Research on customer demand acquisition method based on scrap steel reverse supply chain service platform

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Abstract: In order to obtain the accurate service demand of scrap steel reverse supply chain for realizing the service resource composition and completion service process, the service demand is classified. Aiming at the difficulty of obtaining service demand information caused by customers’ individual differences, a demand acquisition method is proposed, and then a semantic expression model and ontology model of customer service demand are constructed. The correctness and feasibility of the service demand acquisition method of scrap steel reverse supply chain are verified by a case.

1. Introduction
Scrap steel reverse supply chain service system platform manages the whole service process of customer-oriented personalized service demand, the formation of service scheme and the implementation of service process. As a typical complex system, the scrap steel reverse supply chain service system needs to obtain customer service demand, transform service demand into service process, service activities and service resources, and then the service scheme is formed. The whole process is very complex. In the previous research, the modeling, mapping and matching of service activities and service resources have been completed. How to obtain the customer’s service requirements and transform them into the service process is a problem worthy of discussion.

In recent years, many experts and scholars are engaged in the research and application of customer service requirement information [1,2]. Wang Chen proposed a multi-dimensional user requirement acquisition method based on requirement ontology and cognitive process to solve the problem of insufficient acquisition and low reuse rate of customer requirement information [3]. Wang Lei et al. proposed a dynamic requirement acquisition strategy to solve the problems of confusion and difficulty in extracting remanufacturing service requirements, established the candidate ontology and semantic expression model of remanufacturing service requirements, and constructed the customer remanufacturing service requirements ontology by Web table effective block partition, similarity calculation, content extraction and other methods [4]. In order to provide personalized literature search results, Xu Hao proposed a real-time user demand discovery method for literature searching system [5]. The above research mainly attempts to discover and obtain customer needs based on products or services from the aspects of psychological attributes and acquisition methods. Although the shortcomings and differences of customer cognition considered in the methods, the personalized requirements and typical service needs of customers, and the transformation from personalized service requirements to typical service requirements are not comprehensively considered in the system.
Therefore, considering the personalized needs and typical service needs, a method of obtaining the service needs is proposed. After analyzing the semantic ontology of the service needs, the service needs ontology is established for building the service integration platform of scrap steel reverse supply chain.

2. Service demand acquisition strategy of scrap reverse supply chain

2.1. Service process of scrap steel reverse supply chain
The basic service process of scrap steel reverse supply chain service mainly contains that the customer puts forward the service demand in the scrap steel reverse supply chain service integration platform, and the service integration platform gives the service solution according to the service demand information and service provider’s service resource information. The model of Service process of scrap steel reverse supply chain is shown in Figure 1.

![Figure 1: Service process model of scrap steel reverse supply chain](image)

The customer puts forward the personalized service demand of scrap steel utilization in the service integration platform. After the platform receives the service demand, the service demands are analyzed, and the service process are constructed according to the standardized or customized scrap steel process in the knowledge base. The service integration platform adopts complex system decomposition method to decompose, divide, organize and manage the service process. Service process can be divided into service activities and service resources. After the division of service activities and service resources, the service integration platform needs to match the service resources, and finally form an overall service resource solution to deliver or implement services to customers.

2.2. Service demand classification of scrap reverse supply chain
The characteristics of the demand of customer service is individuation and diversity. There are some problems as follows: (1) There are many kinds of scrap steel, and the composition and the size of the scrap steel are not clear, so the customer cannot put forward accurate demand; (2) Due to the constraints of time, space and other conditions, customer service demand changes at any time by the service content provided by the service provider, resulting in more changes in service demand; (3) The description of customer service requirements is disordered and not clear; (4) Customers have different ways of expression and habits, and the description of requirements is lack of uniformity. Therefore, a standardized demand should be offered in the scrap steel reverse supply chain service system for customers to express their service requirements.

The service demands put forward by customers to the scrap steel reverse supply chain service platform mainly include personalized customer demands and typical user demands. Typical customer service demand can be the specific information of recycling service, transportation service, processing...
service and other services proposed by users, including service duration, service quantity, service price and other information. The personalized service demand, that is, the differentiated service demand information of different users, contains the user's personal preference, such as the specified scrap steel recycling manufacturer, scrap steel type, not accepting outsourcing services and other user demand information.

2.3. Service demand acquisition strategy of scrap reverse supply chain

The typical service requirements can be submitted to the service integration platform, and the created ontology model of related service requirements can be directly applied in the information knowledge base. The personalized service demand of customers contains explicit demand and implicit demand. It is necessary to explore the implicit demand to establish an appropriate ontology model of service demand.

The personalized service requirements can be obtained by the following methods. ① The web page is built by user-defined, and the service requirement name and the attribute value are given by the user. For the service requirements with multiple attributes and attribute values, the multi-layer multiple requirement attributes can be established, and the attribute name and value can also be given. ② According to the requirement keywords, the service integration platform can search the corresponding service requirement ontology in the knowledge base, and push "potential requirements" to customers to help them put forward more service requirements. The service requirement acquisition model is shown in Figure 2.

At the beginning of service system construction, typical customers service requirements knowledge base can be constructed. With the increase of users, more personalized service needs can be transformed into typical needs. Through the analysis of large-scale personalized user needs, user history or historical business processes can be deeply mined and analyzed. Service integration platform can extract and define requirement patterns from typical service requirements.

