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Retraction

Retracted: Online Procurement and Inventory Technology Based on Cloud Computing System

Security and Communication Networks

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Security and Communication Networks has retracted the article titled "Online Procurement and Inventory Technology Based on Cloud Computing System" [1] due to concerns that the peer review process has been compromised.

Following an investigation conducted by the Hindawi Research Integrity team [2], significant concerns were identified with the peer reviewers assigned to this article; the investigation has concluded that the peer review process was compromised. We therefore can no longer trust the peer review process, and the article is being retracted with the agreement of the Chief Editor.

References

[1] Y. Xue and Q. Sun, "Online Procurement and Inventory Technology Based on Cloud Computing System," *Security and Communication Networks*, vol. 2022, Article ID 7112715, 13 pages, 2022.
[2] L. Ferguson, "Advancing Research Integrity Collaboratively and with Vigour," 2022, https://www.hindawi.com/post/advancing-research-integrity-collaboratively-and-vigour/.

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Research Article

Online Procurement and Inventory Technology Based on Cloud Computing System

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In order to explore the collaborative development of online procurement and inventory technology, this paper combines cloud computing technology to build online procurement and inventory management models, and builds a collaborative procurement computing experimental model with the help of a service system. Moreover, this paper clarifies the evolution problem of clustered supply chain network, and defines and constrains the model. In addition, this paper uses Agent technology to construct individual model and behavior model. Further, by complementing the advantages and disadvantages and mapping rules between Agent technology and Web service technology, the Agent model is mapped into a service model, which integrates the intelligence of Agent and the openness and cross-platform characteristics of Web services. Finally, this paper simulates the procurement and management model proposed in this paper through the simulation platform. The data analysis and research results show that the online procurement and inventory management technology based on the cloud computing system proposed in this paper can effectively promote the stable operation of procurement and inventory.

1. Introduction

The traditional procurement inventory management of manufacturing enterprises is aimed at a single enterprise. In addition to the raw materials required for production, the purchased materials also include purchased parts and fixtures in product manufacturing. The purpose of purchasing is to replenish inventory, and the purpose of inventory is to ensure production. Moreover, the purchasing department generally does not care about the production process of the enterprise, nor does it need to understand the production progress of the enterprise and the changes in product demand, and only needs to purchase according to the inventory. Therefore, the procurement plan formulated by the procurement department is often incompatible with the changes in the manufacturing needs of the enterprise. In the procurement process, the work of procurement focuses on transactional activities with suppliers. Usually, in order to reduce the purchase price, it is preferred to increase the purchase volume, and the resulting increase in inventory and working capital is relatively less considered.

Purchasing management occupies a very important position in modern enterprise management. Its role is not limited to providing the necessary material supply for the production of enterprises, but also an important way for enterprises to reduce management and operating costs and enhance competitiveness. Therefore, comprehensively improving the level of procurement management has become an inevitable requirement for modern enterprises to improve their competitiveness and continue to grow and develop.

Procurement cost is an important part of enterprise operation and management cost. In particular, for manufacturing enterprises, the proportion of procurement costs in the operation and management costs of enterprises can be as high as 30%–75% [1]. Therefore, the effect of controlling procurement costs on reducing the operating costs of enterprises can be imagined. Scientific and efficient procurement management can not only reduce the cost of material purchase, thereby reducing the cost of products, but also reduce the amount of inventory, inventory management, and material transportation costs, thereby improving inventory turnover, improving the overall operating efficiency of the enterprise, and reducing operating costs [2].

As the concept of supply chain management is deeply rooted in the hearts of the people, more and more companies regard suppliers as important support for their own product development and development. Moreover, they are placing increasing emphasis on establishing and maintaining long-term partnerships with their suppliers, so that with the help of the suppliers' technology and R&D capabilities, they can obtain the development trends of major raw materials and related technical support without direct investment. This undoubtedly provides favorable conditions for the research and development and development of enterprise products [3].

This paper combines cloud computing technology to build an online procurement and inventory management model, and analyzes the balance between procurement and inventory management to improve the level of enterprise procurement and inventory management.

2. Related Work

Realizing the role of purchasing management to reduce costs, reducing the cost of purchasing inventory management is a key part of it, and the control of the overall cost of inventory management is inseparable from the cooperation of purchasing management. It can be said that purchasing management and inventory management have an inseparable relationship [4].

Purchasing management is an important means of inventory control. There are many means of inventory control, such as controlling the quantity of purchases, controlling the time of purchases, and reducing the amount of safety stock [5]. The fundamental and effective way to control inventory is by no means limited to these "symptom" methods, but should focus on the overall situation of supply chain management, grasp the cause of inventory, and control it from the process. This comprehensive inventory management concept is inseparable from cooperation with procurement management: first, the formulation of inventory management strategies must consider the coordination with procurement strategies and the level of procurement management, whether it is the setting of safety stock levels, the setting of order quantities, the calculation and issuance of material requirements, and the delivery of manufacturers. The control of the quantity and batch must consider the coordination of the existing procurement management level and procurement strategy; secondly, from the perspective of overall supply chain management, procurement management is an important means of inventory control. From the perspective of the supply chain, the control of inventory is inseparable from the cooperation of the upstream and downstream of the supply chain [6].

The realization of inventory control goals is inseparable from the cooperation of reasonable procurement strategies. The implementation of inventory management strategies requires the support of reasonable procurement control processes established by effective procurement management and the cooperation of good supplier partnerships. Second, procurement management should be oriented toward inventory management goals. The most basic function of procurement is to meet the demand; in the actual operation of the enterprise, the material demand must be based on the customer's order demand, and it is determined on the basis of considering the inventory management indicators [7].

Purchasing management is fundamentally oriented toward the goal of inventory management. In addition, in advanced enterprise management, in addition to the most basic function of meeting demand, procurement management should also take cost reduction as an important purpose, and inventory cost is the top priority of enterprise operating costs [8]. In this sense, procurement management must also be oriented toward the goal of inventory management. Finally, although there are differences between procurement management and inventory management, they both take the overall goal of supply chain management as the ultimate goal [9]. Their common goal is to improve the efficiency of business management and operation and reduce business operating costs. They are both key links in supply chain management, and they are interdependent and inseparable. It is precisely because procurement management and inventory management have such an interdependent and inseparable relationship; starting from the closest relationship between the two, the research on procurement inventory management strategy as a whole is carried out in-depth research [10].

Procurement management and procurement are two different concepts. As mentioned above, procurement is an important production and operation activity of an enterprise. In order to ensure the smooth progress of procurement activities and its consistency with the company's overall operational goals, it is necessary to carry out necessary planning, organization, coordination, and control, that is, procurement management [11]. Purchasing management is the whole process of purchasing activities from plan release, purchase order generation, purchase order execution, arrival receipt, inspection and storage, purchase invoice collection to purchase settlement, supervision, to achieve scientific management of the implementation process of corporate procurement activities [12]. Purchasing management is the most basic goal of ensuring that materials meet the needs of production and operation. For different procurement activities, the difficulty of procurement management is also different due to the different procurement objectives, procurement environment, and the complexity of procurement materials. In different business environments, the operation and coverage of procurement management are also different [13].

