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# Architecture of Next-Generation E-Commerce Platform

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**Abstract:** E-commerce, driven by computer and internet technology, has experienced a significant growth in almost all fields during the past two decades. E-commerce has significantly changed the rules of business. Numerous research institutions and enterprises have made e-commerce more intelligent and convenient. Here, we propose a novel prototype of next-generation e-commerce platform with an architecture framework and theoretical models. Each subject, including the individual, enterprise, and administrative department, has his/her personalized portal to complete the subject information synchronization, supply release, demand satisfaction, and social contact. By using the personalized portal, instead of the traditional trading platform, the consumers and suppliers can complete intelligent matching transactions without intermediate traders. Moreover, the overall transaction process can be reviewed, making the transaction safer, more transparent, and more interesting. Moreover, the interconnected personalized portals solve the isolated islands of information, and the counterparts support parallel processing. Thus, this may improve the operating efficiency of the entire society.

**Key words:** e-commerce; personalized portal; accurate demand; reliable supply; smart cyberspace

## 1 Introduction

The way of life and production will change completely by the continuous growth of internet technology. The basic logic of life and production in the future network society are openness, interconnection, cooperation, and sharing; the fundamental characteristics are interconnection, intelligence, and sensitization. With the development of internet and other technologies, the transaction efficiency would constantly improve, gradually making the market decentralized and disintermediated. In the future network society, any interaction among the subjects is a transaction to some extent, and each transaction activity results from a supply chain with several nodes. The intelligent network, a large-scaled, open-styled, self-organized, and ecological network consisting of numerous interconnected intelligent subjects, can achieve the integration of information, physics, and consciousness. To comply with the trend of network society, we propose a Next-Generation E-Commerce Platform (NGECP) comprising numerous individuals, enterprises, and administrative departments. On the NGECP, any individual or organization of the realistic world has his/her own personal portal and unique counterpart with the same patterns of perceiving, thinking, and behaving. One generic model is proposed for all types of NGECP participants. A user of the NGECP can complete the demand recognition, supply release, matching, transaction, and credit evaluation within his/her own personalized portal, and each participant can be the center to some extent. Moreover, all the participants can connect and interact among themselves through four channels of accurate ontology, reliable supply, intelligent demand, and smart cyberspace.

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## 2 Previous Literature

Currently, e-commerce is one of the most important channels of transaction. Persons, enterprises, and governments all participate in e-commerce transaction. Different models of e-commerce have been developed based on different application scenarios. The most common models are Business-to-Business (B2B)[1], Business-to-Customer (B2C)[2], Customer-to-Customer (C2C)[3], Online-to-Offline (O2O)[4], and Government-to-Business (G2B)[5]. The common problems of the main e-commerce models are as follows:

- Lack of learning ability. The platform cannot understand the complete information of users, such as the hobbies and interests, because of the lack of proper human–computer interaction.
- Lack of personalization. Same results are obtained with the same search keywords from different users. This can be regarded as the lack of personalization.
- Uncertainty of search result. Different results are obtained from different platforms with the same search keyword due to the data island formed by the platforms.
- Inflexible interactive mode. The common interactive modes are text input and mouse click, which are less convenient than voice interaction.
- Limitation of supply information. The demand may not be satisfied within one platform; therefore, consumers must try different platforms.

The use of a counterpart to reflect realistic individuals has been mostly considered in the studies of a cyber-physical system, e.g., Cyberself[6], Cyber-I[7], and Cyber-Anima[8]. However, such studies on the counterparts of realistic individuals are in the initial stage and should be developed and improved, and the main application domain is social network. The existing demand elicitation methods include choice board[9], customer negotiation[10], online reviews[11], fuzzy demand[12], consultation interface[13, 14], collaborative recommender[15], and online communities[16]. Choice board provides a standard and uniform interface and process to all the customers, while ignoring the heterogeneity of the customer in the knowledge level and ability of demand expression[17]. For the customers lacking expertise, it is difficult to accurately express their demand through the available options, or they may feel confused because of too many options[18]. The quality function deployment[19] and technique for order preference by similarity to an ideal solution[20] can be used in the optimization of commodity configuration after receiving the customer's demand information. The uncertainty and risk can be reduced by reading online reviews[21–23], a network information without a prescribed form or agreed template[24].

## 3 Architecture of NGECP

Nowadays, most of the trading platforms act as mediators, the reverse trend of disintermediation. The platform obtains the data generated by all its participants, even resulting in harmful monopolization. However, a user of NGECP can complete the demand recognition, supply release, matching, transaction, and credit evaluation within his/her own personalized portal.

In this study, we followed the top-down idea. To explore the evolution of the market, first a macrolevel architecture should be established to characterize the NGECP.

