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Service optimization model of mechanical manufacturing under cloud manufacturing mode

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Abstract. The service optimization model of mechanical manufacturing under the cloud manufacturing model has played an important role in the development of manufacturing industry. In order to perfect the related technologies and theories in the manufacturing industry of our country, the related theories of cloud manufacturing model and machining were summarized in this paper. Furthermore, a customer demand and manufacturing company were taken as the cases. And based on the mathematical model of multi-granularity manufacturing service optimization, the operation efficiency of different modes was contrasted and analyzed. The results show that the service optimization model of machining manufacturing in the cloud manufacturing model has certain practical significance for the development of manufacturing companies. The purpose of the study is to provide theoretical research for follow-up studies.

Key words. Cloud manufacturing model, machining manufacturing, service optimization model.

1. Introduction

With the development of the times, "peace and development" has gradually become the theme of the development of the world. All the industries in the world have been greatly developed and improved, which has brought a very important driving role and practical significance for the promotion of the comprehensive strength of each country. In the new era of development needs, science and technology have gradually become an important productive force in the rapid development of the times, and various new technologies have been constantly researched and produced, thus providing important impetus for the development and prosperity of some industries and fields, and bringing positive effects on the revival of some countries and peoples. In the process of rapid development of the times, the important influence brought by the progress of science and technology has provided more opportunities and challenges for the development of various industries and fields.

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2. State of the art

As an important industry in the development of the times, the mechanical manufacturing industry can provide certain parts and components for the development of related industries, so as to be one of the basic industries of the world economic development [1]. With the development of various industries in the world, the machinery manufacturing industry is becoming more and more important. However, in the traditional mechanical manufacturing industry, because more procedures are carried out by manpower, there are some shortcomings such as low productivity, so that the further improvement of the world economic level has been negatively affected to some extent [2]. Nowadays, many scholars have put forward new technologies and theories and applied them to the development of actual manufacturing industry. As a new technology, computer technology has a positive impact on the development of the world manufacturing industry [3]. Many researchers have believed that because computer aided technology can collect relevant data information, machinery manufacturing industry based on computer aided technology can connect the enterprise with the advanced world level, and then recognize the shortcomings, improve the efficiency of enterprise development, and thus enhance the overall level of enterprise [4]. Many researchers have believed that today's computer technology is also affected by the increasing amount of data [5].

3. Methodology

With the development of the times, China's various industries have achieved greater progress and promotion, which has positively affected the comprehensive level of our country, and has further enhanced the international status of our country [6]. Under the influence of the rapid development of the world economic level, the development of China's various industries has also been affected. Manufacturing enterprises, as one of the important pillar industries in the rapid development of China's current economic level, has provides some basic support for the development of other related industries in China [7]. However, in the traditional machinery manufacturing industry in our country, the manufacture of related mechanical parts is done more manually, which may result in poor accuracy of components due to some subjective factors, thereby affecting the further development of other related industries. In addition, manual work may be affected by physical strength, and the work efficiency may be low in the whole work process, thus to produce a negative impact on the continuous development of the industry, and further affect the comprehensive level of China's machinery manufacturing industry. Statistics show that, in the larger machinery manufacturing industry in China, more is the introduction of other developed countries or industries due to defects in some manufacturing processes, which directly or indirectly improves the production cost of our country, and has a negative impact on the development of other industries [8]. Therefore, many scholars in China have put forward more perfect theory and technology of machine building industry, and have gradually introduced these technologies into the actual mechanical manufacturing process, thus making the level of China's technology in-

dustry greatly improved. Now, the machinery manufacturing industry in China is moving towards a more vigorous development direction, and its important influence is also gradually increased. Through the statistics of the output value of the machine processing industry in China from 2008 to 2016, with the continuous development of its industry, the output value of China's machinery manufacturing industry has shown an increasing trend year by year [9]. This has provided a certain degree of scientific and technological support for further development of other industries, and has provided a very important driving force for the overall development of China's economic industry.

In order to better determine the advantages and development of the machining industry in the cloud manufacturing mode, through the combination of theory and practice, the follow-up related research was carried out. And the research methods are as follows:

1. On the basis of a clear understanding of the relevant theories, the relevant tasks in the mechanical manufacturing services were further optimized. And the optimization model of process level and component level manufacturing service in the process of mechanical manufacturing service was constructed.