Purchasing management has completed the transition from the simple process of negotiating prices and purchasing materials in the traditional sense to modern purchasing management. Modern procurement management, as one of the three cores of supply chain management, has been endowed with more functions and higher expectations, and it has become a key part of improving the competitiveness of enterprises [14]. The value of modern procurement management has far exceeded its traditional value. It not only is the main link that affects the cost structure of enterprises, but also affects the time to market and delivery of enterprise products, product quality, and enterprise delivery flexibility. Profitability is thus comprehensively affecting the competitiveness of enterprises. In modern procurement management, the procurement functional department should not only pay attention to the unit price of materials, but also pay attention to the total cost of procurement and even the overall cost of supply chain management [15], not only to complete short-term transactions with certain suppliers, but also to focus on training and maintenance. Long-term strategic partnership with suppliers not only passively performs functions to fulfill demand or cost goals, but also actively participates in the product development process and makes recommendations that are beneficial to ensuring the supply of raw materials required for products [16]. In order to realize the above procurement management value and make it perform its functions effectively, the management of each enterprise began to formulate procurement strategies suitable for their own characteristics under the background of supply chain management and established corresponding procurement management models under the guidance of procurement strategies [17].

3. The Construction of Collaborative Procurement Model

3.1. Agent Model of Procurement Enterprise. The size of a business is related to its growth rate. The initial growth rate is determined by the location of the enterprise, the enterprise grows according to a certain growth rate, and the growth rate is affected by the synergistic effect. An enterprise has a life cycle and experiences an S-shaped o-curve that tends to stabilize from growth to peak, as shown in Figure 1. Therefore, the scale growth model of the enterprises in the cluster can be constructed according to the logistic growth model, and the growth process of the enterprises in the cluster can be described.

According to the Rogers model, the growth rate of a firm at time t is shown in

$$\frac{\mathrm{d}x_i(t)}{\mathrm{d}t} = r_i(t)x_i(t)\left(1 - \frac{x_i(t)}{k_i}\right). \quad (1)$$

Among them, $x_i(t)$ is the growth scale of the purchasing enterprise at time t, $r_i(t)$ is the internal growth rate achieved by the purchasing enterprise only relying on limited resources, and $r_i(t) > 0$, k_i is the maximum scale that the purchasing enterprise can grow with only limited resources.

The synergy effect affects the growth rate of the enterprise. The synergy effect of the purchasing enterprise Agent is only the horizontal synergy effect, expressed by cooprateAdd, and the enterprise development scale in the case of horizontal synergy is shown in

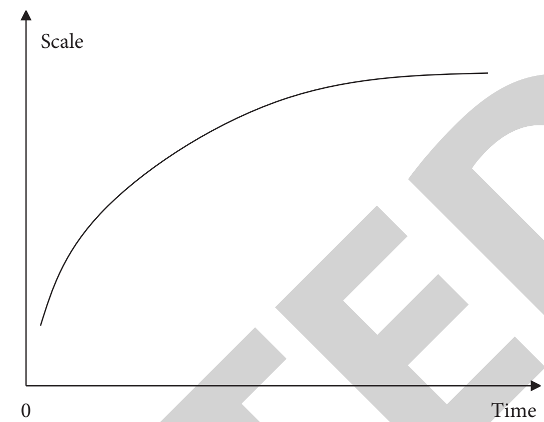


Figure 1: O-shaped curve of firm size.

$$\frac{dx_i(t)}{dt} = r_i(t)x_i(t)\left(1 - \frac{x_i(t)}{k_i} + \text{cooprateAdd}\right). \quad (2)$$

cooprateAdd is the synergy effect when purchasing enterprise i selects the same type of company j for synergy (horizontal synergy), and the value is $\sum a_{ij}x_j(t)/k_j$, where a_{ij} is the cooperation effect coefficient, which represents the influence of cooperative company j on purchasing company i, and $-1 < a_{ij} < 1$.

Comparing formulas (1) and (2), it can be seen that enterprises can achieve a new scale by breaking through their own maximum scale limitations through rapid development through coordination. The development of enterprises pursues long-term cooperation benefits, and through collaboration, enterprises can achieve better scale growth.

3.1.1. Changes in the Collaborative Attitude cAt of the Enterprise over Time. The behavior set of purchasing enterprise Agent is $A[a1, a2]$, where a1 is an independent purchasing behavior, a2 is a cooperative purchasing behavior, and its initial behavior probability T is a random number of (0,1), and $T_{a_q} + T_{a_2} = 1$ and T_{a_2} are cAt.

In collaborative procurement, the purchasing Agent's goal is to obtain the biggest reward and punishment signal in the market environment, that is, the profit value. In each production activity, the purchasing enterprise Agent accepts the input of the market environment state s and makes a tentative behavior a. This behavior causes the market environment state s to change to s', and the purchasing enterprise Agent accepts the reward and punishment signal f of the market environment. If a certain behavior of the purchasing enterprise Agent leads to more market environment rewards, the probability of the behavior increases; that is, the tendency of purchasing enterprise Agent to take this behavior strengthens, as shown in

$$\begin{aligned} CAt &= T_{a_2} \\ &= T'_{a_2} + \frac{f - f'}{f'}, \end{aligned} \quad (3)$$

Among them, T_{a_2}' is the purchasing enterprise in the last production activity. The probability of the Agent's cooperative behavior, f', is the income value of the purchasing enterprise Agent in the last production activity.

3.1.2. Changes in the Income Value of Purchasing Enterprises over Time. The income value of purchasing enterprise is shown in

$$\text{cFadapt}(t) = \text{in}(t) - \text{co}(t). \quad (4)$$

In formula (4), $\text{in}(t)$ represents the current income of the enterprise at time t, and its value is $\text{in}(t) = \text{cPrice} * \text{cNim}$. $\text{co}(\text{t})$ is the cost of the current purchasing company at time t, and its value is

$$\text{co}(t) = \text{pur}_{\text{co}}(t) + \log_{\text{co}} + \text{sto}_{\text{co}} + \text{coop}_{\text{co}}, \quad (5)$$

where T_{a_2}' is the purchase cost, $\log_{\text{co}}$ is the logistics cost, and $\text{sto}_{\text{co}}(t)$ is the storage cost, all of which are nonlinearly proportional to the batch. coop_{co} is the collaborative management cost, which mainly includes the fixed cost of collaborative behavior and the proportional commission price_alliance of each collaborative benefit, and its value is shown in formula (5).

Among them, α is a fixed ratio. If we assume that the current selling price and quantity of the purchasing enterprise remain unchanged, the current income of the purchasing enterprise remains unchanged, and the current value of the Agent's income is determined by the cost.