### 3.1 Connection relationship

NGECP is a large-scale, open-styled, self-organized, and ecological intelligent network. The participants of decentralized NGECP can be classified into the following three categories: people, enterprise, and administrative department, as shown in Fig. 1. Many people may consider decentralization as not a center. However, decentralization indicates that each participant can be the center to some extent. The decentralization changes the situation—the platform becomes the center. As a result, the relationship between platform and participants is not unequal anymore. Any interaction between two participants on NGECP is a transaction to some extent. Thus, all the

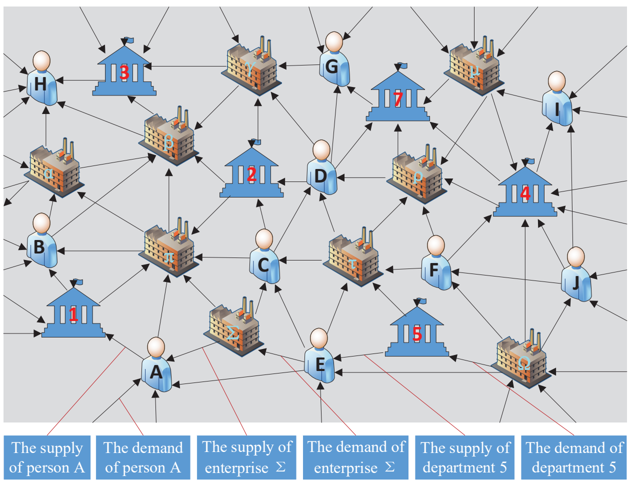


**Fig. 1 Connection relationship of NGECP.**

participants connect and interact mutually.

### 3.2 System architecture

Figure 2 shows the system architecture of NGECP. The typical roles within a supply chain include consumers, couriers, distribution centers, manufactures, and raw material suppliers. To complete the transaction, NGECP provides the release, demand recognition, searching, recommendation, matching, pricing, and credit evaluation. NGECP also provides the data storage, data encryption, data decryption, data audit, data destruction, and data originality and integrity verification.

Each participant has his/her own personalized portal; all the interactions are completed through the portal as shown in Fig. 3. The numerous portals are interconnected through four channels: accurate ontology, reliable supply, intelligent demand, and smart cyberspace.

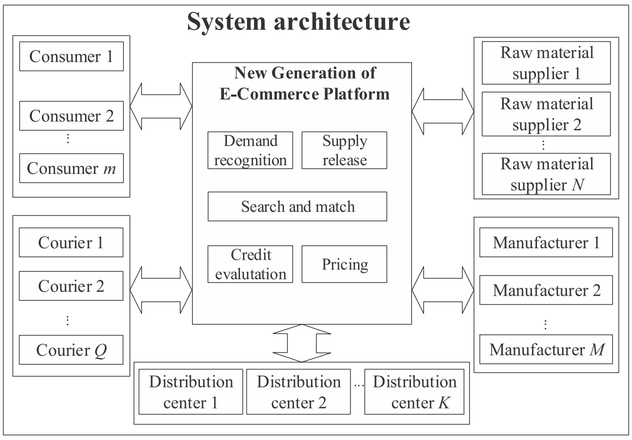


**Fig. 2 System architecture of NGECP.**

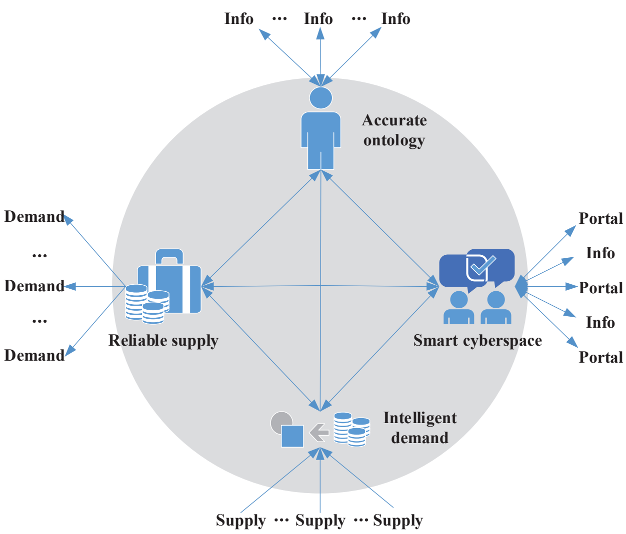


**Fig. 3 Personalized portal of NGECP.**

Accurate ontology consists of information and behavior from the realistic world, and it is the counterpart in reflecting a realistic individual or organization. Accurate ontology can provide the user's basic information, 3D model, and knowledge graph.

Reliable supply thoroughly provides the supply release, history, preference, and status of the subject thoroughly through words, images, Virtual Reality (VR), Augmented Reality (AR), Radio Television (RTV), and real-time interaction. All the supply information of standardized description should be certified by the certification system.

Similarly, the demand proposal, history, preference, and status of the subject can be thoroughly presented through words, images, VR, AR, RTV, and real-time interaction. Then, the logical information world and actual physical world can be syncretized, increasing the accuracy of demand identification. The personalized demand information, based on the user preference, basic information, and instant demand information, is recognized by the demand recognition system. Then, the intelligent matching system provides a configurable and holographic supply chain to the user.

Smart cyberspace collects and arranges the information automatically from the owner and those who interact with him/her; the social network of user-centered forms with the weights and relations is updated in real time based on this information. The smart cyberspace acts as a way to know the world and solves the isolated islands of information; this may improve the operating efficiency of the entire society.

