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Article

Logistics optimization based on biomechanical principles and bionic algorithms and its innovative approach to intelligent supply chain management

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Abstract: With the rapid development of the logistics industry, traditional supply chain management faces challenges such as inefficiency and resource wastage. Research on logistics optimization based on bionic algorithms, which is inspired by behavioral patterns and biomechanical principles, enabling these algorithms to effectively address complex issues like logistics path optimization, resource scheduling, and inventory management. In intelligent supply chain management, the application of bionic algorithms not only enhances the intelligence level of decision-making but also improves the adaptability and flexibility of the system. By integrating Internet of Things (IoT) technology, real-time monitoring of logistics resources is achieved, allowing bionic algorithms to comprehensively optimize the logistics process. A cloud computing-based platform architecture enables efficient information sharing among different participants, thereby improving the overall efficiency of the supply chain. This study explores practical applications of bionic algorithms in logistics optimization, demonstrating their effectiveness in enhancing logistics management accuracy, reducing costs, and improving customer satisfaction.

Keywords: biomechanical principles; bionic algorithms; logistics optimization; intelligent supply chain; internet of things (IoT); cloud computing

1. Introduction

With the same freight logistics area slowly becoming a space area where many logistics enterprises gather, how to accelerate the basic construction of the supply chain management platform of the logistics park, and apply to various logistics enterprises to give logistics supply chain service projects according to the logistics park, has become a hot spot for scientific research of experts and scholars around the world. However, compared with the existing supply chain management service platform, the supply chain management data platform of the logistics park encounters the following problems [1]. The business content of various logistics enterprises that move daily tasks and gather in the park usually shows large-capacity frequent service specifications, which requires the timeliness and accuracy of data collection of the supply chain business in the industrial park. The degree of specialization is high, the logistics park has the most typical characteristics of the industrial group, and the relevant enterprises have a high degree of specialization. Therefore, the stability and timeliness of information transmission between enterprises are more demanding, and the requirements for providing services with massive information are higher. There are

many logistics companies gathered in the logistics park. The acceptance of SaaS and PaaS service methods is also very high. As a result, the amount and amount of information on the supply chain management platform on campus has multiplied. The ability to efficiently and massively data processing along with the characteristics of massive information on campus increasingly highlights how to intelligently explore and process a large amount of logistics data to provide intelligent information services, and helping enterprises to immediately and clearly obtain appropriate information and knowledge services at the appropriate address and time is also a major test encountered by the supply chain management service platform on the current stage of the freight logistics campus. The rapid development of Internet of Things technology has brought new ideas to solve the above problems.

The Internet of Things refers to the Internet that connects all goods and big data through information sensor devices such as RFID, infrared sensors, satellite navigation systems, and laser scanners [2]. Carry out information exchange and communication in accordance with the agreed agreement to achieve intelligent identification, accurate positioning, tracking, monitoring and management methods. It has the characteristics of all-round cognition, reliable transmission and intelligent solution. However, the current research on the Internet of Things is mainly in the core technology common to the Internet of Things industry. For example, for example, Internet of Things coding technology, RFID radio frequency identification technology, sensors, wifi network transmission, big data processing, intelligent control systems. How to use a large amount of product information efficiently in the later stage. Unify a variety of services. Provide more humanized service projects for enterprises and individuals [3]. That one didn't get enough attention. In the logistics supply chain, the use of information sensor devices such as RFID for data exchange and communication enhances efficiency but also raises issues of data security and privacy protection. When RFID technology is used for real-time tracking of goods, it may face the risk of data leakage. For instance, unauthorized third parties can potentially access sensitive information by reading RFID signals. The development of Internet of Things technology meets the specific needs of various industries through differentiated deployment, system integration, and the embedding of different algorithms. The manufacturing sector can utilize real-time monitoring and predictive maintenance, agriculture can achieve precision farming, while the logistics industry enhances efficiency through intelligent scheduling and route optimization. Meanwhile. At this stage, applied research is common in smart transportation, power engineering water meter and smart home, but the application of freight logistics supply chain management is rare. The application of the Internet of Things and cloud computing in logistics supply chain management significantly enhances operational efficiency and transparency. The IoT enables real-time tracking and monitoring of goods through sensors and RFID technology, ensuring timely data collection and transmission, which optimizes inventory management and transportation scheduling. Cloud computing, on the other hand, provides robust data storage and processing capabilities, allowing various segments of the supply chain to quickly share information and facilitate collaborative decision-making. Hangzhou Zhonglian Logistics Company has significantly improved the efficiency and accuracy of its logistics supply chain by implementing RFID technology. After the implementation of RFID, the accuracy of inventory management increased from the

original 93% to over 98%, and the inventory turnover time was reduced by 31.2%. In 2023, the company achieved a 13.4% reduction in overall operating costs. IoT devices collect data in real-time through sensors, such as temperature, humidity, and location information. This data is transmitted via wireless networks to a cloud platform for processing and storage. The analysis results are generated through data mining and machine learning algorithms, optimizing inventory management, transportation scheduling, and production processes, thereby enhancing supply chain efficiency. Therefore, the article intends to analyze the characteristics of logistics supply chain management in the same region. Promote the application of the Internet of Things and cloud technology in the supply chain management of logistics parks, build a supply chain management service platform based on Internet of Things technology, integrate the use of social development logistics resources, and improve the rational layout and efficiency of logistics parks. At the same time, by optimizing the workflow of warehouses and distribution centers based on biomechanics principles and designing ergonomically sound work environments, employee fatigue and injury risks during handling and operation can be effectively reduced, thereby improving work efficiency. Additionally, by utilizing IoT technology to collect biomechanics-related data (such as employee movement trajectories and workload), and analyzing it with cloud computing, human resource allocation and workflow can be optimized, enhancing overall logistics efficiency.