3. Organization and expression of service demand

After users submit the service requirements on the web page through human-computer interaction, the service integration platform needs to build the service requirements ontology, which can provide the basis for the selection and matching of service modules and scheme decision-making of scrap steel reverse supply chain. Combined with the idea of manufacturing resource ontology modeling and the characteristics of scrap steel reverse supply chain service field, the typical service resources and service demand knowledge widely which are existing in the scrap steel recycling enterprises information system are regarded as a huge knowledge resource base. In order to improve the efficiency of building customer service requirement ontology on knowledge platform, a complete and professional service requirement ontology and its semantic expression model are constructed by fusing the different description knowledge in service requirement knowledge base.

3.1. Concept set of service requirement ontology

Based on the previous research on the reverse supply chain service of scrap iron and steel, the concept set of service demand ontology can be summarized into four categories. (1) scrap steel recycling service, mainly including user area recycling service, recycle center recycling service and processing center recycling service. (2) Scrap steel transportation service mainly includes user area transportation service,
recycle center transportation service, processing center transportation service or third-party transportation service. (3) Processing service mainly refers to disassembly or simply processing service in the recycling station, sorting service, disassembly service, flame cutting service, punch processing service, self-grinding service, bundling service, packaging processing service and other activities of scrap steel processing enterprises. (4) Decision-making services, such as distribution decision-making service, inventory decision-making service, processing route decision-making service, etc.

3.2. Semantic relationship of customer service requirement ontology
By analyzing the concept set of service requirement ontology of scrap steel reverse supply chain, the relationship between service requirements is divided into species relationship and instance relationship. Species relationship describes the relationship between father and son concepts (attributes) at different levels. Instance relationship is used to describe the relationship between concepts and instances.

Definition 1: Specific relationship of ontology. It refers to the relationship between concepts Oc1, Oc2, Oc1 ∪ Oc2 ∈ Soc. It means the ontology concept set Soc contains the connotation Oc1 and Oc2. It is denoted as Spe-rel (Oc1, Oc2).

Definition 2: Attribute relationship. It refers to the relationship between element a (a ∈ SA) in attribute set SA and concept Oc, denoted as Atr-rel (A, Oc).

Definition 3: Instance of relation. It refers to the relationship between instance I (I ∈ Sic) and concept Oc in instance set Sic, denoted as Ins-rel (I, Oc). The instance of I will inherit the data attribute and object attribute of the concept, and the attribute value should be given.

Then the service demand metadata model can be constructed, as shown in Figure 3.

![Figure 3 Service demand atomic data model of scrap steel reverse supply chain](image)

3.3. Establishing service requirement ontology
After analyzing the relationship between ontology concept set and ontology, the service requirement ontology can be expressed as a four tuple. CSROCR = {CRCR, RCR, ACR, ICR}, where OCR represents user requirement ontology, CRCR represents the set of classes, RCR represents the relationship between ontology concepts, ACR represents the attribute of the concept, ICR represents the data or datatype of the concepts, which can be the data of requirement concepts or type data. Using the software of Protégé the service requirement ontology is constructed and output in the form of Web Ontology Language (OWL).

4. Cases
The region where X metal resources company is located needs to build the scrap steel integrated application service system and the scrap steel reverse supply chain service integration platform. X metal resources company needs to recover 200 tons of scrap iron and steel from the recycling centers. The service requirements involved include recycling service, transportation service and processing service. The scrap steel service demand is put forward to the service integration platform, as shown in Table 1.

| type                  | Attribute name | Attribute value | Service demand type | Attribute name | Attribute value |
|-----------------------|----------------|-----------------|---------------------|----------------|-----------------|
| Recycling service     | ID             | HS20190126      | Transport service   | ID             | HS20190426      |
In order to express the service demand information more clearly, and more easily to build information system, OWL language is used to express and store the service demand information of scrap steel reverse supply chain. The above ontology modeling method and software protégé are used to build the ontology model of service requirement. The parts of owl fragments are given.

5. Conclusions
Scrap steel reverse supply chain service is a complex system operation process. Accurately obtaining service demand and expression is the key process to realize service matching, service scheme decision and service implementation successful. Aiming at the problem of individual differences of customers and difficult to require the service demand information, the service demands are classified, and a service demand acquisition strategy is proposed. Then a semantic expression model and ontology model of customer service demand are built. The correctness and feasibility of the service demand acquisition method of scrap steel reverse supply chain are verified by a case study.

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References
[1] Wang X., Qiao W.W. (2020) Research on User Implicit Demand Analysis Based on Cloud Platform[J]. Machine Design and Research, 36(5): 8-11,17.
[2] Liu Y., Lim S. C. (2013) Product Family Design through ontology-based faceted component analysis, selection, and optimization[J]. Journal of Mechanical Design, 135(8): 1885-1901.
[3] Wang C., Zhao W. (2016) CHEN Lin. Multidimensional customer requirements acquisition based on ontology[J]. Computer Integrated Manufacturing Systems, 22(2): 908-916.
[4] Wang L., Xia X.H., Cao J.H. (2018) Dynamic requirements acquisition method and application for remanufacturing service[J]. Computer Integrated Manufacturing Systems, 24(3):781-792.
[5] Xu Hao, Chen X., Hu X.F. (2015) Finding method of users' real-time demands for literature search systems[J]. Journal of Computer Applications, 35(7): 1975-1978, 1983.