## 4 Accurate Ontology

Any individual or organization of the realistic world has an accurate ontology on NGECP, consisting of the basic information and behavior.

### 4.1 Visualization and presentation

The physical characteristics, knowledge, and reminding information of the subject can be thoroughly presented through words, images, VR, AR, RTV, and real-time interaction. Then, the logical information world and actual physical world can be syncretized; this enhances the reality and reliability of the subject.

The ontology structure of an individual can be properly presented from five dimensions: physiology, personality, knowledge, belief, and experience. The physiology dimension can be presented by a 3D model that can be used in virtual fitting and a few power bars showing the condition of the body such as the physical strength, mental state, and body immunity. The radar analysis is used in the personality dimension, because the radar chart can show the preferences intuitively. The knowledge dimension includes education and profession. The education shown on the map contains the position, school badge, specialty, and time interval. The basic information about a profession can be shown by the organization chart of the company, and the relationships and professional experience can be presented by networking and an event list, respectively. The belief dimension shows the statistical analysis results of viewpoint and comments by key words and grades.

Similar to the individual ontology, the ontology structure of an organization can also be presented from five dimensions: physiology, personality, knowledge, belief, and experience. The physiology of an organization can be obtained from the infrastructure, general information, profitability, debt-paying ability, and development capability. The infrastructure should be presented by a 3D model; therefore, everyone can have an immersive experience of the organization. The profitability, debt-paying ability, and development capability can be shown by power bars. In the physiology dimension, the radar chart can show the self-interested behavior and risk preference intuitively. The knowledge dimension includes staff composition, leadership quality, and quality of staff. The education, position, seniority, gender, and place of origin of the staff composition can be shown by a few pie charts. The abilities of the leaders can be summarized by a radar chart. The advertising video, typical story, image, and slogan can interpret the corporate culture, thus the belief of the company. The experience of one company consists of the employee turnover, income and expenditure, and transaction history. The employee turnover can be shown by an organization chart of the company, revealing the entry and exit of the employee, and the career history and next job of each employee can be known. By using a graphical user interface, the state of operation can be shown very well, and the balance sheet, income statement, and cash flow statement can be shown to others if possible. The transaction history can be classified by commodities and customers.

### 4.2 Dynamic development progress

The dynamic update of the ontology should be presented visually, and there should be notifications to convey which behavior updates the dimensions or properties. Then, the system can provide advice on how to optimize the future behavior based on the dynamic updated information. Further, the key point and event should be highlighted. In addition, the dynamic development process such as 3D models, power bars, values, maps, and radar charts, between any time period can be shown by a gif or flash.

### 4.3 Knowledge graph

By recording, exhibiting, and learning the interaction information, the personalized portal should be able to organize and manage the knowledge, which is the theoretical basis of making decision automatically.

- Standardized express of knowledge. The concept, attribute relation, axiom, consciousness, and behavior pattern should be expressed in a standardized form to make the interaction convenient.
- Self-organization of knowledge. The information from the cyberspace, which may be associated with the user, should be acquainted automatically. Then, the acquainted information with various formats is cleaned according to the specific algorithm.
- Management of knowledge graph. The acquainted knowledge should be added to the graph automatically and rationally. Then, the graph shows differentiated level to different subjects.

### 4.4 User permission settings

The permission setting, visitor view, stealth setting, range of information presented, identity data, sample data, message permission, free ads setting, and blacklist setting can be adjusted by interacting with the ontology.

## 5 Reliable Supply

The supply release, history, preference, and status of the subject can be thoroughly presented through words, images, VR, AR, RTV, and real-time interaction. Then, the logical information world and actual physical world can be syncretized; this enhances the reality and reliability of the supply.

The standardized description of supply ensures that the supply is easy to identify. The supply certification makes the supply information credible. The production process visualization, retrospect visualization, and management visualization can boost the transaction credibility. By feeding back the distribution of supply and demand information within the platform in time, the credibility of the supply optimization strategy can be boosted.

### 5.1 Standardized description

By describing the supply information in a standard manner, it is easy to recognize the accurate supply information. This may help to search and select the optimal supply from numerous supplies. From the standardized description of supply information, the supply keywords and quantitative information can be obtained.

A standardized description method for heterogeneous supply should contain the following information: structural information, utility information, and evaluation information. In addition, commodity and service focus differently on describing the supply information as shown in Tables 1 and 2, respectively.

### 5.2 Trusted certification

The information about transaction subjects and objects should be certified by the certification system before they can be searched, browsed, classified, traded, and evaluated. The certification system provides the functions such as certifying the information about transaction subjects and objects, coding the online commodity, releasing the credible commodity or service, setting a standard for the exchange and share of the information, and formulating the standard and model of the service contract.