2. Platform technical architecture

The freight logistics supply chain management method platform based on The Internet of Things technology refers to a variety of Applications of the Internet of Things, such as terminal equipment such as sensors, data acquisition devices, and sensor network networks. IoT devices such as sensors and RFID tags are used for real-time tracking of goods, with data transmitted to the cloud via wireless networks to ensure real-time accuracy. The platform employs edge computing technology to perform preliminary processing at the data source, reducing latency and improving response speed, like animals' immediate stress response to external stimuli, mobilizing their body functions instantly. For data storage, a distributed database system is utilized to efficiently manage large volumes of data, while data analysis leverages big data technologies and machine learning algorithms to extract valuable insights from vast datasets, supporting decision-making. like the cells in a living organism that perform their respective functions and work together. During the migration process, animals have evolved over a long period of time to form extremely sophisticated route selection strategies, aiming to achieve their goals with minimal energy consumption. Analogously to logistics transportation, with the biomechanics principles incorporated into the design of the logistics supply chain management platform, it is of great significance to optimize transportation routes by imitating animal migration patterns. We embed similar intelligent algorithms, just like giving the logistics system a set of "biological instincts", enabling it to automatically explore the most energy-saving and efficient paths, reducing unnecessary energy consumption and detours.

This integration approach endows the platform with efficiency and flexibility. Complete the supervision of the whole process of logistics resources such as vehicles,

goods, shipping containers, warehouses, etc. [4]. Build a unified campus multi-data integrated messaging middleware. Here the SOA platform framework is selected to build the Zhouqu integrated supply chain management method platform, the support point platform is based on the SaaS system to provide system software system services for various freight logistics service physical lines inside and outside Zhouqu, and the PaaS platform and the establishment of the industrial park supply chain "cloud computing technology" public service. When designing a logistics supply chain management platform, biomechanical principles can be applied to optimize transportation routes by mimicking animal migration patterns. Based on the optimal routes, the movement trajectories of animals can minimize energy consumption, such as the optimal distance achieved by the dung beetle algorithm. Therefore, it is essential to embed necessary algorithms to optimize these trajectories. According to the data exploration of the supply chain on campus, the rational allocation of logistics resources in the same area is completed. The data model of the platform is composed of seven levels: logistics resource layer, data collection layer, communication network layer, supply chain data layer, supply chain APP network layer, supply chain service layer and supply chain management. This is shown in **Figure 1**. The relationship between big data cloud computing and the Internet of Things.

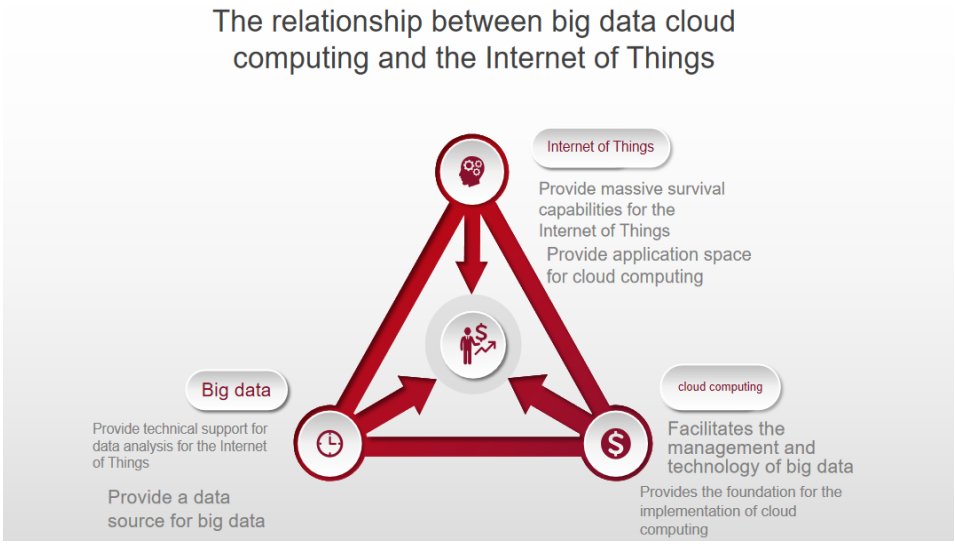

Figure 1. The relationship between big data cloud computing and the internet of things.

(1) Logistics resource layer

This hierarchy describes the primary view of the campus supply chain management approach facing logistics resources.

(2) Data collection layer

This layer uses IOT core technology to monitor and track a variety of logistics resources. The data collection time range includes instant data collection based on end device data devices (e.g., RFlD) and comprehensive on-time data collection based on dedicated company sockets; Emergency data collection based on special circumstances, such as road traffic information in the event of devastating flood disasters. As shown in **Table 1**. Cloud computing and edge computing for the Internet of Things [5].

Table 1. Cloud computing and edge computing of the internet of things.

Classify	Parameter	Numeric value
Basic parameters	Product size	100 × 80 × 32 (unit:mm)
	Product weight	200 G + 50 G (antenna)
	Installation mode	The positioning hole fixes the live DIN navigation
	Work environment	−25 ℃–75 ℃, 5%–95% No condensation
	Working power supply	DC9-24V
	Operating current	100 mA

(3) Communication network layer

This layer combines the cable TV/wifi network and wireless sensors in the logistics industrial park to create a responsive and generative Internet of Things communication system software, focusing on the construction of a wired Internet according to the aggregation point of the mixed platform. As shown in **Table 2**, the implementation of a bus track optimization system based on the Internet of Things and cloud computing.

Table 2. The implementation of a bus track optimization system based on the internet of things and cloud computing.