The vertical coordination process of the Agent of the large-scale purchasing enterprise is similar to that of the Agent of the small and medium-sized purchasing enterprise. Due to the large-scale purchasing enterprise's abundant Agent resources and strong ability, it can select the supplier Agent within a certain range. Firstly, according to the cooperation success probability calculated during the trial operation period, the supplier Agents within the scope are screened. If the cooperation success probability is greater than the failure probability, that is, the cooperation success rate is > 0.5, the comprehensive evaluation function R is selected according to the supplier to evaluate all the supplier Agents in the range. The comprehensive evaluation function R is shown in

$$R = \alpha * \text{price} + \beta * \text{quali}. \quad (6)$$

Among them, $0 \leq \alpha, \beta \leq 1$ and $\alpha + \beta = 1$. We use the comprehensive evaluation function R to check the comprehensive evaluation results of the supplier Agent's price and capability, select the optimal supplier Agent within this range, and negotiate the conflict items to determine whether a collaborative agreement is reached.

The collaborative procurement process of purchasing enterprise Agent is shown in Figure 2.

Purchasing enterprise Agent chooses to cooperate with other purchasing enterprise Agents according to certain collaborative selection rules. Figure 3 shows the steps of purchasing enterprise Agent cooperating with other purchasing enterprise Agents.

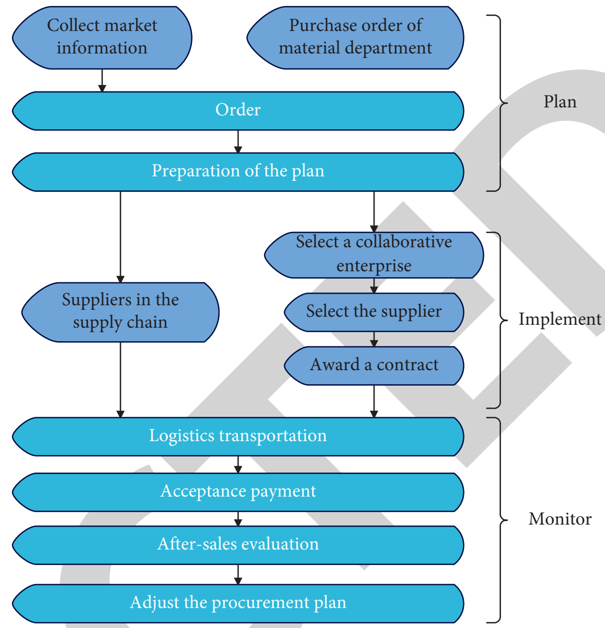


Figure 2: Collaborative procurement process.

Agents of purchasing enterprises interact with each other in the market environment, constantly perceive the environment, adapt to the environment, and choose the optimal action to achieve the target task through learning. However, not all enterprises in the cluster have complete information, and the different information, cognition, preferences, and processing methods they have at different stages lead to different behaviors. The Agent behavior decision function of purchasing enterprise is shown in

$$A_{r+1} = \omega\left(A_r | \text{cFada}(p)t\right). \quad (7)$$

3.2. Supplier Agent Model in Collaborative Procurement. Part of the objective attributes of the supplier Agent all change with time.

3.2.1. Scale of Supplier Agent. The scale of the supplier Agent also follows the Rogers model, and the scale of the enterprise development under the cooperation of the supplier Agent is shown in

$$\frac{dx_i(t)}{dt} = r_i(t)x_i(t)\left(1 - \frac{x_i(t)}{k_i} + \text{cooprate Add} + \text{procrate Add}\right). \quad (8)$$

Among them, $x_i(t)$ is the growth scale of the supplier at time t, $r_i(t)$ is the internal growth rate achieved by the supplier only relying on limited resources, $r_i(t) > 0$, and k_i is the maximum scale that the supplier can grow with only limited resources. coopratеAdd is the synergy effect when supplier i selects the same type of enterprise j for synergy (horizontal synergy), and the value is $\sum a_{jj}x_j(t)/k_j$, where a_{ij} is the cooperation effect coefficient, which indicates the influence degree of cooperative enterprise j on supplier i, and

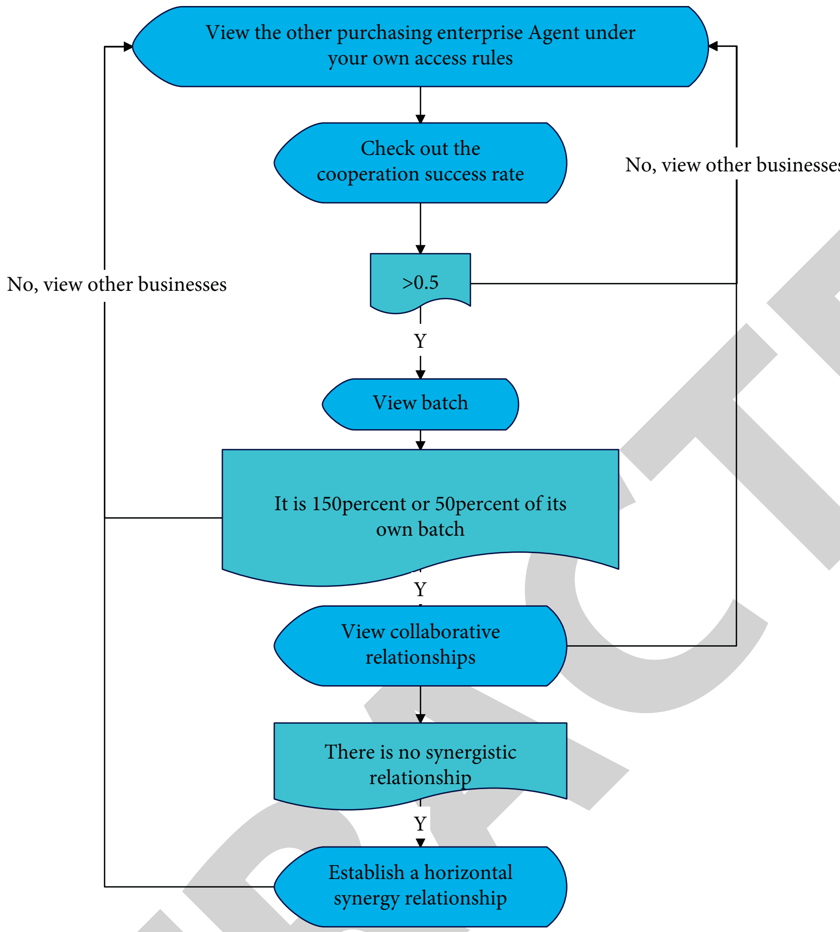


Figure 3: The steps of purchasing enterprise Agent to collaborate with similar enterprises.