The structure of a supply release is shown in Fig. 4. When the individual or enterprise releases the supply information, all the user information and details of supply information should be sent to the certification system. Then, the information can be searched if the information passes the certification process. For the commodity or service with a transaction record, its

**Table 1 Standardized description of commodity.**

| Item | Meaning |
|---|---|
| Category | Physical or digital |
| Industry | A–Z |
| Brand level | 1–5 |
| Level | 1–5 |
| Specification | Size and packing |
| Valid date | Whether needs sales promotion |
| Price index | Historical and average price, trend |
| Sales information | Time, location, price, and volume |
| Image | Products and environment display |
| Video | Products and environment display |
| Credit | Subject and object credit |
| Label | Based on the semantic analysis |
| Instruction | Detail information |
| Link | More information |
| Cases | Typical application |
| Distributing center | Cover range and supply capacity |
| Similar commodity | Substitutability: 1-0 |
| Inventory | Location, volume, and price |
| Production capacity | Average and peak capacity |
| Supply resources | Region, quality, capacity, and price |
| Ingredients | Detail information |
| Target buyers | Gender, age, job, and preference |
| Recommended item | Correlation: 1-0 |
| Cautions | Holographic display |
| Main function | Application scenarios |
| Storage mode | Space, temperature, and humidity |

**Table 2 Standardized description of service.**

| Item | Meaning |
|---|---|
| Service content | Education, delivery, and health care |
| Category | A–Z |
| Brand level | 1–5 |
| Level | 1–5 |
| Valid date | When the service is available |
| Location | Where the service is available |
| Capacity | Average and peak capacity |
| Price index | Historical and average price, trend |
| Sales information | Time, location, price, and volume |
| Image | Products and environment display |
| Video | Products and environment display |
| Credit | Subject and object credit |
| Label | Based on the semantic analysis |
| Instruction | Detail information |
| Link | More information |
| Cases | Typical application |
| Similar service | Substitutability: 1-0 |
| Target buyers | Gender, age, job, and preference |
| Recommended item | Correlation: 1-0 |
| Cautions | Holographic display |
| Main function | Application scenarios |

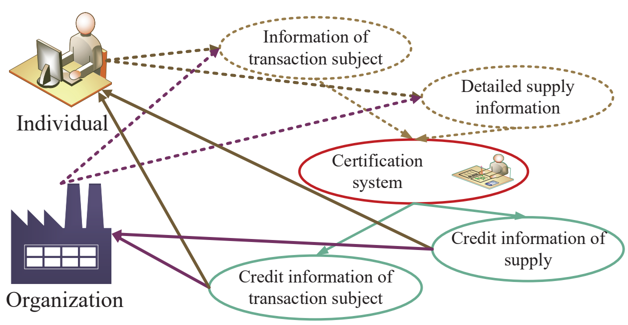


**Fig. 4 Structure of supply certification.**

network reputation and transaction evaluation must be fed back to certification system. Thus, the search and propagation of supply information are supervised by the certification system.

## 5.3 Holographic display

Taking physical commodity as an example, the raw materials, production process, transport process, and application process, the lifecycle of the commodity, can be shown through graphics and text information, VR, AR, and RTV. A holographic display can improve the reliability of supply and user experience.

### 5.3.1 Holographic product

More information about a commodity to the customer helps more to improve the system's matching accuracy and speed. The multidimensional information consists of basic information, production information, specific information, portfolio information, exhibition information, and supply and demand information, as listed in Table 3 . Besides the traditional images and words, VR display, voice interaction, and complete traceability information can be used to display the commodity.

### 5.3.2 Holographic process

By creating an online factory using visual reality and augmented reality, the consumers and partners can know the production environment, production level, production capacity, inventory status, and demand information interactively. This increases the credibility and probability of the transaction.

Seeing is believing. The consumers and partners do not need to visit the real factory; an online factory can make it easier. The 3D model of the factory is made in one-to-one scale. Thus, one can walk in the virtual factory with the first-person perspective. The production information, i.e., environment, level, capacity, and demand, is presented near the production line. In addition, all the production processes can be viewed by real-time videos.

Consumers and partners can know about the production process, production status, and production quality by reviewing the raw materials, parts, and orders. When an order is generated, the order progress, location, and production process are updated in real time. The review of the overall process can increase the credibility of the objects. In addition, the production enterprise can achieve visual management based on the holographic process that offers real-time operation information and order information. Production scheduling may be the most common management behavior.

**Table 3 Holographic information of commodity.**

| Dimension | Information structure |
|---|---|
| Basic information | Name, category, brand, bar code, specifications, date, etc. |
| Production information | Supplier, production situation, commodity composition, hedonic price, etc. |
| Specific information | Application scenarios, announcements, contrast situation, etc. |
| Portfolio information | Related commodity, substitute commodity, composite commodity, etc. |
| Supply and demand information | History, statistics, status, forecast, etc. |

## 5.4 Supply optimization

### 5.4.1 Supply parameters

Suppose there are $m$ suppliers and $n$ commodities within one district. The key supply information $\mathrm{SI}_{ij}$ of commodity $j$ from supplier $i$ is listed in Table 4.