S1	Get the basic data for custom inputs from the expert system, including bus routes to be optimized, operating plans, vehicle information, and crossing information
S2	Get the basic data for custom inputs from the expert system, including the vehicle's real-time position at the current moment, real-time speed, and real-time weather conditions
S3	Based on the bus characteristic information and intersection information, the time interval for the vehicle to reach the next intersection is calculated, and the speed guidance strategy is determined according to the relationship between the time interval of the vehicle reaching the next intersection and the time interval corresponding to the red light at the intersection
S4	According to the determined speed guidance strategy, the trajectory optimization model considering the comfort of the bus is established, and the optimal trajectory from Jupiter to the respective pickups is solved
S5	Test records the comfort of passengers during actual operation

(4) Supply chain data layer

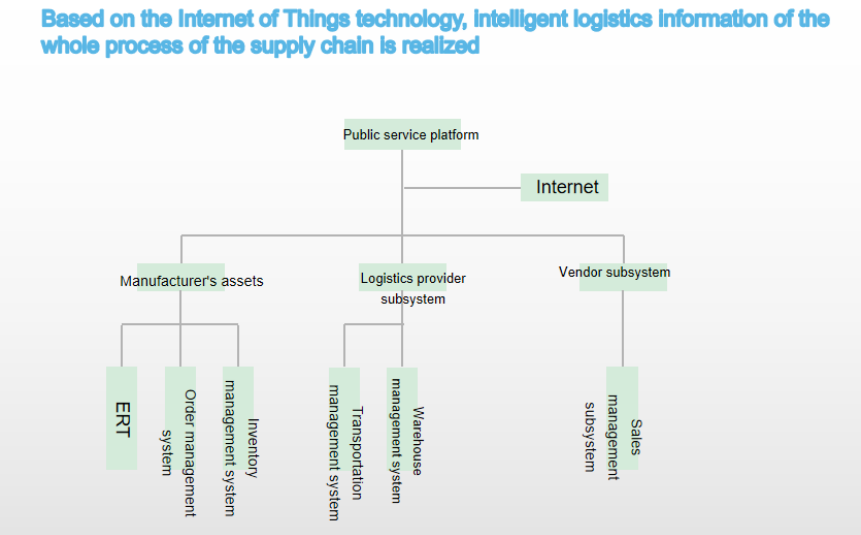

Figure 2. Intelligent logistics information for the whole process of supply chain based on internet of things technology.

This layer gives four data management method components such as data definition, data integration, data interchange and data distribution, and sets up a commonly used integrated data message middleware that applies to the unified description of the entity model of the main view of various freight logistics data and the separate and unified browsing of logistics resources and business data in industrial parks. As shown in **Figure 2**, intelligent logistics information for the whole process of supply chain based on Internet of Things technology.

(5) Supply chain APP network layer

The SaaS application model provides consumers with rental services for several system software such as freight logistics intelligent management system, warehouse management software, driver mobile phone service system software, freight forwarding company intelligent management system, LCD/LED information release software, etc.

$$(\text{NSID-IOT}) + (\text{NB-IOT}) + (\text{OID-IOT}) = \text{IOE/IOE*N} = \text{IOT} \quad (1)$$

(6) Supply chain service layer

This layer defines four supply chain universal service modules: network resource accurate positioning service, information transmission service, and resource scheduling service. Applicable PaaS platform services, providing consumers with these four web services.

ROI (Return on Investment) refers to the value that should be returned through the investment, that is, the economic return of an enterprise from an investment activity, which is generally the ratio of the income that we get and the input cost. In the e-commerce link, we believe that ROI is equal to the seller's investor output ratio.

$$\text{ROI} = \text{income/investment of 100\%/ROI} = (\text{cost reduction} + \text{revenue growth})/\text{total cost} \quad (2)$$

(7) Supply chain management

The key is to establish and use the public service of "cloud computing technology" in the industrial park, allocate relevant cloud computing servers according to customer needs and the overall goal of resource allocation in the same area, and carry out large-scale data mining of distributed systems [6]; According to the results of data analysis and discovery, business cooperation and management optimization of the supply chain on campus are applicable. As shown in **Table 3**. Big data, job prospects and salary forecasts in the computer industry.

Table 3. Big data, job prospects and salary forecasts in the computer industry.

Firm	Post	Monthly salary	Years of service
JD.com	Big Data Engineer	30 K–60 K	5–10 year
China Merchants Bank Credit Card Center	Spark/Hadoop developer	30 K–60 K	5–10 year
Fun Shop	Technical Manager of Big Data Development	30 K–50 K	5–10 year
360	Hadoop architect	30 K–50 K	3–5 year
Sina.com	Big Data Development Engineer	25 K–50 K	3–5 year
Bilibili	Big Data Development Engineer	25 K–50 K	3–5 year

3. Realization of key technologies

3.1. Internet of things construction technology supporting supply chain management in the park

Logistics industrial park in the work of mobility and business diversity and other advantages, the provisions of the construction of cable TV/wifi network and sensor network combined with the Internet of Things technology, to cope with various obstacles, to meet the industrial park connection and masking requirements, including RFID, EPC, diversion of data terminal equipment and other data in it, the industrial park logistics supply chain at all stages of the main through VPN and other wired networks to collect and exchange business process data, such as warehousing enterprises and transportation enterprises between the delivery of order information data; Company, vehicle transport, driver, etc. [7]. This is like how organisms evolve diverse ways of perception to adapt to the complex and changing living environment. According to the broadband and other wifi networks, the collection and exchange of the location of the car and the use of status data and other logistics resources and goods status data, the real-time status detection of goods, shipping containers, trolls and other storage tools in the cell is usually collected using the sensor network in the cell. The application of the IoT technology in various fields of the park, the overall synergy, like an organic organism. Each part based on the principle of biomechanics, precise division of labor, close cooperation, to protect the logistics supply chain efficient and smooth operation, to cope with the complex and changing market demand, to achieve the park's steady development. This is shown in **Figure 3**.

