistics documents, the document data on the alliance chain can be traced throughout the process and the data status of logistics documents can be monitored in real-time. Given that traditional paper documents are not timely signed, easy to lose, easy to be tampered with, high management costs, Jingdong is based on blockchain technology and electronic signature technology, and the development of "on-chain signature" products. At the same time, the use of digital signature technology, to solve the problem of ordinary document processing, to ensure that in the delivery process, anomalies can be found, timely correction, and the correct data is uploaded to the chain. Jingdong takes advantage of the logistics supply chain and relies on its existing logistics network and technology to create a blockchain-based trusted document signing platform, aiming to realize the integration of document flow and information flow, improve the efficiency of document flow, reduce transportation costs, and improve delivery quality.

### **3.4 JD Chain technology features**

Transparency of supply. Through the anti-counterfeiting traceability platform built by Jingdong, based on the traceability code, the traceability information of the goods is presented to the user, so that each product has its code, giving the goods an "identity card", each piece of information has everyone's digital signature and time stamp so that all participants have the traceability ability, thus improving the transparency of the supply chain. Improve the transparency of the supply chain.

Logistics security. Based on "signing on the chain" and based on the blockchain-trusted document signing platform, Jingdong uses blockchain technology to build an alliance chain, to achieve the purpose of paperless operation, paperless handover, and automatic document verification, so that the flow of documents and information flow become a whole. Adopting blockchain technology to ensure the security and privacy of logistics documents, the utility model greatly reduces the inspection workload during the circulation of paper documents and promotes the safe and efficient delivery of logistics.

Cooperation and sharing. JD Chain is an open platform that provides services for commercial organizations. It takes lowering the threshold of enterprise application as its mission. From the standpoint of enterprise users, JD helps enterprises enter the door of blockchain applications and provides a complete set of solutions. Including a one-click deployment function, open and compatible with a variety of base layers, reliable authentication of the identity chain, enterprise dynamic networking, horizontal expansion, lightweight gateway, and a series of technical features.

## **4 Analysis of the impact mechanism of JD Chain on supply chain collaboration**

### **4.1 Supplier collaboration**

Supplier collaboration is embodied in reducing procurement costs and improving procurement efficiency. JD builds blockchain technology architecture, builds an alliance chain with suppliers, builds a supplier database, forms information sharing between the two, and insights into consumers' consumption preferences through big data analysis, and manufacturers produce tailor-made products for customers. In this way, product selection can be recommended according to consumers' preferences, which can effectively and

appropriately purchase, avoid excessive inventory overstock caused by blind purchasing, and reduce ordering costs.

The anti-counterfeiting traceability platform built by Jingdong can, according to the information network formed by it, establish a supplier database, record the information related to supplier cooperation and supply records, and select the best suppliers in the database for comparative analysis to reduce transaction costs, and adjust prices in real-time according to product purchase and sales, to reduce the cost caused by poor information.

JD applies blockchain technology to the electrification of value-added tax invoices to realize an intelligent and transparent procurement process, reduce problems such as false invoices and repeated reimbursement of special value-added tax invoices, and transmit data to the recipient so that the recipient can query the invoice information that cannot be tampered with and improve transaction efficiency.

## 4.2 Customer collaboration

Customer collaboration is embodied in reducing sales costs. The needs of consumers are elusive, and with the use of big data such as blockchain, it is easier and cheaper to capture consumer preferences. The products of Jingdong's anti-counterfeiting traceability platform are used to form intelligent analyses of consumer preferences, and the system tracks, collects, and analyzes users' browsing and purchasing behaviors. Combined with the results of big data analysis, the users who scan the code are analyzed to achieve accurate market positioning and improve customer acquisition and satisfaction. The use of artificial intelligence technology to provide customers with products that they may be interested in reduces labor costs.