The distribution of commodity $j$ from multiple suppliers forms a sparse matrix, shown in Fig. 5,

**Table 4 Supply information $\mathrm{SI}_{ij}$.**

| Factor | Expression |
|---|---|
| Location | $(x_i, y_i)$ |
| Quantity | $\mathrm{SQ}_{ij}(t)$ |
| Sales volume | $\mathrm{SV}_{ij}(t)$ |
| Commodity price | $\mathrm{SP}_{ij}(t)$ |
| Commodity credit | $\mathrm{CC}_{ij}(t)$ |
| Supplier credit | $\mathrm{CS}_i(t)$ |
| Relevance | RR |

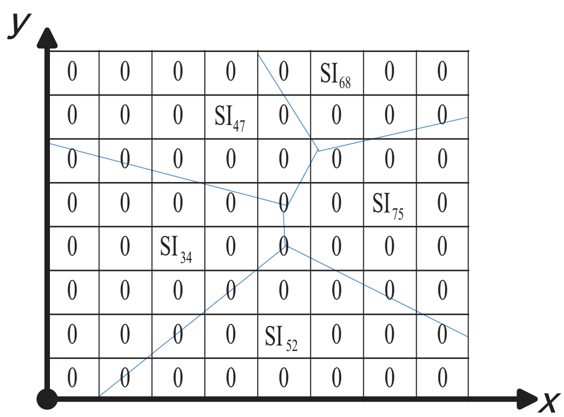


**Fig. 5 Matrix of supply location.**

and each element of the matrix represents the supply information. If the coverage area of one supplier is decided by the distance between the supply and demand, the Dirichlet region can be obtained for any district. Then, the area that supplier $i$ takes over is $SD_i$.

The calculation models of commodity $j$ within the district are shown in Table 5. The price index $IM_j$ of commodity $j$ is associated with the prices from all the suppliers. However, the price index $IS_i$ of supplier $i$ is only associated with its commodities; this probably indicates that its commodity price is high or low. The sales volume $SSV_i$ and credit $CS_i$ of supplier $i$ consist of the sales volume and credit of all its commodities, respectively. The social evaluation of supplier $i$ is associated with its price index $IS_i$, sales volume $SSV_i$, credit $CS_i$, and location $(x_i,\ y_i)$. Similarly, the social evaluation of commodity $j$ is associated with its price index $IM_j$, sales volume $SCV_j$, and credit $CC_j$.

### 5.4.2 Product family planning

Commodity relevance refers to the relationship between commodities, including substitution and complementarity. The relevance of two specific commodities refers to the degree of correlation between the two commodities in the composition, function, material, form, etc. The higher the degree of commodity relevance, the easier the acceptance by consumers, and vice versa. The relevance of consumers refers to the commodities by gender, age, culture, occupation, and geographical characteristics.

According to the demand of consumers, market segments are tapped by using cluster analysis, and each segment can be subdivided into some smaller segments. In addition, the evolution of demand segmentation in any time period can be demonstrated, and the demand segmentation in the future can be predicted. By mining the potential demand, the common demand-centered customer segmentation can be sought, and the product configuration can be extracted.

**Table 5 Calculation models of supplier *i* and commodity *j*.**

| Factor | Calculation expression |
|---|---|
| Price index of commodity $j$ | $IM_j(SP_{1j}(t), ..., SP_{ij}(t), ..., SP_{mj}(t))$ |
| Price index of supplier $i$ | $IS_i(SP_{i1}(t), ..., SP_{ij}(t), ..., SP_{in}(t))$ |
| Sales volume of commodity $j$ | $SCV_j(t)=\sum_{i=1}^{m} SV_{ij}(t)$ |
| Supply quantity of commodity $j$ | $SQ_j(t)=\sum_{i=1}^{m} SQ_{ij}(t)$ |
| Sales volume of supplier $i$ | $SSV_i(SV_{i1}(t), ..., SV_{ij}(t), ..., SV_{in}(t))$ |
| Credit of commodity $j$ | $CC_j(CC_{1j}(t), ..., CC_{ij}(t), ..., CC_{mj}(t))$ |
| Credit of supplier $i$ | $CS_i(CS_{i1}(t), ..., CS_{ij}(t), ..., CS_{in}(t))$ |
| Social evaluation of commodity $j$ | $\varphi_{Cj}(SCV_j(t), CC_j(t), IM_j(t))$ |
| Social evaluation of supplier $i$ | $\varphi_{Si}(SSV_i(t), CS_i(t), IS_i, (x_i, y_i))$ |
| Supply uniformity of commodity $j$ | $U_{Sj}(t) = 1 - \frac{\sum_{i=1}^{m} \lvert SQ_{ij}(t) - SQ_j(t)/m \rvert}{SQ_j(t)}$ |
| Coverage area uniformity of commodity $j$ | $U_{Cj}(t) = 1 - \frac{\sum_{i=1}^{m} \lvert \frac{SQ_{ij}(t)}{SD_i(t)} - \sum_{i=1}^{m} \frac{SQ_{ij}(t)}{SD_i(t)}/m \rvert}{\sum_{i=1}^{m} \frac{SQ_{ij}(t)}{SD_i(t)}}$ |

### 5.4.3 Supply matrix optimization

The supplier can view the distribution of the supply and demand of any time period, and the system can suggest the optimal supply location and optimization effect.