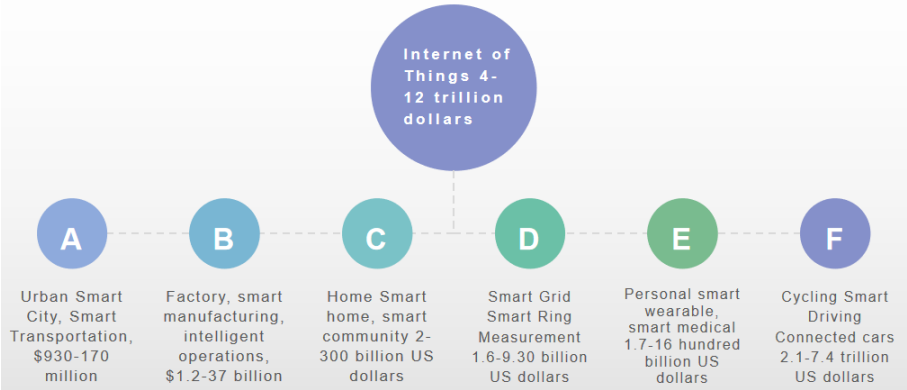

Figure 3. The application of internet of things technology in various fields.

The campus sensor network design scheme uses responsive self-organizing network system software based on the Zigbee protocol and cluster topology, including three types of nodes: aggregate data points, regional router nodes, and sensor nodes, each of which has a self-healing level [8]. It's not just about data collection. It also has a data transmission and detection role. The network configuration allows all wireless network sensor nodes to communicate with each other immediately. In addition, each sensor node has several paths to the communication base station node. Each Internet forwarder selects one or several roads in the southern region to carry out multi-hop forwarding, forwards the forwarded data information content to the communication base station, and improves the stability of the information network forwarding. As

shown in **Figure 4**, a smart home system based on IoT computing works.

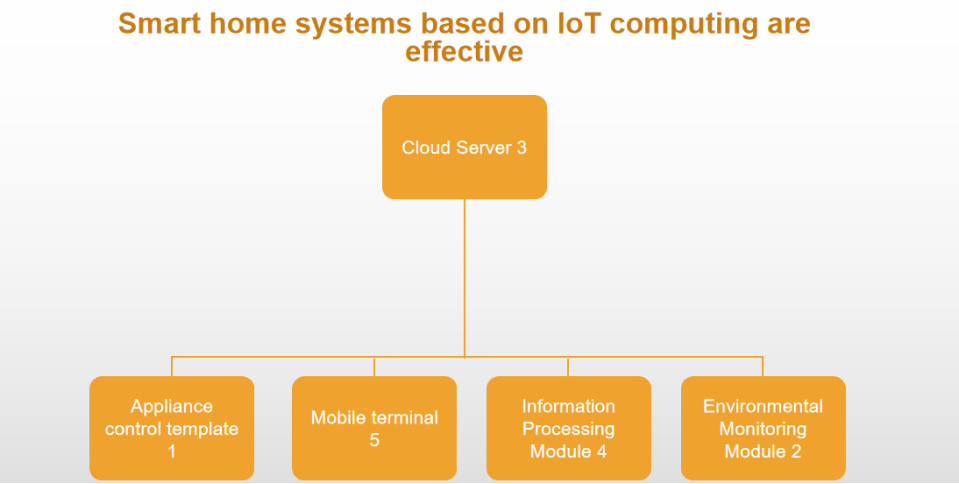

Figure 4. A smart home system based on IoT computing is effective.

3.2. Multi-source data integration middleware technology for integrating internet of things data

Logistics industrial park supply chain management has the existence of data access and interaction model, in which many key points that are consistent with the principles of biomechanics. The data file formats of different logistics resources vary greatly, and it is necessary to create a unified data integration middleware that enables different types of APP applications to access independent heterogeneous data sources. It includes six data management models: network resource characteristic data model, logistics business data model, indoor spatial data model, step data model, metadata model and knowledge data model [9]. This process like the nervous system precisely coordinates various parts of the body to respond to external stimuli in a unified manner. Among them, the network resource characteristic data model, logistics business data model, and indoor space data model are static data source data. Data file format definition module, source data representation module, data transfer management method module, and data quality control module in middleware. The on-campus supply chain service platform provides access to many types of data standards described above. This is similar to the condition that sensory organs of organisms collect various environmental information. Abstract distributed system data into a structured distributed systems database file. The whole process data model embodies the characteristics of dynamic process data collected in real time according to IoT technology in the same region. And this process is similar to the process of organisms converting complex external stimuli into internal processable signals. Data access management method module and data quality control module according to data middleware. Efficient storage and access to a large number of step data streams. According to the distributed system isomer data source integration module in the data middleware, it is possible to summarize, clean, and organize the data from different sensor nodes, and obtain a process data flow induction entity model that records the movement status of the goods in detail [10]. The metadata model is a unified master view entity model of supply chain management data on campus built through the Data Projection Module, XML Representation Module, Data Transformation Module, and

Word Conflict Resolution Module. According to the entity relationship, the appropriate data structure is selected, and the network association between the network resource characteristic data, logistics business data, indoor space data and process data is added to indicate that the data transformation and standard expression are carried out in accordance with the data requirements, and the independent access professional knowledge data model applicable to different APP software systems reflects a variety of professional knowledge information applicable to the supply chain optimization on campus, including fleet management improvement information, distribution route improvement information, etc. This information is obtained based on the metadata acquisition module, the data access module, the data integration module, and the data mining module. Solve the basic information obtained from the initial data, and actively push it to different disciplines at a moderate time and place. It is used to complete the collaborative operation between various aspects of supply chain management in the industrial park. As shown in **Figure 5**, the relationship between IoT and big data cloud computing