$-1 < a_{ij} < 1$. procrateAdd is the synergy effect when purchasing enterprise p selects the current supplier i for purchasing (vertical synergy), and the value is $\sum a_{jj}x_j(t)/k_j$, where ap is the cooperation effect coefficient, which represents the influence degree of cooperative enterprise p on manufacturer j, and $-1 < a_{pt} < 1$.

The size of an enterprise is determined by the initial growth rate and the synergy between enterprises. In the case of the same initial growth rate, the size of the synergistic effect between enterprises determines the size of the enterprise. Comparing formula (1) and formula (8), it can be seen that the development scale of supplier Agent is affected by the synergy effect including horizontal synergy and vertical synergy.

3.2.2. Product Price Provided by Supplier Agent. The price of the product provided by the supplier Agent changes inversely proportional to the purchase batch in the order of the purchasing enterprise Agent, as shown in

$$\text{sPrie} = \frac{1}{k}\text{cPeac}. \tag{9}$$

Among them, $k > 0$. Within a certain range, the larger the purchasing batch of the purchasing enterprise Agent, the lower the price provided by the supplier's Agent. Due to constraints such as cost, the product price is ultimately maintained in a relatively stable range, as shown in Figure 4.

3.2.3. Income Value of Supplier Agent. The income in(t) of the supplier is similar to that of the purchasing enterprise Agent. Since the supplier Agent directly faces the raw material market and does not have the production behavior of purchasing raw materials, the cost of the supplier Agent is shown in

$$\text{co}(t) = \log_{\text{co}} + \text{sto}_{\text{co}} + \text{coop}_{\text{co}}. \tag{10}$$

logco(t) is the logistics cost, stoco(t) is the storage cost, and both are nonlinearly proportional to the batch. coopco(t) is a collaborative management cost consisting of a fixed fee, fixfee_alliance, and a percentage of collaborative income, which is similar to the collaborative management cost of this case.

The purchasing enterprise Agent submits the purchasing task to the service system Agent, and the service system Agent splits and merges it, generates the corresponding bidding documents, and publishes it to the supplier Agent. The bid is represented by a triple, as shown in

$$\langle VPC, T_t, CT_t \rangle, \tag{11}$$

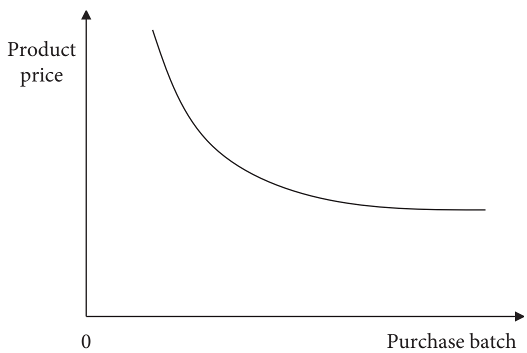


Figure 4: Product price curve.

Among them, VPC represents the virtual procurement alliance, that is, the tenderer of the procurement task, T represents the procurement task of the virtual procurement alliance at time t, that is, the procurement of products, and CT represents the constraints of the virtual procurement alliance on the supplier Agent at time t. Among them, CT is represented by a quaternion as shown in

$$CT_t = \langle P, Q, A, S \rangle. \quad (12)$$

P represents the price of the purchased product, Q represents the quality of the purchased product, A represents the delivery capability of the supplier Agent, and S represents the after-sales service of the supplier Agent.

The purpose of the supplier's Agent's production and operation is to meet the products that the purchasing enterprise's Agent needs. Supplier Agent can win the competition and become a member of virtual collaboration alliance, depending on its own ability.

Explicit abilities mainly include the following:

(1) Work space: The place of supplier's production activities;
(2) Equipment: The number of equipment used in the production process and the advanced nature of the technology used by the supplier Agent;
(3) Material: Raw materials or semi-finished products for production and living held by the supplier Agent;
(4) Product quality: It includes basic product attributes: identifier, description, name, etc.; product specifications: physical attributes, structural attributes, technical attributes, performance attributes, etc., as well as quantity, price, and version. Product quality is expressed by product qualification rate and product repair rate as shown in

$$\text{Product percent of pass} = \frac{\text{Total Numbers of qualified products}}{\text{The total number of the products}}, \quad (13)$$

$$\text{Product repair rate} = \frac{\text{The total number of qualified product}}{\text{The total number of the products}}. \quad (14)$$

Hidden abilities mainly include the following:

(1) Personnel ability: the number of personnel, professional level, etc.
(2) Management ability: personnel professional familiarity and experience knowledge, etc.
(3) Delivery ability: the ability to complete the order task within the specified time. If the punctuality of delivery is low, it will inevitably affect the production technology of the purchasing enterprise and ultimately affect the response of the entire clustered supply chain to the market. It is measured by the on-time delivery rate, which is shown as follows:

$$\text{On time delivery rate} = \frac{\text{On time delivery times}}{\text{Total number of delivery}}. \quad (15)$$

(4) Production flexibility: the ability of suppliers to adapt to changes in demand. Quickly adapting to changes in market demand is one of the goals of a clustered supply chain, and the enterprises in it must also have the ability to quickly adapt to the film and television environment, so production flexibility is also an important indicator for evaluating an enterprise's capabilities. Moreover, production flexibility can be measured using quantity flexibility and time flexibility. Quantity flexibility refers to the adaptability of suppliers when the purchasing quantity of the purchasing enterprise changes.
(5) Service capability: the capability to provide direct after-sales service support for the product.

The service system Agent selects the supplier Agent according to the evaluation result of the supplier Agent's ability according to the supplier Agent's constraint conditions, as shown in formula:

$$\text{On time delivery rate} = \frac{\text{On time delivery times}}{\text{Total number of delivery}}. \quad (16)$$

Among them, $0 \le \alpha, \beta, \delta, \varepsilon \le 1$ and $\alpha + \beta + \delta + \varepsilon = 1$. The algorithm checks the comprehensive evaluation results of the supplier Agent in terms of price and capability through the comprehensive evaluation function R′, selects the optimal supplier Agent within the scope, returns the winning information, and assigns the task to the winning bidder. At the same time, the algorithm returns rejection information to other bidding companies and sends the bid-winning supplier Agent information to the purchasing company's Agent. If there is no vertical synergistic relationship between the purchasing enterprise Agent and the optimal supplier Agent within the scope, a cooperative relationship is established.

In addition, the service system Agent can judge the scope and degree of cooperation between enterprises, the sharing authority of information and knowledge, etc., and adjust it according to the continuous changes of the environment.