According to the historical demand data, the element of a supply matrix as shown in Table 6 can be predicted by grey prediction[25], season index, etc. As a result, the supply can be optimized for an instant, predicted, and reserved demand scenario.

The supply location can be optimized based on the supply uniformity, dynamic price, delivery fee, and credit. The distribution characteristic of demands achieved from the cluster analysis is the optimized orientation of the supply distribution. The supply distribution adjusts continually, and the manufacturer and collecting distribution center tend to be smaller, more dispersed, and more customized[26].

When the consumer cannot receive or sign for a part of the commodities, the system makes sequential delivery. Predictive delivery of the distribution center may reduce the consumers' waiting time.

## 6 Intelligent Demand

The demand proposal, history, preference, and status of the subject can be thoroughly presented through words, images, VR, AR, RTV, and real-time interaction. Then,

**Table 6 Supply matrix.**

| Supplier | Credit | Location | ... | Commodity | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | ... | $n$ |
| 1 | $CS_1(t)$ | $(x_1,y_1)$ | ... | $SI_{11}$ | $SI_{12}$ | ... | $SI_{1n}$ |
| 2 | $CS_2(t)$ | $(x_2,y_2)$ | ... | $SI_{21}$ | $SI_{22}$ | ... | $SI_{2n}$ |
| — | — | — | — | — | — | — | — |
| $m$ | $CS_m(t)$ | $(x_m,y_m)$ | ... | $SI_{m1}$ | $SI_{m2}$ | ... | $SI_{mn}$ |

the logical information world and the actual physical world can be syncretized, increasing the accuracy of demand identification.

### 6.1 Standardized description

The demand information may be mixed with uncertain linguistic information because of limited experience and knowledge background[27]. The complexity of the commodity itself may also reduce the accuracy of demand information. Meanwhile, multigranularity and multisemantic are used by different consumers in describing the demand information. To solve the problem of dealing with complex linguistic information characterized by multigranularity and mixed language variables, it is necessary to design a standardized description method for heterogeneous demands. By describing the demand information in a standard manner, it is easy to recognize the accurate supply information; this may be helpful to search and select the optimal supply from numerous supplies. A standardized description method for heterogeneous demand should include but not limited to the information shown in Table 7: name, quantify, quantity, time, place, mode, credit, and special requirements.

**Table 7 Information of standardized description.**

| Item | Parameter |
|---|---|
| Name | Supplier<br>Brand<br>Commodity<br>Category |
| Quality | Available time<br>Quality level |
| Quantity | Size<br>Packaging |
| Time | Date manufactured<br>Order time<br>Delivery time<br>Life cycle |
| Place | Production place<br>Destination |
| Mode | Payment method<br>Delivery method |
| Credit | Supplier<br>Commodity |
| Special requirement | Speed<br>Sales volume<br>Price<br>Credit<br>Specified |

### 6.2 Demand classification

The demand can be divided into explicit demand, implicit demand, and unknown demand as shown in Fig. 6. Explicit demand includes instant demand and period demand. The implicit demand can be called predicted demand. Moreover, each type of demand can be subdivided into noncustomized and customized demand. According to different demands, the corresponding countermeasures are designed.

The instant demand is the most common demand, and the demand information can be actively input or automatically recognized by NGECP.

The periodic demand is similar to the instant demand, but the demand information and orders are in sequence. In addition, a configuration table shows the detailed information, such as the frequency, time, and duration. The statistical condition of the completed transaction sequence updates constantly. The adjustment and optimization of the follow-up transaction sequence refer to the feedback from the statistical and market conditions.

The predicted demand will be inferred or recognized based on the ontology and internet of things. A prediction scenario often occurs in consumables, time-expired commodities, and seasonal commodities. The consumables can be shown by a Gantt chart, making it easy to know what to buy. Pervasive sensors can show the life expectancy of commodities. Seasonal commodities are properly recommended in every possible scenario. The commodity with a recommended reason is presented by 3D models, and each commodity

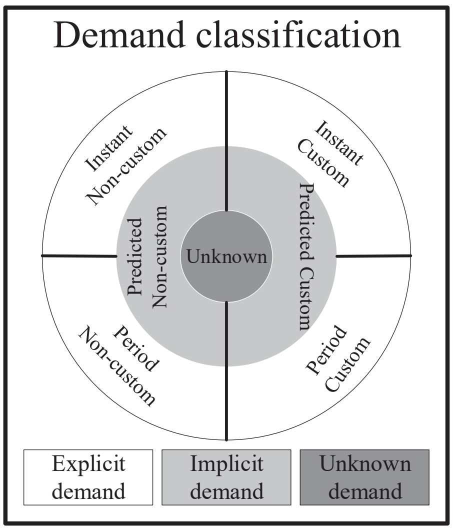


**Fig. 6 Results of scenario analysis.**

has its potential supply chain. Moreover, a supplier in the potential supply chain knows about the consumer's personalized information. Then, the supplier can adjust the supply and feed the information to the consumer; this may increase the transaction probability.