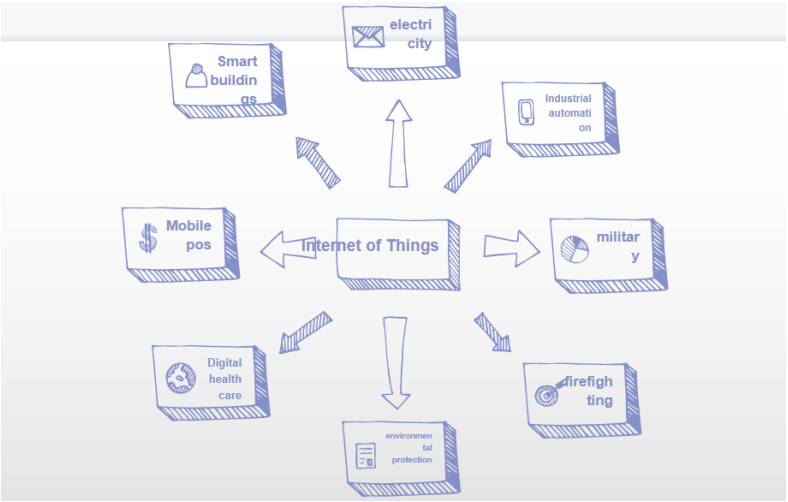

Figure 5. The relationship between IoT and big data cloud computing.

3.3. Information intelligent push service technology based on task situation

The application of the Internet of Things not only provides strong data collection and communication services for the supply chain platform of industrial parks. More importantly, it must provide strong service support for the data transmission between different actors of Gangqu supply chain management [11]. In particular, according to the task environment faced by different actors, intelligent messages push business information and knowledge. Daily task scenario refers to the characteristics of the internal and external environmental elements faced by the daily task of supply chain management on campus. Build an intelligent information push service system software according to the front and back of the daily tasks, solve the information according to the daily task context perception, and provide immediate and appropriate data transmission and release services, so as to improve the demand sensitivity and adaptability to the daily tasks under the complex conditions of the system. As shown in **Figure 6**, IoT-cloud computing builds smart city information systems.

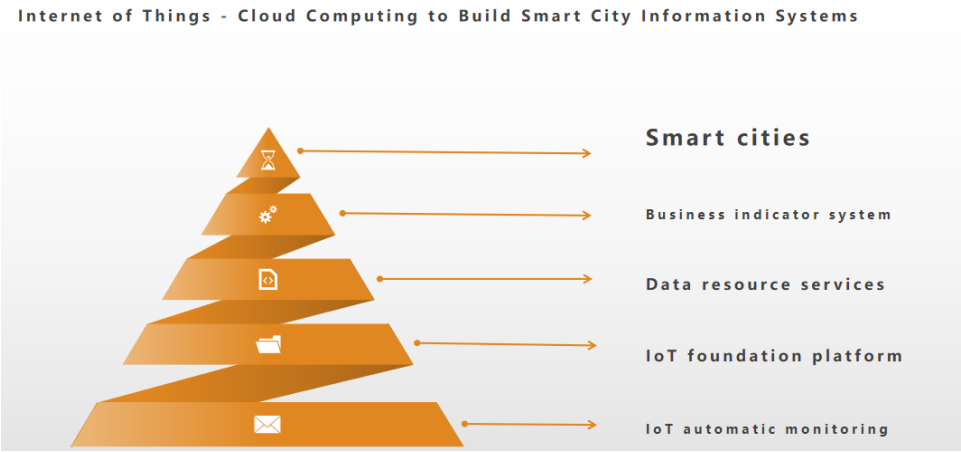

Figure 6. Internet of things—Cloud computing builds a smart city information system.

Among them, the data transmission service project provides adaptation point to point swap and master and slave relationship exchange mixed business data transmission entity model and system, according to the Internet of things data, cloud computing technology, enterprise data special public cultural service form to complete the campus supply chain management daily task of data collection and business data transmission: data distribution or push services to provide tasks of context perception and open parts [12]. Be able to structural describe the characteristics of daily task script production. Open standards with default settings. The regional supply chain management service platform is applicable to provide user companies with active, immediate and purposeful information classification and intelligent push service. For example, the service requester retrieves the information push service started in and after the task time, the information push service started in the before and after of the daily task site, and the information push service launched in and after the daily task customer preference. As shown in **Figure 7**, there are 266 supply chain innovation and application pilot enterprises.

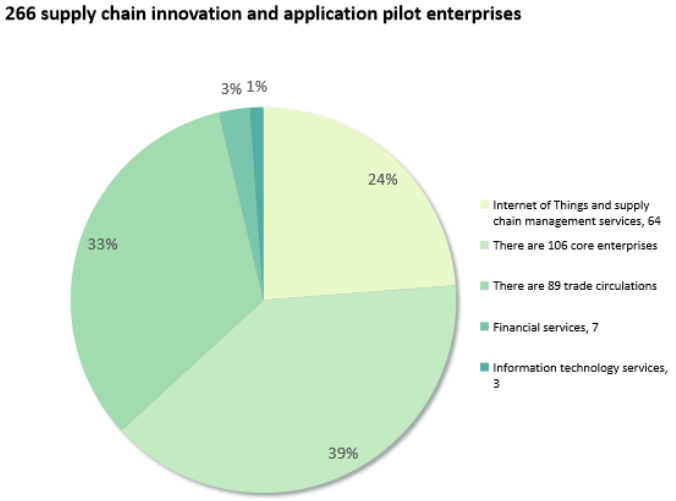

Figure 7. 266 supply chain innovation and application pilot enterprises.

3.4. Park supply chain decision optimization technology based on the "cloud computing" public platform

Table 4. Cross-border integration of technology in the era of artificial intelligence Internet of Things cloud computing and other cross-border scientific and technological frontier areas.