This is reflected in increasing sales revenue. Song mentioned the impact of blockchain on customers' attitudes towards JD products that the anxiety and anger in the comments of products with blockchain services were 1/5 of those without blockchain services, which largely shows that blockchain can increase customers' trust and loyalty, thus improving consumption level [11]. The self-survey data of Jingdong also shows this: the sales volume of nutrition and health care products and maternal and infant milk powder increased by 29.4% and 10.0% respectively; The re-purchase rates of fresh seafood, nutrition and health care, infant and infant milk powder and beauty and skin care products increased by 47.5%, 44.8%, 6.8%, and 5.2%. For fresh seafood products, while launching traceability services, clairvoyant video helped product sales increase by 77.4%.

## 4.3 Logistics coordination

Jingdong uses blockchain to realize the electrification of logistics documents in logistics links, effectively integrates logistics information, builds a visual and transparent logistics network based on the blockchain supply chain, and speeds up the circulation of logistics documents. In addition, in logistics distribution, Jingdong uses big data technology such as blockchain to locate warehouses closer to customers and is equipped with corresponding Courier personnel to provide the optimal transportation route, improve distribution efficiency, and realize the efficient deployment of multiple warehouse tasks, thus reducing transportation costs.

## 4.4 Management collaboration

Management collaboration is not only an important way to improve the operation efficiency of enterprises, but also an important way to improve the business process of enterprises. With the help of the JD Chain information sharing mechanism, enterprises can exchange information more deeply, create a good atmosphere for receiving and providing opinions,

and generate frequent interaction between enterprises, and the cooperation methods and cooperation goals are more similar.

## 5 Analysis of supply chain collaboration performance

### 5.1 Selection of supply chain collaborative performance indicators

According to the analysis of the effect of Jingdong's *Smart Chain* on supply chain collaboration, the analysis of supply chain collaboration performance is also conducted from five levels: supplier collaboration, customer collaboration, logistics collaboration, and management collaboration, and appropriate financial indicators are selected to reflect the changes and analyze the resulting performance. At the level of supplier collaboration, the impact of blockchain invoices and supplier databases is measured by whether procurement costs are reduced. At the level of customer collaboration, revenue, revenue growth rate and the proportion of marketing expenses are used to measure whether customers' trust and purchase rate have improved. The logistics collaboration level is to see whether the additional cost caused by poor information is reduced through the performance cost rate. The management collaboration level can see the operational efficiency of the management through the inventory turnover rate and the proportion of its various revenues.

### 5.2 Supplier collaborative performance analysis

From the Jingdong Group annual report 2021, although the procurement cost of Jingdong shows an upward trend year by year from 2017 to 2021, this is caused by the continuous expansion of the types of goods sold by Jingdong. With the increase in purchased products, the procurement cost will naturally increase. However, as shown in Figure 1, the proportion of procurement cost in operating income is still relatively stable and has a slight downward trend in 2018 and 2019. Meanwhile, according to the availability, the growth rate of procurement costs has decreased since 2018, which indicates that Jingdong has taken certain measures to control procurement costs, including the use of blockchain technology to reduce procurement costs. Reduce unnecessary costs by using blockchain technology.