### 6.3 Demand analysis

Besides text, voice and image are the input methods of a demand analysis system. As shown in Fig. 7, the inputs of a demand analysis system are the current demand information, personal information, behavior history, and digital labels. Then, the output provides detailed demand information.

First, NGECP obtains the demand information shown in Table 8 by semantic recognition and reasoning from the standardized description of the present moment. Second, the personalized information achieved from the ontology is added to the demand list, such as physiology, personality, knowledge, belief, and experience.

### 6.4 Demand optimization

Suppose there are $M$ consumers and $N$ commodities within one district. The key demand information $\mathrm{DI}_{ij}$ of commodity $j$ from consumer $i$ is shown in Table 8.

The calculation models of commodity $j$ within the district are shown in Table 9.

The statistical information of demand should be presented to the consumer in a proper way, such as the demand category in a pie chart, demand time or frequency in a timeline or histogram, demand preference in a radar chart, and evaluation preference

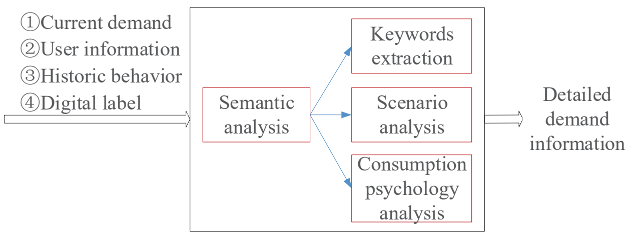


**Fig. 7 Demand analysis structure.**

**Table 8 Demand information $\mathrm{DI}_j$.**

| Factor | Expression |
|---|---|
| Location | $(X_i, Y_i)$ |
| Quantity | $\mathrm{SQ}_{ij}(t)$ |
| Commodity price | $\mathrm{BP}_{ij}(t)$ |
| Demand credit | $\mathrm{CD}_{ij}(t)$ |
| Time of demard proposing | $t_{ij}(t)$ |
| Frequency | $f_{ij}(t)$ |

**Table 9 Calculation models of consumer *i* and commodity *j*.**

| Factor | Calculation expression |
|---|---|
| Demand quantity of commodity $j$ | $\mathrm{DQ}_j(t)=\sum_{i=1}^{M}\mathrm{DQ}_{ij}(t)$ |
| Average price of commodity $j$ | $\overline{P}_j(t)=\frac{\sum_{i=1}^{M}\mathrm{DQ}_{ij}(t)\cdot\mathrm{BP}_{ij}(t)}{\mathrm{DQ}_j(t)}$ |
| Analysis of commodity $j$ | $\varphi_{Aj}(\mathrm{DQ}_j(t),\overline{P}_j(t))$ |
| Credit of consumer $i$ | $\mathrm{CD}_i(\mathrm{CD}_{i1}(t), ..., \mathrm{CD}_{ij}(t), ..., \mathrm{CD}_{iN}(t))$ |
| Demand uniformity of commodity $j$ | $U_{Dj}(t)=1-\frac{\sum_{i=1}^{M}\lvert\mathrm{DQ}_{ij}(t)-\mathrm{DQ}_j(t)/M\rvert}{\mathrm{DQ}_j(t)}$ |

in a label. The consumer can view the distribution of the supply and demand of any time period. According to the historical demand data, the element of demand matrix as listed in Table 10 can be predicted by grey prediction, season index, etc.

The supply information on NGECP is classified and presented in the same category of demand. Then, the transaction strategies for different scenarios are made according to the demand and supply information. Furthermore, the effects of the adjustment of quality or time of the order on the price and credit should be considered. The effect of price fluctuation on demand quality should also be considered.

For an instant demand, the proper order time $T_{\mathrm{opt}}$ can be recommended according to the price fluctuation, and the proper transaction object $O_{\mathrm{opt}}$ and quantity $Q_{\mathrm{opt}}$ can be advised based on the analysis of suppliers and the relationship between trading number and price. For a periodic demand, when the price changes, the consumer should be informed, and the adjustment of order should be suggested, such as a reduction in commodity, stocking up in advance, and selecting a substitute commodity. For a predicted demand, the trend and degree of changes in prices should be informed to the consumer, and $T_{\mathrm{opt}}$, $O_{\mathrm{opt}}$, and $Q_{\mathrm{opt}}$ should be suggested. When the commodity quantity is increased, the total

**Table 10 Demand matrix.**

| Consumer | Credit | Location | ... | Commodity | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | ... | $N$ |
| 1 | $\mathrm{CD}_1(t)$ | $(X_1, Y_1)$ | ... | $\mathrm{DI}_{11}$ | $\mathrm{DI}_{12}$ | ... | $\mathrm{DI}_{1N}$ |
| 2 | $\mathrm{CD}_2(t)$ | $(X_2, Y_2)$ | ... | $\mathrm{DI}_{21}$ | $\mathrm{DI}_{22}$ | ... | $\mathrm{DI}_{2N}$ |
| — | — | — | — | — | — | — | — |
| $M$ | $\mathrm{CD}_M(t)$ | $(X_M, Y_M)$ | ... | $\mathrm{DI}_{M1}$ | $\mathrm{DI}_{M2}$ | ... | $\mathrm{DI}_{MN}$ |

cost consists of the commodity price, fixed cost, and cost of adjustment. Otherwise, the reputation can be affected, and a penalty fee can be paid.