Tackle key research in the frontiers of science and technology
1) A new generation of artificial intelligence Cutting-edge basic theoretical breakthroughs, special chip research and development, deep learning framework and other open source algorithm platform construction, learning reasoning and decision-making, image graphics, language video, natural language recognition processing and other fields of innovation
2) Quantum information Field, intercity, free space quantum communication technology research and development, general quantum computing prototype and practical quantum simulation mechanism value, quantum compact measurement technology breakthrough
3) IC Integrated circuit design tools, key equipment and high-purity targets and other key materials research and development, integrated circuit cash process and insulation mountain bipolar transistor, micro-electromechanical system and other characteristic process breakthroughs, cash savings technology upgrades
4) Brain Science and Brain-Like Research The principle of brain cognition is clear, the brain takes over the neural connection map, the mechanism and intervention of major brain diseases predict the brain law enforcement of children and adolescents, and the research and development of brain-like computing and brain-computer computing fusion technology

According to the cloud supply chain management decision improvement system model. The basis is to establish a cloud computing server cooperation group composed of the campus application of system server, GIS network server, and other hardware and software network resources, including logistics industry network server, under the overall framework of "cloud computing" public cultural services on campus [13]. According to the dexterous production scheduling of a large number of distributed storage resources, all users can experience the massive data analysis and excavation service projects of distributed system isoforms provided by the campus "cloud computing" service platform. In them, the campus supply chain management global manipulation node agent carries out structural dissolution of users' daily tasks, clearly defines the data mining model and related data used, then seeks the corresponding Web service network resource nodes for different sub-tasks, and carries out my own data visualization method to submit to users. Each node agent gives the local autonomous big data mining according to the subtask set assigned by the global manipulation node agent, and returns the execution results of the related sub-tasks back to the superior leadership node. As shown in **Table 4**, cross-border technology cross-border integration technology era artificial intelligence Internet of Things cloud computing and other cross-border science and technology frontier areas [14].

This section will introduce three logistics optimization algorithms based on biological principles, and explore their applications and advantages in park supply chain decision-making

Algorithm 1: Ant Colony Algorithm. The ant colony algorithm is based on the biological principle of ant foraging behavior, simulating the path selection of ants when searching for food.

Algorithm 2: Particle Swarm Optimization. The particle swarm optimization algorithm is derived from the foraging behavior of bird flocks, utilizing collective intelligence for logistics scheduling and resource allocation, enabling rapid

identification of optimal solutions.

Algorithm 3: Dung Beetle Algorithm. The dung beetle algorithm mimics the optimal path selection of dung beetles when searching for food, simulating strategies that minimize energy consumption.

4. Application of case analysis

At present, the platform prototype system has been basically used in Hangzhou genesis logistics technology co., LTD. Hangzhou Genesis Logistics Technology Co., Ltd. is a company focused on intelligent logistics solutions, established in 2015. The company has approximately 300 employees and an annual revenue of 150 million RMB. Before adopting the platform prototype system, Genesis Logistics faced several challenges, including an inventory management accuracy rate of only 85%, an average cargo tracking time of 3 h, annual operating costs reaching 20 million RMB, a customer complaint rate of 5%, an average order processing time of 48 h, and a transportation delay rate of 15%. Research and development of "logistics industrial park logistics supply chain integration management service platform", using the system of logistics industrial park by logistics business physicians (provide information services and charge clearing), freight line, warehousing rental area, freight line area gathered several freight line companies, in more than 40 cities with the country collaboration handling point, can provide goods for the park nationwide logistics distribution services.

The APP uses the system architecture. The system first in the warehouse area such as sensor node and other data acquisition equipment, using "all-in-one-card" system will RFID card associated to the car, storage equipment and personnel, complete the cable network and sensor network Internet integration of Internet technology system then set up by data information, business data, management decision data and database information, to support each APP platform system of independent browsing [15]. Three is to provide campus one-stop register for an examination APP business system, support SaaS way for the park company to provide line logistics management system, logistics warehousing management system, GPS/GIS regulatory APP business system and other mobile software system services, support PaaS way to provide users with public resources network Web services, such as according to the delivery system of logistics logistics distribution service, according to the online garage system garage network resources view and enable service, etc. In the end, the service platform provides a very powerful appreciation information service project. Support the service platform to use the mobile phone information service and special equipment security information to accept the self-service role of the information service hall, to provide strong classified information promotion services for various customers.

Hangzhou Genesis Logistics Technology Co., Ltd. optimizes logistics delivery routes through the ant colony algorithm, collecting data in real-time and calculating path selection probabilities. The algorithm's embedded design includes several parameters:

- Initial pheromone concentration: set to 1.0, indicating the basic attractiveness of the path.

- Pheromone evaporation rate: set to 0.1, representing the decay speed of pheromones over time.
- Heuristic function weight: set to 1.5, emphasizing the impact of path length on selection.
- Pheromone weight: set to 1.0, highlighting the influence of pheromone concentration on selection.
- Number of ants: set to 50, ensuring diverse path selection.
- Maximum iterations: set to 100, limiting algorithm runtime.
- Minimum path length: set to 10 km, filtering unreasonable paths.

(1) E-commerce, the Internet of Things

The rapid development of e-commerce has promoted the level of logistics information management and operation, and entered a new stage of intelligent freight logistics [16]. On the contrary, the automation and information ability of logistics management system have promoted the further development of e-commerce. E-commerce has brought good application scenarios to the Internet of Things technology. In the next few years, the Internet of Things technology will undoubtedly be the best way to deal with the personnel shortages, information occlusion and compliance issues facing the industry, and will also become the main technical support for e-commerce companies to further occupy the market.