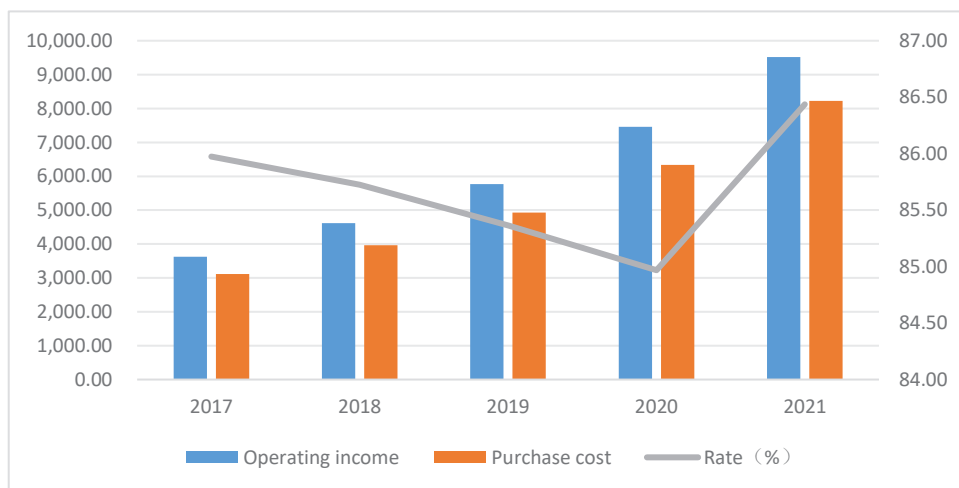


Fig. 1. JingDong 2017-2021 operating income ratio.

### 5.3 Analysis of customer collaborative performance

From 2017 to 2021, the company's operating income increased from 362.3 billion yuan to 951.6 billion yuan; Although the year-on-year growth rate has dropped, it has always been higher than 25%.

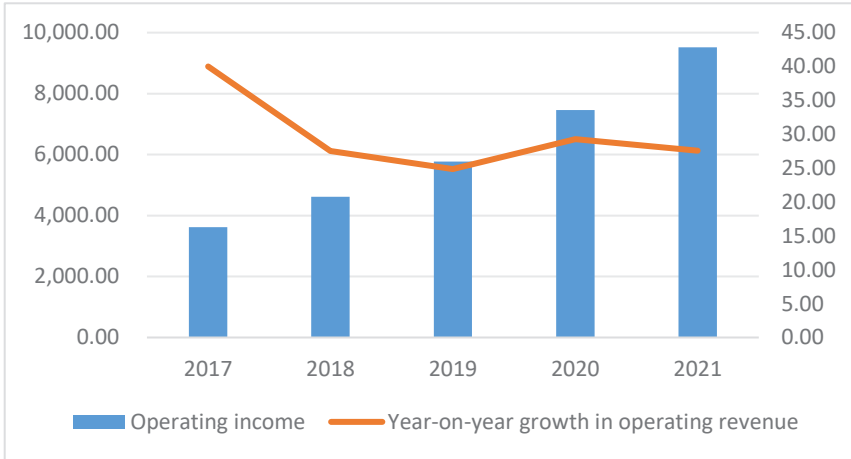


Fig. 2. JingDong 2017-2021 operating income.

As shown in Figure 3, with the improvement of supply chain efficiency and the continuous optimization of other aspects of the enterprise, Jingdong's gross profit margin on sales remained in a relatively stable state, rising to 14.63% from 2018 to 2019. On the whole, the data of Jingdong's net profit margin on sales is not optimistic, and even negative in some years, which means that its cost is too high, but it has changed in 2019 and 2020. To sum up, these three improved in 2018-2020, because JD carried out a series of organizational reforms at the end of 2018, accelerated the pace of entering the Internet, and increased investment such as the application of blockchain technology in the supply chain.

