Research on optimal selection of services and optimal allocation of resources in cloud manufacturing environment

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Abstract. As a new manufacturing mode in recent years, cloud manufacturing has provided a new method for manufacturing industry from low efficiency to efficient utilization of resources, based on the concept of "manufacturing as a service". Cloud manufacturing is the product of the integration of high-tech, as information technology, Internet of things and big data. To promote global manufacturing to a healthy, green direction, cloud manufacturing technology converges massive service resources, centralizes utilization, reasonably allocates, and realizes high-level utilization and real-time sharing of manufacturing resources. However, due to the large number, wide scope and complexity of cloud manufacturing resources, and the uncertainty and diversity of cloud manufacturing users, how to achieve optimal deployment of cloud manufacturing resources, it is an urgent problem to meet the different individual needs of users and to improve the efficient sharing of manufacturing resources. Therefore, this paper studies cloud manufacturing service optimization, cloud manufacturing service comprehensive evaluation system and resource optimal allocation, and uses the relevant software tools to design the system function modules and establish a cloud manufacturing service platform system.

1. Introduction
The advancement of the cloud manufacturing model is a major step forward in the development of the manufacturing industry. It not only has a major impact on the manufacturing industry, but also promotes the development of the national economy. Nowadays, with the rapid development of science and technology, communication, learning and cooperation in all walks of life tend to be networked. Because of the convenience and operability of networking, networking mode has been accepted by most users. Therefore, in the process of promoting cloud manufacturing mode, it is necessary to establish a public management platform. The construction of cloud manufacturing service platform system can provide great convenience for the promotion and application of cloud manufacturing mode. With the introduction of the cloud manufacturing model, scholars have begun extensive research on cloud manufacturing.

Yao-ping YU\textsuperscript{[1]} proposed a simulation method for manufacturing services, established a mapping relationship between manufacturing services and simulation models, and established mathematical models to establish unique decision evaluation indicators for service users and service providers. Han Zhang\textsuperscript{[2]} proposed a hierarchical model based on the hierarchical manufacturing process for the uncertainties, coarse-grained, diverse and dynamic problems in the process of service resource combination. Hui Wang\textsuperscript{[3]} proposed a new cloud manufacturing environment-based logistics supplier
evaluation method and entropy Topsis model. Jae Yoo Lee[4] proposed a comprehensive evaluation model for Saas quality, defined the key characteristics of Saas, extracted quality attributes based on key characteristics, and defined the metrics for quality attributes. In order to make a more reasonable evaluation of cloud services, Guihua Nie[5] first proposed a complete cloud service evaluation index system. Secondly, the problem of prioritization of evaluation indicators is solved by using Analytic Hierarchy Process (AHP). Finally, a quantitative model of qualitative indicators was established to make cloud service procurement decisions more scientific and persuasive. Head MR[6] divided resources and users in the context of virtualization, and proposed a new resource allocation algorithm to achieve fair resource sharing. Po-Chi Shih[7] analyzed the strength of the existing methods and proposed an intelligent processing allocation method that comprehensively considers the speed variability and resource segmentation effects. With the increase of research results, cloud manufacturing technology is gradually enriched, which laid the foundation for the promotion and improvement of the cloud manufacturing model. However, due to the continuous accumulation of resources from all walks of life, there is still an urgent need to establish a public management platform to centrally manage resources, so that the enterprise users can also use the resources in the platform according to their own needs while providing resources, so as to achieve the purpose of sharing resources to a large extent.

2. Overall architecture and business process of cloud manufacturing service platform system

Under the cloud manufacturing model, high-efficiency resource sharing needs to be achieved between different enterprises. Therefore, a unified description of cloud manufacturing services is inevitable. This paper builds a cloud manufacturing service platform system by unifying all services. This section provides the overall architecture and related business processes of the system.

2.1. Overall architecture of the system

Cloud manufacturing has the concept of “manufacturing as a service”, and SOA is a service-oriented architecture. This feature makes cloud manufacturing coincide with SOA. Therefore, this paper proposes an architecture of SOA-oriented cloud manufacturing service platform, and builds a prototype system of cloud manufacturing service platform. The specific architecture is shown in Figure 1.

As can be seen from Figure 1, the architecture mainly consists of user layer, human-computer interaction layer, system function layer, resource-aware access layer, data resource layer, hardware and basic support layer.

- Hardware and basic support layer is the basic software and hardware facilities for system operation, such as related data service centers, server clusters, etc.
- Data resource layer mainly includes related software resources, hardware resources, computing resources and other resources. It mainly stores resources in the data resource layer so that users can query at any time to support the safe use of cloud manufacturing system platform.
- Resource-aware access layer identifies and perceives manufacturing resources and capabilities mainly through related intelligent technologies and devices, and integrates information through sensor networks and the Internet, and then describes and encapsulates manufacturing resources and capabilities according to relevant technologies.
- System function layer is mainly related to the platform management of services, including service registration, service release, service optimization, resource optimization configuration, transaction management, service evaluation, etc. It provides reference for users through service optimization and resource optimization configuration.
- Human-computer interaction layer mainly provides support for platform operators, resource providers and resource users based on the visual interface to implement the operation of different manufacturing tasks.
User layer is the terminal of the system service platform, that is, the application layer of the service, which provides services for different users according to their different personalized requirements.