2. Then, the mathematical model of multi-granularity manufacturing service optimization was constructed, and the related characteristics of the constructed mathematical model were analyzed (Cheng et al. 2014) [12]. Thus, the relevant index values of each influence factor were determined. The relevant mathematical models used in the study are as follows:

$$f(t) = f(t_{\mathrm{t}}) + f(t_{\mathrm{s}})\,, \tag{1}$$

$$f(t_{\mathrm{s}}) = \sum_{i=1}^{m}\sum_{j=1}^{n_i} x_{ij}t(ij)\,, \tag{2}$$

$$f(t_{\mathrm{t}}) = \alpha\sum_{j=1}^{n_1} x_{1j}t(0j) + \sum_{i=1}^{m-1}\sum_{j=1}^{n_i}\sum_{k=1}^{n_{i+1}} x_{ij_{(i+1)k}}t(ij,(i+1)k) + \beta_{mj}t(mj)\,. \tag{3}$$

Here, $f(t_{\mathrm{t}})$ and $f(t_{\mathrm{s}})$ represent the running time of the whole machine manufacturing operation process and the processing time of each process for the related products. The formula (2) represents the total time cost of the whole machining process for the manufacture of the product, and the formula (3) represents the final time cost of the whole mechanical manufacturing process, which consists of three different operating processes: $\alpha\sum_{j=1}^{n_1} x_{1j}t(0j)$ represents the total process time required by a customer to book a mechanical product to the manufacturing process, $\sum i = 1^{m-1}\sum_{j=1}^{n_i}\sum_{k=1}^{n_{i+1}} x_{ij_{(i+1)k}}t(ij,(i+1)k)$ represents the running time between processes in different mechanical products, and $\beta_{mj}t(mj)$ represents the total time spent from the processing of the product to the end of the customer's premises.

3. Finally, a mechanical manufacturing enterprise in our country was taken as an example. And the operation cost, operation efficiency and operation income of the enterprise before and after the application of the service optimization model of mechanical manufacturing under cloud manufacturing mode were compared and analyzed. Thus, the advantages of this technology for the production of machinery manufacturing industry in China were determined, and the technical support for the improvement of other technologies and theories was also provided.

4. Result analysis and discussion

Under the trend and background of the times, the promotion of the comprehensive strength of various industries has become one of the important criteria for the national economic strength and comprehensive level. After China's reform and opening up, more innovative technologies and theories have been introduced, so that the comprehensive strength of China's various industries has been developed to a certain extent. In this context, the machinery manufacturing industry has gradually become an important pillar industry of China's economic development. With the continuous improvement of the industrial model, a variety of new technologies are gradually integrated with the industry, making the overall level of the industry further developed. Cloud manufacturing technology is a new technology which obtains relevant results through the cloud computing of basic data in the background of the rapid development of information technology. In the development of this technology, there are many advantages and characteristics of service oriented and converged with network technology. The main architecture includes physical resource layer, basic information resource layer, central service, application layer and other main structures (Fig. 1). In actual use, in the operation process of the platform technology, the industry related manufacturing information resources are input to the platform center, and then the manufacturing service is formed. After entering the relevant platform, the customer can understand and analyze the status of the enterprise's production, so as to determine some of the services they want to obtain and release the requirements. Then, enterprises and customers form relevant contracts and carry out related work. In this technique, cloud computing is used to run traditional operating processes, so that the operation efficiency of the whole operation process is improved, the resource sharing is further increased, the time cost is reduced, and the overall production efficiency of the enterprise is higher, and the overall economic strength of the enterprise is improved.

On the basis of a clear understanding of the relevant theories, in this paper, a service model framework for machining manufacturing in the cloud manufacturing model was proposed. It consists of three levels: task release level, service level and final decision interface layer, in which, the framework of service hierarchy. The process is mainly in the related platform of manufacturer's related product production information input value. Then, the system sets the platform's daily maximum access and access time parameters. When the customers meet these two requirements, they can browse the relevant information and release their own demand. Thus, the

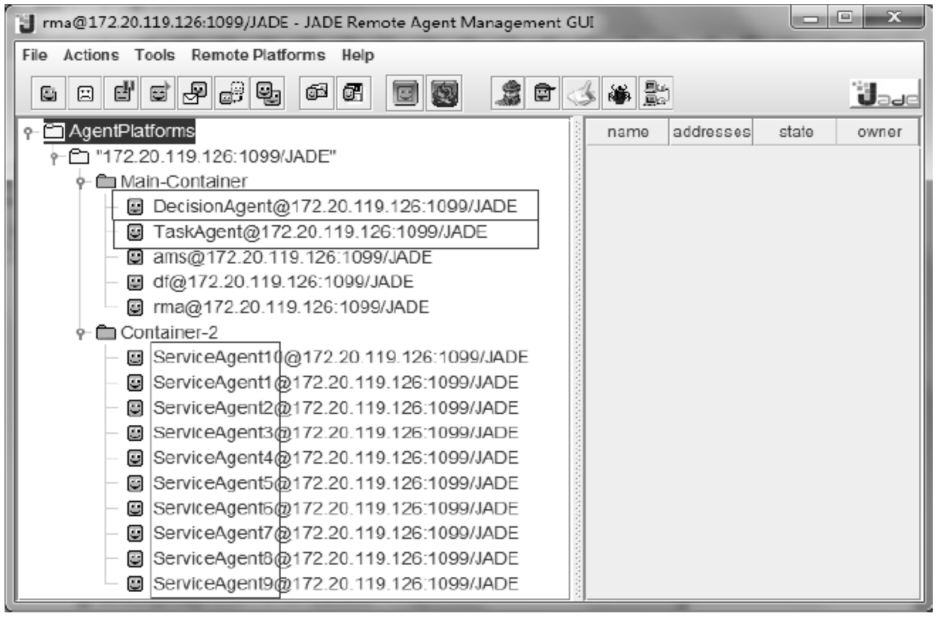

Fig. 1. Development of cloud manufacturing model

connection between the customer and the producer and the sharing of relevant information resources are realized, thereby reducing the cost increase caused by the restriction of time and space in the traditional communication process.