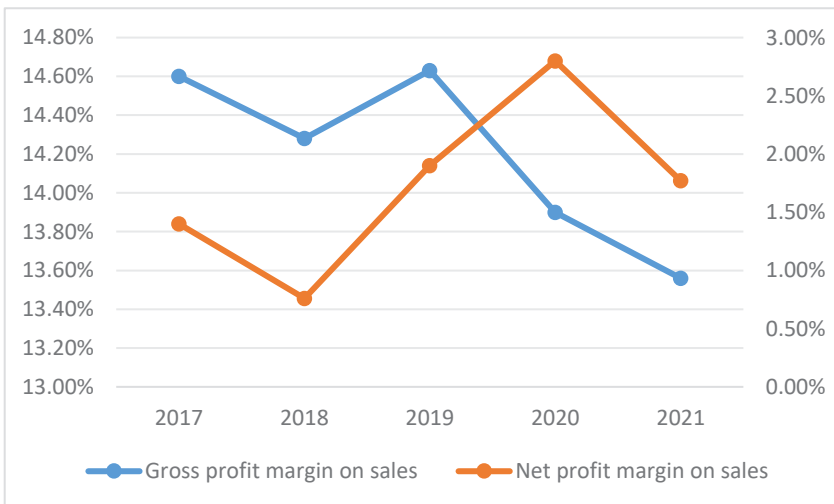
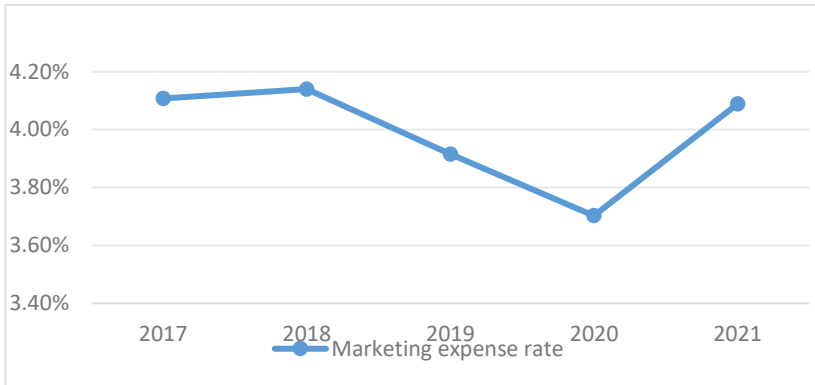


Fig. 3. JD.com's earnings from 2017 to 2021.



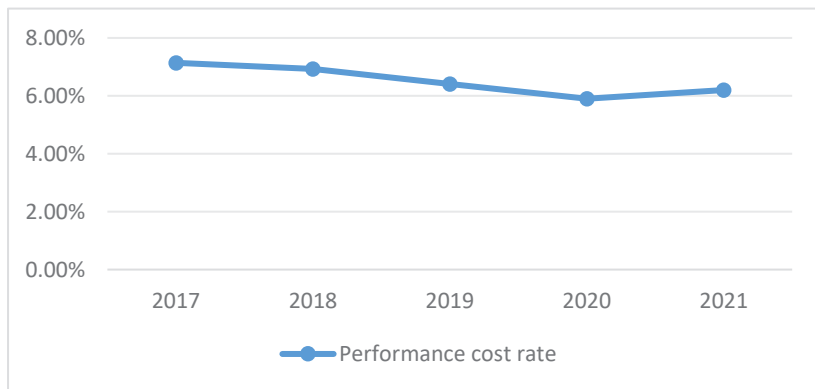
As shown in Figure 4, Jingdong's marketing expense rate tends to decline. This means that blockchain technology promotes product marketing and correspondingly reduces marketing costs, such as advertising promotion.



**Fig. 4.** Marketing expense rate.

### 5.4 Logistics collaboration performance analysis

In recent years, Jingdong has invested in new businesses, built and leased new warehouses, and established more distribution stations to increase sales volume and improve customer satisfaction. However, its performance expense keeps rising, but its performance expense rate shows a downward trend. As shown in Figure 5, the performance expense rate has dropped most significantly, to 6.2%. With the further use of artificial intelligence, big data, and blockchain, Jingdong will further improve its performance capacity and enhance the efficiency and utilization rate of personnel. In addition, with the improvement of efficiency and the release of scale supported by science and technology, Jingdong's performance fee rate still has room to decline.



**Fig. 5.** Performance cost rate.

### 5.5 Management collaborative performance analysis

Inventory turnover refers to the ratio between a company's operating expenses and inventory balance in a certain period, that is, the liquidity of inventory and the occupancy of inventory. From this, the inventory turnover rate of Jingdong has not exceeded 15% in the past five years, that is, the inventory turnover days are less than 30 days, which indicates that the time

required for Jingdong to get the inventory to consumption and sales is relatively short, and the inventory turnover rate is also relatively high. The data of Jingdong's ultra-short inventory turnover days, is inseparable from Jingdong's long-term efforts in intelligent supply chain, logistics, and other fields, integrating blockchain technology into various scenes, breaking through the blocking point, and helping the digitalization of the whole chain.