3.3. Construction and Implementation of Web Services. When interacting with the service system, the model analyzes the functions of each department and maps the

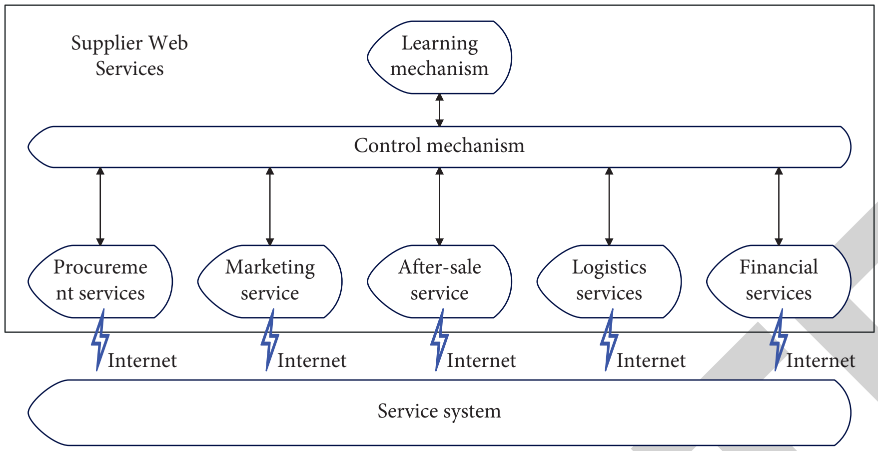


Figure 5: Provider's Web service model.

department resources that interact with the service system into corresponding services according to the relationship between resources and services according to the service requirements of the supplier Agent, as shown in Figure 5.

In the specific Web service modeling process, considering the similarity between object-oriented analysis and design and service-oriented analysis and design, the UML modeling method is used for reference in the modeling process, as shown in Figure 6.

In QoS-based service selection, QoS attributes need to consider both determinism and uncertainty of attribute values. First, it is necessary to quantify the QoS attributes, that is, to standardize the QoS attributes, so that the QoS attributes of each service are comparable.

3.3.1. Determining Numerical QoS Attribute Matches. S represents that the QoS attribute is a numeric publishing service. m QoS attributes are chosen to describe the service. The matrix Q is obtained as shown in formula:

$$Q = \begin{pmatrix} q_{11} & q_{12} & \cdots & q_{1m} \\ q_{12} & q_{22} & \vdots & q_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ q_{r1} & q_{r2} & \cdots & q_{nm} \end{pmatrix}. \tag{17}$$

There are two types of exact numerical QoS attributes. One type is positive quality attributes (such as benefit attributes). The larger the value, the better the service quality (such as after-sales service, etc.). One category is negative quality attributes (such as cost attributes and delivery time). The smaller the value, the better the quality of service (such as purchasing services). In order to make the two types of QoS attributes comparable, the negative attributes need to be processed. As shown in formula (18), the negative QoS attributes are quantified into positive quality attributes with values between 0 and 1:

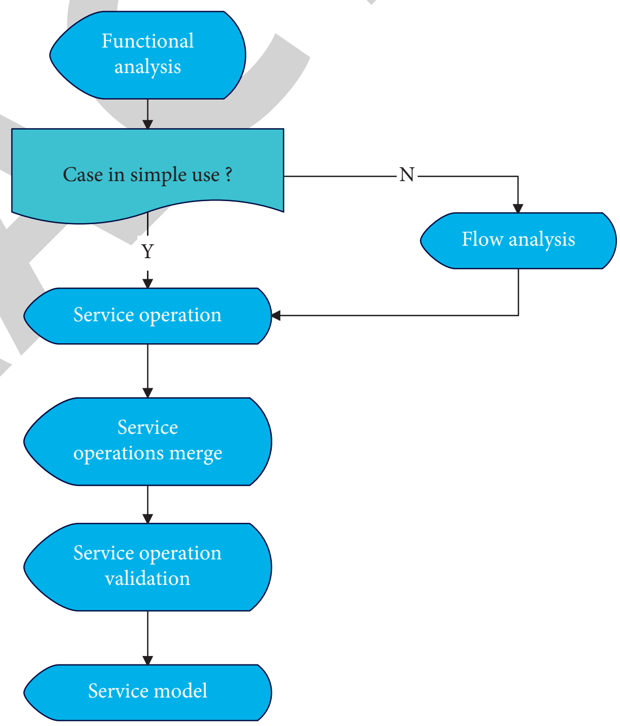
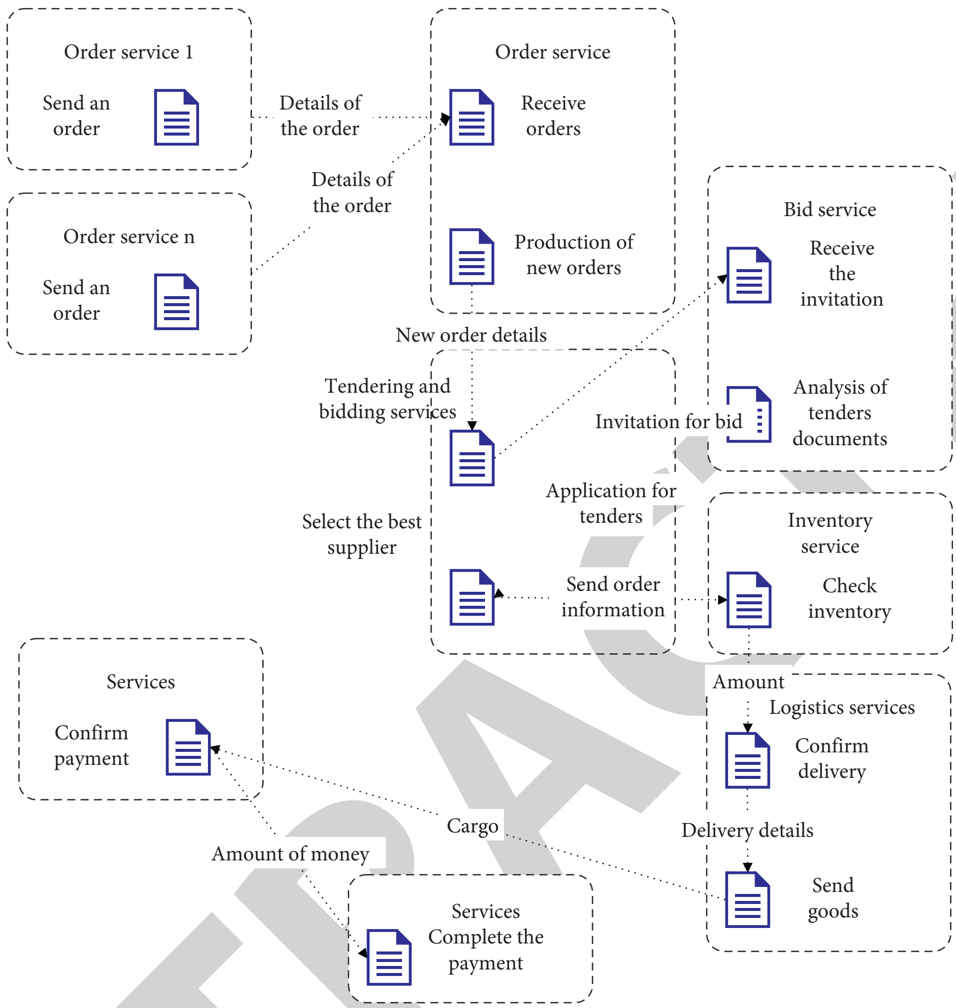