At the present stage, e-commerce companies have actively sought for multi-dimensional cooperation with the Internet of Things companies, in order to continuously upgrade the freight logistics by relying on the Internet of Things technology, and improve their competitiveness [17]. For example, in January 2017, JD.COM, Banma High-tech and Xinhua three jointly announced the establishment of the "Internet of Things E-commerce Logistics Joint Laboratory", paying close attention to the three scenarios. It is the application of data visualization and intelligent management methods, data visualization and data statistical analysis of the towing and cage car assets of the existing express sorting and repackaging in freight logistics. As shown in **Table 5**, the list of subsidiaries of the three major operators covering the IoT cloud computing space is covered.

Table 5. Covering the list of subsidiaries of the three major operators in the field of IoT cloud computing.

List of the three operating subsidiaries			
Main business scope/operator	China Telecom Group Co., Ltd. (25 companies)	China Mobile Communications Group Co., Ltd. (21 companies)	China United Network Tongxin Group Co., Ltd. (23 companies)
terminal	Tianyi Telecom Terminal Co., Ltd	China Mobile Communications Group Terminal Co., Ltd	China Unicom Huasheng Communications Co., Ltd
Internet of Things	IoT Branch	China Mobile Internet of Things Co., Ltd	Unicom Digital Technology Co., Ltd
cloud computing	Cloud Computing Branch		Unicom Digital Technology Co., Ltd
finance		China Mobile Communications Group Finance Co., Ltd	China Unicom Group Finance Limited

According to the large-scale, high demand and diversity of e-commerce logistics, the automation and intelligent level of e-commerce logistics basically represents the highest level of logistics enterprises. Therefore, e-commerce companies to accelerate the reasonable layout of unmanned warehouses. Among all kinds of technologies of

unmanned warehouse, the most important thing is data perception. It is conceivable that the future Internet of Things technology in the e-commerce application field requirements will be huge. In addition, O2O and new retail based on e-commerce also add a new application to the Internet of Things.

(2) Telecom network and the Internet of Things

As mentioned above, according to the Internet of Things technology, the telecom network has basically completed the transparency and visual management of the transportation process, and the optimization and integration of the transportation network resources, so as to achieve the efficient transportation and transportation, and complete the real-time tracking and traceability management of goods. The Internet of Things technology has completed the all-round integration of freight transportation network resources, car network resources, freight drivers and large truck aftermarket consumption information [18]. It can be said that the telecom network has become the most basic and reasonable layout of the development trend of transportation and logistics. The application of the latest Internet of Things technology is not only reflected in the service quality of logistics cost, timeliness and user experience, but also from the safety factor, stability, instant information, algorithm optimization, logistics warehousing management, high efficiency and other aspects.

Form recognizable IP features with efficient aggregation:

$$\text{Internet realization} = \text{“IP + community + e-commerce”} \tag{3}$$

For example, the intelligent vehicle management solution released by Yanhua Industrial Control can not only collect statistical data and return to the background management system, but also carry out stability point calculation and statistical analysis of the cloud car, people and product information, and directly carry out the industrial Internet of Things. According to the complex industrial Internet of Things of the data collected by the on-board computer, it can prevent and correct the dangerous driving behavior of drivers in time, and complete the proactive safety prevention measures.

$$\text{New stage} + \text{New normal} + \text{informatization} = \text{"Internet +”} \tag{4}$$

(3) Intelligent manufacturing system, the Internet of Things

With the promotion of intelligent manufacturing system and Industry 4.0, the need for logistics standardization, automation and intelligence is increasing. Internet of Things technology, especially sensors and intelligent control technology, has been widely used in logistics management system [19]. The Intelligent manufacturing system not only needs the intelligence of the logistics management system, and in order to realize the matching with the production line, the seamless connection, and the data sharing of the information management system.

$$\text{CPA mode: eCPM} = \text{ctr} \times \text{cvr} \times \text{cpa} \times 1000 \tag{5}$$

5. The application and development of the internet of things in China

The Internet of Things technology will be more commonly used for economic and social development and social development, mainly for smart home system, smart

medical care, new smart city, smart environmental protection, smart transportation, intelligent storage, intelligent industry, intelligent agriculture, intelligent education, etc. The existence of the Internet of things adds to the probability of intelligence to everything around you. According to the wifi network, people can achieve the dialogue and control of such intelligent things, so as to obtain the efficiency of social use. China has put the development trend of the Internet of Things industry chain at the core of the strategy. The application of the Internet of Things technology has greatly improved the identification in the supply chain. This is shown in **Table 6**.

Table 6. Smart city industry policies and regulations.

Time	Policy name	Promulgation Department	Synopsis
2016.02	Several Opinions on Further Strengthening the Management of Urban Planning and Construction	Ministry of Housing and Urban-Rural Development	Strengthen the urbanization of urban management and service systems, and strengthen the construction and functional integration of urban digital platforms
2016.03	Outline of the 13th Five-Year Plan	General Office of the Central Committee, State Council	Accelerate the construction of new cities, accelerate the construction of modern information infrastructure, and promote the development of big data and the Internet of Things.
2016.11	New smart classroom urban evaluation index	National Development and Reform Commission, Cyberspace Administration of China	From the objective indicators, supervisor indicators, self-selected indicators three parts of the smart city evaluation work.