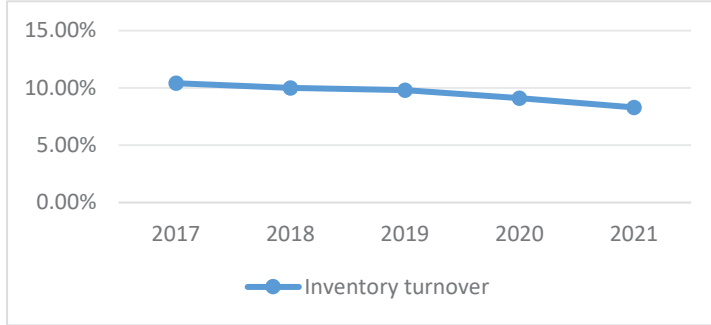


Fig. 6. Inventory turnover.

Jingdong's income and expense ratio overall shows an upward trend. The expense ratio of Jingdong fluctuates between 12% and 14%, which is mainly due to the layout of its own logistics system and the application of big data technology such as blockchain to the logistics system to reduce the order expense ratio. In recent years, the R&D expense rate of Jingdong has not exceeded 3%. Therefore, Jingdong needs further research and development to improve its core competitiveness.

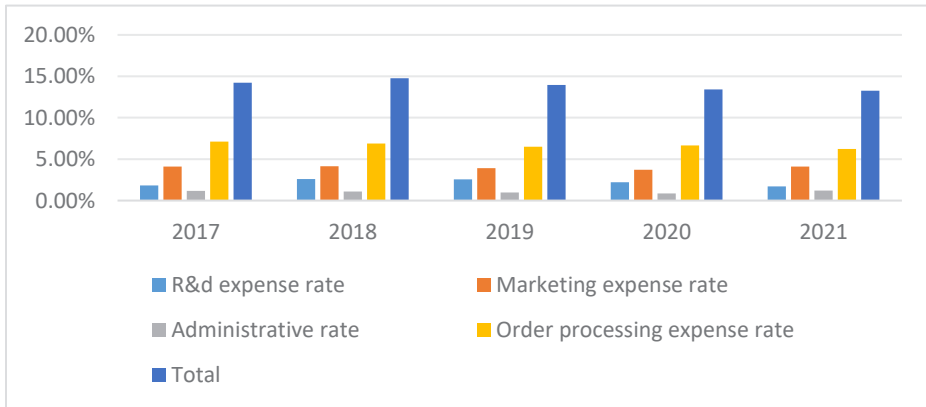


Fig. 7. Jd.com's revenue and expense ratio from 2017 to 2021.

## 6 Conclusion

This study studies the architecture and characteristics of the blockchain technology of Jingdong, an industry representative company, and evaluates its blockchain performance according to the supply chain collaboration theory. The application of blockchain technology has a positive effect on the supply chain collaboration performance and economic added value. At the supplier collaboration level, procurement costs are reduced and procurement efficiency is improved; Customer collaboration level, increase sales revenue, reduce sales expense rate; Logistics coordination level, reduce the performance cost rate; Manage the coordination level, reduce the number of days of inventory turnover, reduce operating costs,

and improve operational efficiency. However, it should be noted that enterprises should choose the way to utilize blockchain technology according to their strength. For SMEs, factors such as weak technical strength and relative lack of funds are not conducive to non-technology enterprises to devote themselves to the independent development and application of blockchain. It is a suitable choice for SMEs to join the open source community of blockchain technology built by large enterprises, jointly maintain and operate, jointly train professional blockchain talent teams, develop common blockchain, form information sharing among alliances, realize information sharing in the community, and reduce the cost of obtaining information.

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