Figure 6: Flowchart of SOA-based Web service modeling.

$$V_{ij} = \begin{cases} \dfrac{q_{ij}}{\sum_{i=1}^{r} q_{ij}}, & \text{Forward QoS attributes,} \\ \\ \dfrac{(1/q_{ij})}{\sum_{i=1}^{r}(1/q_{ij})}, & \text{Negative QoS attributes.} \end{cases} \tag{18}$$

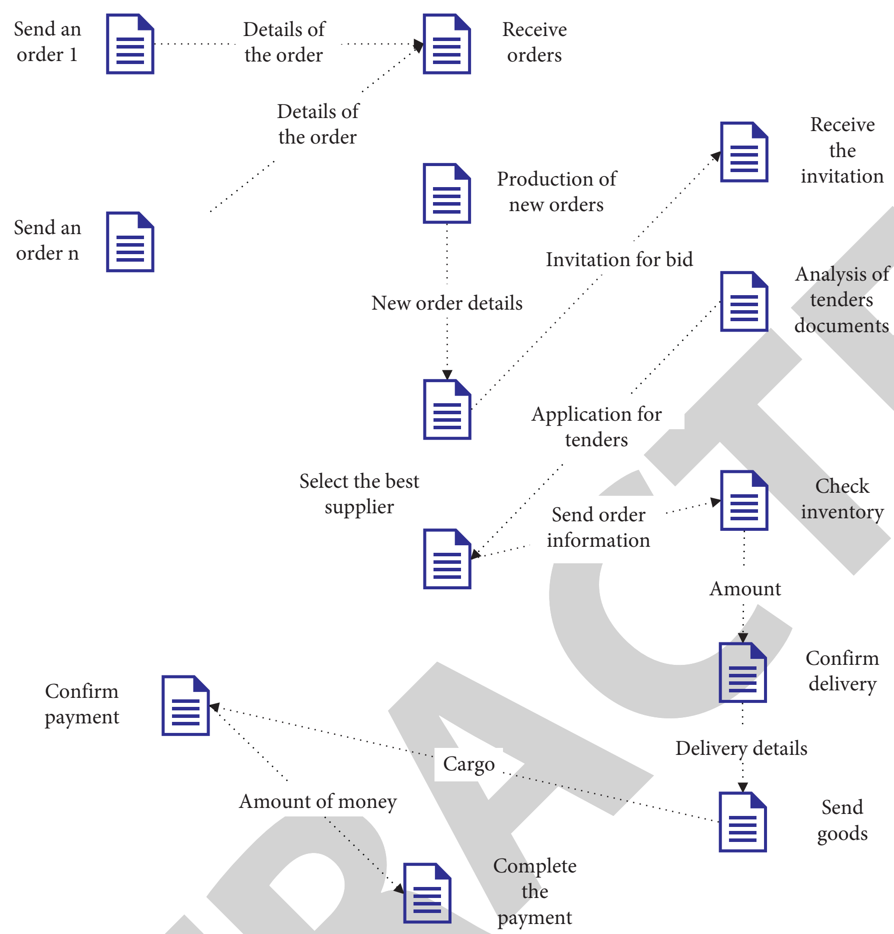
Among them, $1 \leq j \leq m$, $1 \leq i \leq r$.

The quantized arrival matrix of accurate numerical QoS attributes is shown in



(a)

Figure 7: Continued.



(b)

Figure 7: Collaborative procurement model. (a) Collaborative procurement service flow model, (b) collaborative procurement composition services.

$$Q\prime = \begin{pmatrix} V_{11} & V_{12} & \cdots & V_{im} \\ V_{12} & V_{22} & \vdots & V_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ Vr1 & V_{r2} & \cdots & V_{nm} \end{pmatrix}. \quad (19)$$

Among them, $0 \le V_{ij} \le 1$. The model uses the above method to complete the quantification of the numerical QoS attributes and uses formula (20) to calculate the comprehensive value of the QoS attributes of each service $S_i\,(1 \le i \le r)$.

$$\mathrm{QoS}(S_i) = \sum_{i=1}^{m} W_j * V_{ij}. \quad (20)$$

Among them, W_j is the weight of the jth QoS attribute defined by the service requester. Then, compare the service quality according to formula (20). The larger the $\mathrm{QoS}(S_i)$ is, the better the service can meet the needs of the service requester.

3.3.2. Uncertainty of QoS Values, That Is, The Matching of Interval-Type QoS Attributes. When the value of the QoS attribute is uncertain, it is represented by an interval value. The size of two interval-type values is calculated mainly by comparing the degree of similarity between the two intervals, that is, whether the two intervals are similar is judged by the possibility between the interval numbers of the QoS attribute. We assume that the two intervals are the interval-type value of $a = [a_1, a_r]$ and $b = [b_1, b_r]$. If the interval value a is a benefit attribute, then a represents the minimum value acceptable to the service requester, a_1 represents the most expected value, and similarly the interval value b is derived. If the interval-type value a is a cost attribute, it represents the most expected value of the service requester, and a_r represents the acceptable minimum value. Similarly, the interval-type value b is derived. Then, the probability of interval $a \ge b$ is shown in

$$p(a \ge b) = \min\left\{\max\left(\frac{a_i^r - b_i^l}{I_{a_i} + I_{b_i}}, 0\right), 1\right\}. \quad (21)$$