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![Diagram of Cloud Manufacturing Service Platform System](image)

**Figure 1. Overall architecture of cloud manufacturing service platform system**

2.2. System business process

After overall architecture of cloud manufacturing service platform is completed, the user first needs to register to obtain the permission to use the platform, and then completes the request, call and related transactions of the service in the platform through login. In the platform, the knowledge base and case library are increasingly updated and gradually expanded, enabling the cloud manufacturing platform to better serve users. The system business flow chart of this paper is shown in Figure 2. It mainly includes service resource release, database update, cloud service optimization, manufacturing task release, task decomposition, service comprehensive evaluation, resource optimization configuration, service selection and service execution. When the manufacturing task is completed by the selected service, the service provider and the demander will evaluate each other, and the evaluation results obtained will be updated to the database at the same time, to provide more reference for other users to select services.
3. Design of cloud manufacturing service platform system

The above content studies and designs the overall architecture and business processes of the cloud manufacturing service platform prototype system. This section mainly combines service optimization, service evaluation and resource optimization configuration. This section will use the relevant software tools to design the system function modules and establish a cloud manufacturing service platform system.

3.1. Development environment and development tools

This article uses Visual Studio.NET as the development tool of the system platform, adopts the client/server (C/S) structure mode, which enables real-time interactivity between the system platform and the user, so that different enterprises can achieve real-time communication to achieve the purpose of efficient sharing of different resources. Visual Studio.NET includes a variety of development languages, including Visual Basic, C++, C#, etc. This article uses C# as the background programming language and Microsoft SQL Server 2012 as the back-end database, and builds a cloud manufacturing service platform system to provide a high-quality user experience for service resource providers and users, and achieve a comprehensive promotion of the cloud manufacturing model.

3.2. Functional module design

According to the above-mentioned system framework, the functional modules of the main design system are five modules: user management, service resource management, service management, transaction management and system management. The specific functions of each module are as follows. The comprehensive functions of the system are shown in Figure 3.

- User Management: This module mainly includes management of users in different roles, that is, management of resource providers and resource consumers. The sub-modules mainly include user registration, user task requirement release, user resource service release, and user information management. The user registers according to his or her identity. When acting as a resource provider, the user publishes the service in the system, and the system saves and verifies the service information.
As a resource demander, the user issues a task request, the system decomposes the task, and searches the system platform for its corresponding service resource for selection.

- **Service resource management**: This module mainly manages service resources in the cloud manufacturing platform. Its sub-modules mainly include service resource classification, service resource update, service optimization, case base and knowledge base management, and industry knowledge sharing. The user publishes the idle service in the platform, and the system updates and classifies the service resources, searches and optimizes the service according to different manufacturing task requirements, and updates the case library and the knowledge base in real time.

- **Business Management**: This module mainly manages the business in the cloud manufacturing platform. Its sub-modules mainly include business process development, service resource evaluation, resource optimization configuration, service resource selection and service resource execution. The cloud manufacturing platform evaluates and optimizes the service resources according to the task requirements, and provides users with high-quality resources for their selection. Then users select resources and tasks are executed.

- **Transaction management**: This module is mainly to ensure the safe execution of cloud manufacturing service transactions. Its sub-modules mainly include transaction process negotiation, transaction contract signing, transaction amount payment, mutual evaluation of partners and transaction records. After the user selects the required service resources, the relevant details can be negotiated according to the transaction process. After confirming, the transaction contract is signed and a certain amount is paid according to the payment rules. After the transaction is completed, the partners will evaluate each other, and the evaluation results and transaction process will be recorded in the platform for subsequent users to select services as a reference.

- **System Management**: This module is used as an auxiliary module of the cloud manufacturing platform. Its sub-modules include log management, data backup, user management and information monitoring. The data in the system platform needs to be backed up and the information is monitored on the entire platform to ensure the orderly and stable transaction process.

![Cloud Manufacturing Service Platform](image)

**Figure 3.** Cloud manufacturing system functional structure diagram

4. **Conclusion**

This paper mainly develops the cloud manufacturing service platform prototype system based on service optimization, service evaluation and resource optimization configuration. The overall architecture and business process of the system, as well as related development tools and software, are introduced, and the functional modules of the system are designed. This enables user task publishing, provider service registration, service operations management, cloud manufacturing service
optimization, cloud manufacturing service comprehensive evaluation, and manufacturing resource optimization configuration to be implemented in the platform. It proves the rationality of the research content of this paper and embodies the application value of the research content of this paper. This paper has carried out related research and exploration on cloud manufacturing service optimization, cloud manufacturing service comprehensive evaluation system and resource optimization configuration. However, the research of key technologies in the cloud manufacturing environment is a complex and systematic task, it needs to learn from many aspects and at multiple levels. The system platform built in this paper is still relatively basic, professionals are also required to complete the system in order to make the system applicable to the actual enterprise.

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