5.1. Visual operations can be performed from manufacturers, distributors to distributors, retailers and even consumers

By analyzing the customer correctly understanding of goods information content, reasonable ensure consumer rights, at the same time is very easy to get good after-sales maintenance service commodity liquidity, retailers can make corresponding order management decisions and marketing way, which not only reduces the inventory consumption and corresponding cost, and enable the retailer to put market information according to the retailer's ordering strategy and marketing strategy, agents timely correct inventory, order to suppliers, dealers also give the order information to manufacturers. 360 Manufacturers timely correct raw material inventory and production according to the purchase of goods, and effectively manage product quality according to the Internet of Things technology [20]. Data visualization of the entire supply chain alleviates the bullwhip effect and enhances the value of the entire supply chain.

$$\text{Second-stage bidding formula: } eCPM = ctr \times cvr \times cpa \times 1000 \tag{6}$$

5.2. Internet of things technology accelerates the company's information automation and completes intelligent management

Using the Internet of Things technology, it can realize the resource sharing between the middle of the enterprise and the whole supply chain, and the company can effectively integrate the workflow and quickly solve the market changes. At the same time, there are many problems, such as inventory management, production orders, distribution channel improvement, and difficult product traceability. The Internet of Things technology can be used to improve immediately. Technical optimization and

automation of all stages of the supply chain can reduce the company's labor costs, inventory costs, logistics costs and other costs, make the management decisions have academic research, further reduce the length of management decisions, improve the competitiveness of the enterprise, and improve the management efficiency of the supply chain.

$$\text{CPC delivery: eCPM} = \text{ctr} \times \text{cpc} \times 1000 \tag{7}$$

5.3. The internet of things technology accelerates the company's information automation and realizes resource sharing

Using the Internet of Things technology, it can realize the resource sharing between the middle of the enterprise and the whole supply chain, and the company can effectively integrate the workflow and quickly solve the market changes. At the same time, there are many problems, such as inventory management, production orders, distribution channel improvement, and difficult product traceability. The Internet of Things technology can be improved immediately. Technical optimization and automation of all stages of the supply chain can reduce the company's labor costs, inventory costs, logistics costs and other costs, make the management decisions have academic research, further reduce the length of management decisions, improve the competitiveness of the enterprise, and improve the management efficiency of the supply chain. Refer to **Table 7** for cost-benefit analysis.

$$\begin{gathered}\text{cost} \\ = \text{Number of exposures} \times \text{cpm} \\ = \text{Number of hits} \times \text{cpc} = \text{Number of exposures} \times \text{ctr} \times \text{cpc} \\ = \text{Conversions} \times \text{cpa} = \text{Number of hits} \times \text{cvr} \times \text{cpa} = \text{Number of exposures} \times \text{ctr} \times \text{cvr} \times \text{cpa}\end{gathered} \tag{8}$$

Table 7. Cost benefit analysis.

Item	Calculation Method/Description
Investment Costs	
Equipment Procurement	Total cost of sensors, RFID tags, and other hardware
Software Development & Integration	Costs for developing the IoT platform and cloud computing system
Cloud Service Fees	Annual cloud service fees (based on service provider pricing)
Expected Returns	
Labor Cost Reduction	Calculate reduced labor costs based on the number of employees and salary savings
Inventory Cost Reduction	Calculate reduced inventory holding costs and expiration losses
Logistics Cost Reduction	Calculate savings from improved transportation efficiency
Payback Period	Ratio of initial investment to annual expected returns
Net Present Value (NPV)	Calculate the present value of future cash flows
Return on Investment (ROI)	ROI = (Expected Returns−Investment Costs)/Investment Costs

6. Conclusions and prospects

According to the Internet of things and cloud technology, the proposed logistics

park supply chain management structure is not only applicable to logistics resources and related items of dynamic tracking, complete immediately, appropriate information content intelligent classification and push service, and service platform for SaaS, message push to assist logistics industry to face different tasks of logistics service supply chain, complete the same area of supply chain collaborative system plays a crucial role. This is similar to how biomechanical systems adjust to external forces and maintain stability. The practice shows that the implementation of this platform is beneficial to the high efficiency of the sharing of hardware and software information resources in logistics parks, and significantly reduces the operation cost of industrial park informatization. Park logistics integration of resource capacity. The comprehensive application of the Internet of Things technology is the future trend of the supply chain development, and it is a reflection of the intelligent supply chain management. The rise of the Internet of Things has brought good opportunities and challenges to the supply chain management. In China, the Internet of Things technology has certain advantages in the world, but there are also many technical bottlenecks, the lack of unified standards, and the company's use is relatively limited. This is also same as the challenges in biomechanics where standardization is essential for effective application. This not only needs the government's strong support for the Internet of Things industry chain, but also needs the rapid and continuous improvement of the Internet of Things technology, to ensure that people have their own advantages. At the same time, many enterprises should also focus on the future, and use the Internet of Things technology to the strategic goal in the business strategy as soon as possible. Maximize the overall value of the supply chain, so that the enterprises in the supply chain can get and maintain a lasting core competitiveness, and the overall competitiveness of the supply chain. There are many problems in China's supply chain management in China, which are worth improving in many aspects. For example, the supply chain team members lack of unified information service platform, product information database system lack of unified standard, each link supply chain service efficiency is not high, the company intermediate information communication, after-sales maintenance service is not sound caused by the expansion of the "cow whip effect" cannot guarantee inefficient supply chain, cannot guarantee the reliability and security. With the birth and application of the Internet of Things, the process and management means of the supply chain have been completely changed, and it has become a management means to improve the supply chain. IoT and cloud computing face challenges in supply chain management, including data security risks, device compatibility issues, and high implementation costs. Data security may lead to information leaks, device compatibility affects system integration, and the cost-effectiveness of technology implementation directly relates to the return on investment, increasing implementation complexity. Combining supply chain management and biomechanics, it shows the efficiency, collaboration, and the need for continuous improvement.

The challenges faced during the implementation of this study include algorithm complexity, data processing efficiency, and industry adaptability. These difficulties highlight the necessity of embedding biomechanical—inspired biological algorithms, as they can provide optimization strategies from nature, enhance the intelligence level of the system, and improve decision-making efficiency, thereby increasing the

practicality of overall logistics management. This study explores the integration of biomechanics and biological principles into logistics optimization. By drawing on optimization strategies from biological theories, such as the ant colony algorithm, particle swarm optimization, genetic algorithm, dung beetle algorithm, and fish swarm algorithm, we can enhance the intelligence of supply chain management and improve transportation efficiency. These biological algorithms provide new insights for solving complex logistics problems and are expected to be applied in a wider range of fields in the future.

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