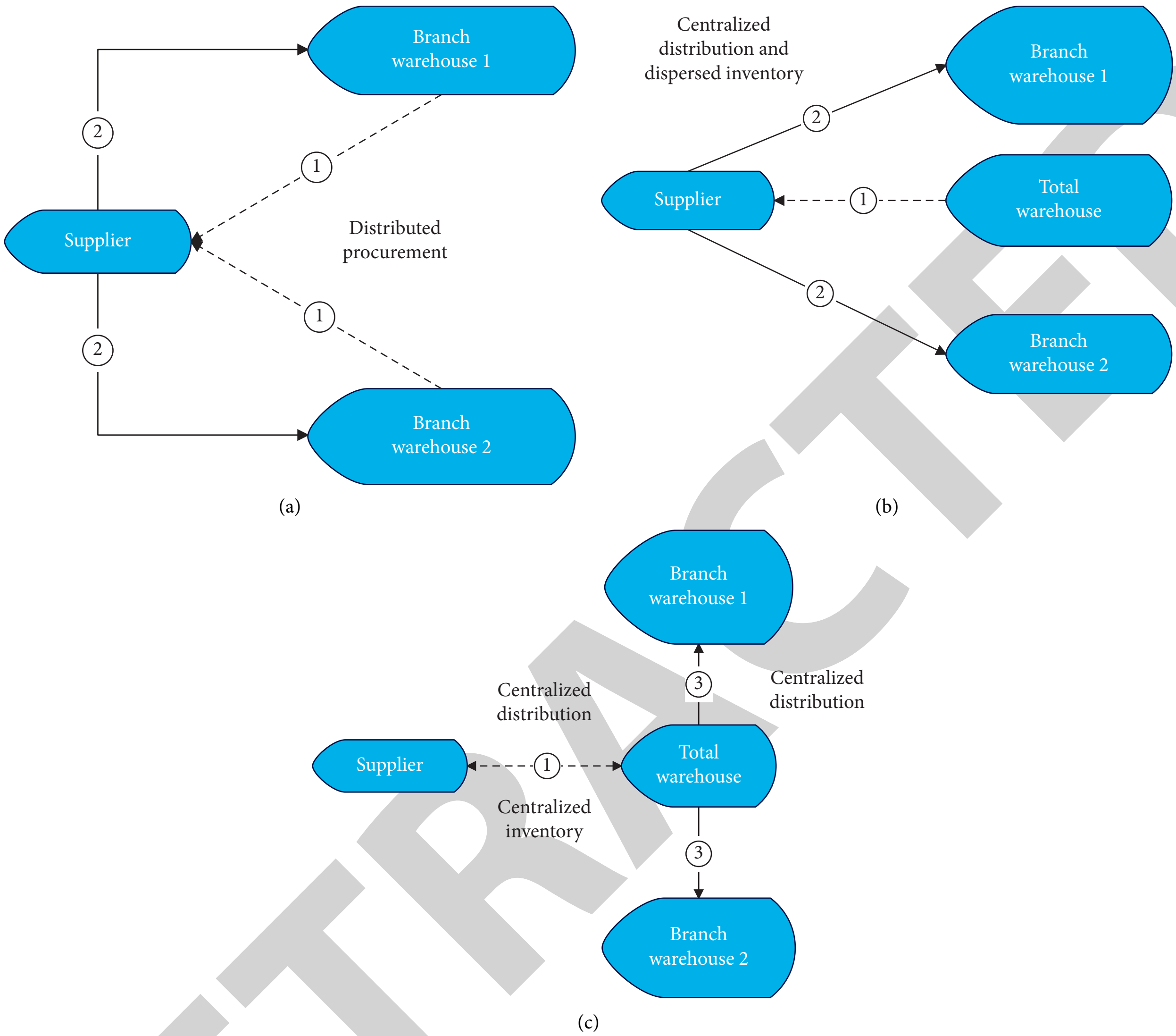


Figure 8: Operation process of inventory allocation strategy under different procurement modes. (a) Decentralized inventory under decentralized purchasing model, (b) decentralized inventory under centralized purchasing mode, (c) centralized inventory under the centralized procurement model.

Among them, I_a is the length of interval a and $I_a = a_r - a_1$, I_b is the length of interval b, and $I_b = b_r - b_1$. When it is extended to multiple intervals: $a_i = [a_i^1, a_i^r]$ and $b_i = [b_i^r, b_i^r]$, the comprehensive possibility of multiple intervals is shown in

$$p\prime (a \geq b) = \sum \beta_i \left\{ \min \left\{ \max \left(\frac{a_i^r - b_i^l}{I_{a_i} + I_{b_i}}, 0 \right), 1 \right\} \right\}. \quad (22)$$

Among them, β_i is the weight of the ith attribute and $0 < \beta_i < 1$, $\sum \beta_i = 1$.

Likewise, $S = \{S_1, S_2, \ldots, Sr\}$ represents a service provided by a service provider whose QoS attribute is an interval-type value. m QoS attributes are chosen to describe the service. The following matrices A and B are obtained as shown in

$$A = \begin{pmatrix} a_{11}^1 & a_{12}^1 & \cdots & a_{1m}^1 \\ a_{21}^1 & a_{21}^1 & \vdots & a_{2m}^1 \\ \vdots & \vdots & \vdots & a_{2m}^1 \\ a_{t1}^1 & a_{t2}^1 & \cdots & a_{tm}^1 \end{pmatrix}. \quad (23)$$

In matrix A, a_{ij}^1 represents the minimum value of the jth QoS attribute of the ith service, where $1 \leq i \leq t$ and $1 \leq j \leq m$.

$$B = \begin{pmatrix} a_{11}^r & a_{12}^r & \cdots & a_{1m}^r \\ a_{21}^r & a_{21}^r & \vdots & a_{2m}^r \\ \vdots & \vdots & \vdots & a_{2m}^1 \\ a_{t1}^r & a_{t2}^r & \cdots & a_{tm}^r \end{pmatrix}. \quad (24)$$

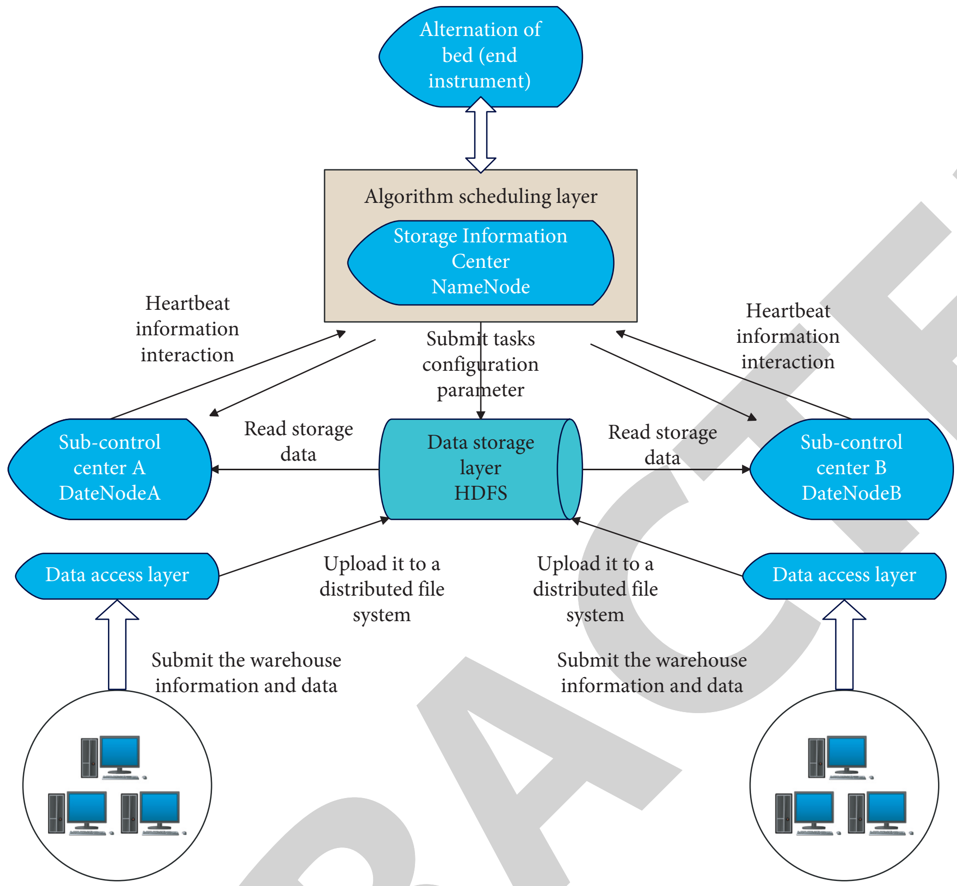


Figure 9: Architecture of distributed inventory allocation model based on cloud computing.