## 7 Smart Cyberspace

A smart cyberspace can be constructed by collecting and arranging the information automatically from the owner and those who interact with him/her. The social network of user-centered forms based on the interactive information, and the weights and relation which can quantitatively express the relationship between two individuals are updated in real time. There is an interface of human–computer interaction for all the users of NGECP. Furthermore, the present priorities of different types of information refer to the ontology; this may increase the personalization of interaction.

### 7.1 Visualization and presentation

There are three sources of information: the information produced by the user, the information produced by someone within his/her social network, and the information produced by the interaction within NGECP. The details of the collected information are shown in Table 11. There are three ways to disseminate information. First, broadcast the information to all the users who may accept or intercept. Second, inform the specific users who may pay attention to the provided information. Third, nobody will be informed, but the information can be searched, viewed, and spread. This is a passive way. Users can set permissions so that only particular users can visualize some personal information. After constantly learning, the ontology can obtain information initiatively and intercept information automatically. Moreover, timely reminders are given based on the collected information.

The collected information can be sorted and shown by location, time, and categories. Through the statistical analysis of the collected information, the preference information of search, browse, focus, trade, and travel can be obtained. This can be shown by a variety of charts such as a pie chart, a histogram, and tag clouds.

**Table 11 Information sources.**

| Source of information | Dimension of information |
|---|---|
| User's own action | Time, location, object, purpose, result, feedback, cost, and process |
| Action from social network | Time, location, object, content, result, and feedback |
| Interaction within NGECP | Time, object, purpose, result, feedback, and process |

### 7.2 Smart connection

In a smart cyberspace, the social spectrum can be shown on a map using different social circles. In addition, the interaction history and latest development within the social network can be shown.

The ontologies of different users are correlative, and the relationship includes practical and potential interactions. The practical interaction between two users is physical interaction. However, the potential interaction is unconscious; for example, somebody proposes one idea that has been proposed before. Each dimension of the relationship between any two users has its specific weight and similarity calculated dynamically. The concrete manifestation of a smart connection is the degree of relationship, interaction history, and indirect relation when one visits another cyberspace. In addition, the additional information can be added to the ontology database, such as image, voice, and text.

Because the ontologies are connected, the transaction information, original content, forwarding information, and popular information can be automatically sorted, manually searched, and filtered. In addition, according to the requirement, the basic information, intimacy, and interaction history are provided to particular contacts.

### 7.3 Smart search and recommend

The ontology can identify the search requirement by semantic disambiguation and understanding of the natural language, and the search information will be fed back to the user. Then, the personalized information of ontology acts as the restrictive condition of search. For example, when a user wants an apple, the system shows Fuji apple as the search result by semantic understanding of the fruit information and user preference. The search result can be optimized by the interaction between ontology and user, and the ontology should accurately recognize the collection and classification demand.

The input of a recommendation system is all types of interaction history. The ontology builds the model and algorithm based on the recommended content, social graph, collaborative filtering, and context awareness. The promotion of proper commodity, coupon, partner, news, and ads at the right time may satisfy the everyday needs of the user. In addition, the frequency and form of recommendation can be adjusted.

## 8 Conclusion and Future Work

We propose the architecture of an NGECP comprising numerous individuals, enterprises, and administrative departments. On the NGECP, any individual or organization has his/her own personalized portal. This has four parts: the accurate ontology, reliable supply, intelligent demand, and smart cyberspace. The decentralized NGECP is a large-scale, open-styled, self-organized, and ecological intelligent network; all the participants in NGECP connect and interact mutually. A user of NGECP can complete the demand recognition, supply release, matching, transaction, and credit evaluation within his/her own personalized portal, rather than using a traditional third-party platform.

Any individual or organization of the realistic world has an accurate ontology on NGECP. This consists of information and behavior from the realistic world. The physical characteristics, knowledge, and reminding information of the subject can be thoroughly presented through words, images, VR, AR, RTV, and realtime interaction by the ontology.

In a reliable supply system, the standardized description of commodity and service is proposed. This ensures that it is easy to identify the supply details. Moreover, all the supply information of standardized description should be certified by the certification system. The holographic display of commodity and its production process improves the reliability of supply and user experience. In addition, the supply optimization methods for NGECP are proposed.

A standardized description of demand will increase the accuracy of demand identification. By analyzing the personalized and instant demand information, the detailed demand information is obtained. The demand proposal, history, preference, and status of the subject can be thoroughly presented.

In the smart cyberspace, the social network of user-centered forms based on the interactive information, and weights and relations are updated in real time. The smart cyberspace acts as a way to know the world and solves the isolated islands of information.

Many further studies can be performed based on this study. First, the data structure of ontology should be studied to improve the accuracy and instantaneity of ontology. Second, the supply information will be more reliable if the block chain technology is used. Third, more accurate recommendation algorithm can be proposed for the NGECP.

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