Then, taking the mechanical manufacturing industry in a city as an example, the application of cloud manufacturing technology in the process of mechanical manufacturing was analyzed. First of all, it was assumed that a customer needed to order a batch of outer products in a stepped bearing. The information about all the product processing is shown in Table 1. The two kinds of information was input to the mechanical processing of the above construction manufacturing service system, so that customers were able to query the relevant information to obtain relevant information about the machinery manufacturing enterprises.

Based on the input of relevant information, the model of multi-granularity manufacturing service optimization was applied to evaluate the service model of mechanical manufacturing and the efficiency of the acquisition of related tasks for different manufacturing companies. And the whole process of mechanical product transportation were contrasted and analyzed. Its results are listed in Table 2. The results show that compared with the traditional mechanical manufacturing and operation mode, the production efficiency and operation efficiency of each company in the cloud manufacturing mode are increased to some extent, and the operation cost is reduced. Therefore, from an example point of view, compared with the traditional machining manufacturing services, the service optimization model of mechanical manufacturing in the cloud manufacturing model can produce relatively high operational efficiency. Through the comparison of the three companies, it can be found that, compared with other companies, there is higher production efficiency in Com.2, which can

better meet the actual needs of customers.

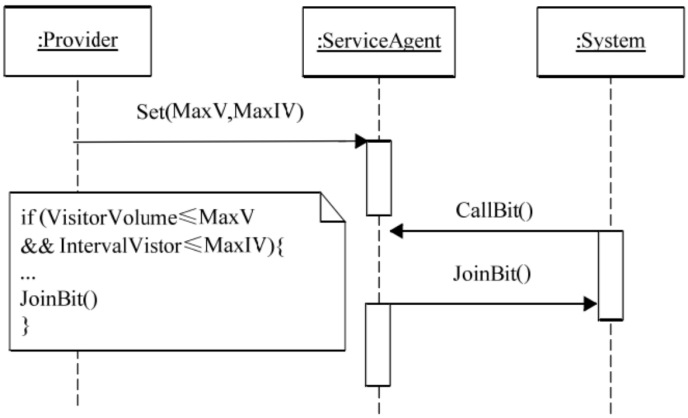

Fig. 2. Sequence diagram of service behavior in mechanical manufacturing

Table 1. Task information for manufacturing products outside the circle

Demand side name (customer)	User1
Address	U.1
Machining process	The car outside the circle and chamfer
Type	Lathe
Material	Steel
Main feature	The outer circle
Diameter (mm)	500
Length (mm)	700
Accuracy class	9
Indicates roughness (Ra)	2.5
Part weight (g)	20
Total ceiling (yuan)	1000
Quantity (unit)	20
Start time	2016-09-04
Harvest time	2017-09-11

Table 1. Task information for manufacturing products outside the circle

Model	Company	$f(t_t)$	$f(t_s)$	Total operating cost (yuan)	Operation efficiency
A service optimization model for mechanical manufacturing in cloud manufacturing	Com.1	4	12	1327	0.67
	Com.2	2	11	1149	0.71
	Com.3	3	13	1424	0.59
Traditional mechanical manufacturing service model	Com.1	5	17	1539	0.44
	Com.2	4	15	1227	0.52
	Com.3	4	18	1644	0.38

5. Conclusion

With the development of the times, manufacturing industry has gradually become one of the most important economic pillar industries in the world. And the development of computer technology has further promoted the comprehensive strength of manufacturing industry. As a new theory in the manufacturing industry, the development of the cloud manufacturing model has a positive impact on the operation efficiency of the whole machinery manufacturing industry. In order to perfect and analyze the technology and theory, in this paper, the relevant data was read and summarized, and the relevant theory was confirmed and clarified. On this basis, the relevant model formulas used for the study were constructed. Then, a customer demand and different mechanical manufacturing companies were taken as examples, and customer requirements and related information about company production and logistics were systematically input. Then, based on the mathematical model of multi-granularity manufacturing service optimization, the operation efficiency of different models and different companies were compared and analyzed. The results show that the service optimization model of mechanical manufacturing under cloud manufacturing model has a positive effect on the development of related industries. Because the cognition of the relevant theories is not perfect enough, there are still some shortcomings in the study, but it can provide reference for the study of related major.

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