In matrix B, a_{ij}^r represents the maximum value of the jth QoS attribute of the ith service, where $1 \le i \le t$ and $1 \le j \le m$. Then according to formula (5–2), quantize a_{ij}^1 and a_{ij}^r in A and B and combine the quantized A and B to obtain matrix C, as shown in

$$C = \begin{pmatrix} [e_{11}^1, e_{11}] & [e_{12}^1, e_2^r] & \cdots & [e_{1m}^1, e_{1m}^r] \\ [e_{21}^1, e_{21}^r] & [e_{22}^1, e_{22}^r] & \cdots & [e_{2m}^1, e_{2m}^r] \\ \vdots & \vdots & \vdots & \vdots \\ [e_{n1}^1, e_{n1}^r] & [e_{n2}^1, e_{n2}^r] & \cdots & [e_{nm}^1, e_{nm}^r] \end{pmatrix}. \quad (25)$$

$([b_1^1, b_1^r], [b_2^1, b_2^r], \ldots, [b_m^1, b_m^r])$ expresses the interval description of m QoS attributes by the service requester. First, formula (18) is used to quantify the interval $[b_i^1, b_i^r]$, then the interval description of the QoS attribute by the service requester becomes $([f_1^1, f_1^r], [f_2^1, f_2^r], \ldots, [f_m^1, f_m^r])$ v, and at this time $0 < f_i^1 < 1, 0 < f_i^r < 1$, where $1 < j < m$.

Finally, formula (22) is used to calculate the multi-interval possibility of the QoS attribute of the service requester and the QoS attribute provided by the service provider. The greater the probability, the more the service is to meet the needs of the service requester.

3.3.3. Service Composition. In the case of collaborative procurement services, the process consists of a series of activities in a specific sequence. A step in the activity flow is an operation of a Web service that completes a specific function, as shown in Figure 7(a).

Figure 7(a) shows the data items and sequence passed in collaborative procurement activities and shows the activities that belong to the same service. It can be seen from the figure that various fine-grained services are combined into coarse-grained combined services with business logic. The service composition meta-model adopts a general architecture based on workflow definition and is independent of language. Its main function is to combine fine-grained services into a coarse-grained service according to business logic and expose its public interface to provide new functions. A composite service consists of multiple service providers that are connected to each other, where multiple fine-grained Web services implement activities in a business process. The collaborative procurement composition service is shown in Figure 7(b).

4. Online Procurement and Inventory System Based on Cloud Computing System

The operation process of inventory allocation strategy under different procurement modes is shown in Figure 8.

The master-slave management structure of the hierarchically controlled distributed inventory allocation model is very similar to the task management structure of the Hadoop cloud platform. The distributed inventory allocation system

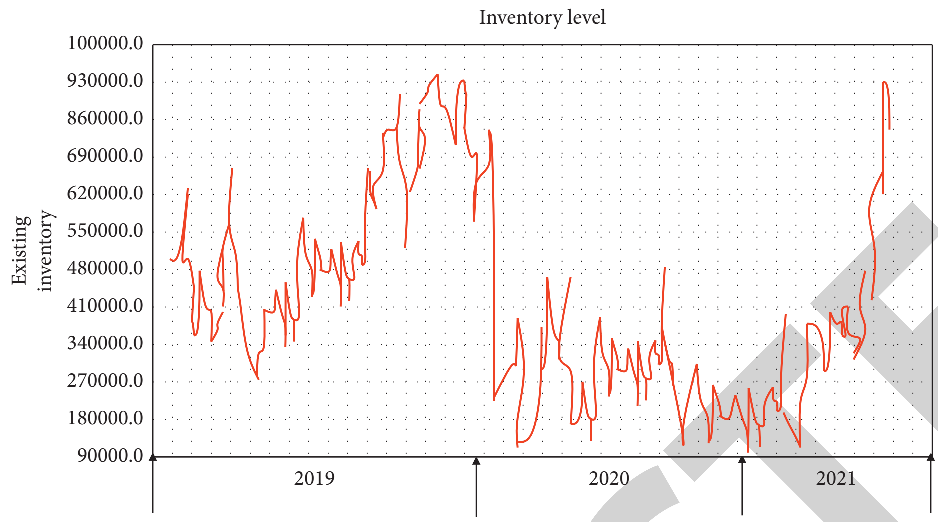


Figure 10: Inventory simulation curve.

Table 1: Online procurement and inventory system based on cloud computing system.

Number	Technical evaluation
1	77.55
2	84.72
3	78.25
4	78.65
5	78.59
6	86.29
7	76.16
8	76.24
9	88.00
10	79.35
11	83.21
12	87.37
13	80.42
14	84.22
15	84.35
16	78.59
17	78.16
18	83.90
19	78.85
20	85.48
21	79.09
22	80.63
23	76.25
24	85.37
25	76.97
26	80.20
27	84.60
28	85.85
29	80.80
30	84.46
31	79.27
32	82.58

is deployed on the cloud platform, and the resulting model architecture is shown in Figure 9.

The procurement and management model proposed in this paper is simulated through the simulation platform, and the inventory simulation curve shown in Figure 10 is obtained.

On the basis of the above research, the effect of the online procurement and inventory system based on the cloud computing system proposed in this paper is verified, and the results are shown in Table 1.

From the above research, we can see that the online procurement and inventory management technology based on cloud computing system proposed in this paper can effectively promote the stable operation of procurement and inventory.

5. Conclusion

Scientific procurement management formulates reasonable material demand plans based on enterprise customer orders, demand forecasts, and production activity arrangements. Therefore, it is necessary to set a reasonable safety stock amount according to factors such as material demand and life cycle, delivery lead time, and material value. At the same time, it is necessary to select suitable suppliers according to the market supply and demand of the required materials and technical level requirements, and establish and maintain long-term partnership with them. All of these provide an important guarantee for meeting the material requirements of the enterprise. This paper combines cloud computing technology to build an online procurement and inventory management model, and analyzes the balance between procurement and inventory management. Moreover, this paper simulates the procurement and management model proposed in this paper through the simulation platform. The data analysis and research results show that the online procurement and inventory management technology based on the cloud computing system proposed in this paper can effectively promote the stable operation of procurement and inventory.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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