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Evaluating of dynamic service matching strategy for social manufacturing in cloud environment

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HIGHLIGHTS

- It is difficult or even impossible to for traditional methods to evaluate the viability of these strategies in social manufacturing.
- We propose a computational experiment-based evaluation framework of service matching strategy in social manufacturing.

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ABSTRACT

As a new form of manufacturing industry in cloud environment, social manufacturing has its inherent "social–cyber" complexity: the source of enterprise services is social, and this sociality aggravates the diversity, uncertainty and dynamics of service supply. Researchers have done a lot to improve the adaptability of service matching strategies. However, it is difficult or even impossible to for traditional methods to evaluate the viability of these strategies because of the "social–cyber" complexity. This poses new challenges to how to evaluate and optimize these strategies in a complex social manufacturing environment. Aiming at the problem, this paper proposes a computational experiment-based evaluation framework, which can simulate all kinds of actual scenarios to verify the performance of service matching strategies. This method includes three parts: (1) design of supply & demand matching strategy; (2) construction of computational experiment system; (3) performance evaluation of service strategies in different experiment environments. A case study is given to verify the applicability of our method by means of comparing several adaptive service matching strategies (supply-oriented, demand-oriented, initial supply & demand-oriented, optimized supply & demand-oriented) in two kinds of market environments. The results demonstrate that our method has a substantial promise.

1. Introduction

The current global market is rapidly changing and user needs are becoming more and more individualized. The competition among manufacturing enterprises is increasingly fierce as well. Manufacturing enterprises often adapt to these changes through the organizational model reform and transformation to remain competitive. Social environment, economic environment and technological development are boosting the continuous innovation and evolution of manufacturing mode. Under such context, social manufacturing mode [1] comes into being. Its core lies that decentralized manufacturing service resources can establish social–cyber–physical interconnection via information networks and Internet of things (IoT), and a variety of communities are formed through the self-organization mechanism. The community here is seen as a complex and dynamic autonomous system, where community members establish interactive relationship and dynamically collaborate around the production of personalized products, in the product life cycle.

As shown in Fig. 1, the operation mode of social manufacturing has the following characteristics: **(1)** Social-oriented interconnection. Efficient interconnection, synergy and interaction among enterprises, users and suppliers are achieved through social networks and other medium tools to promote the large-scale personalized

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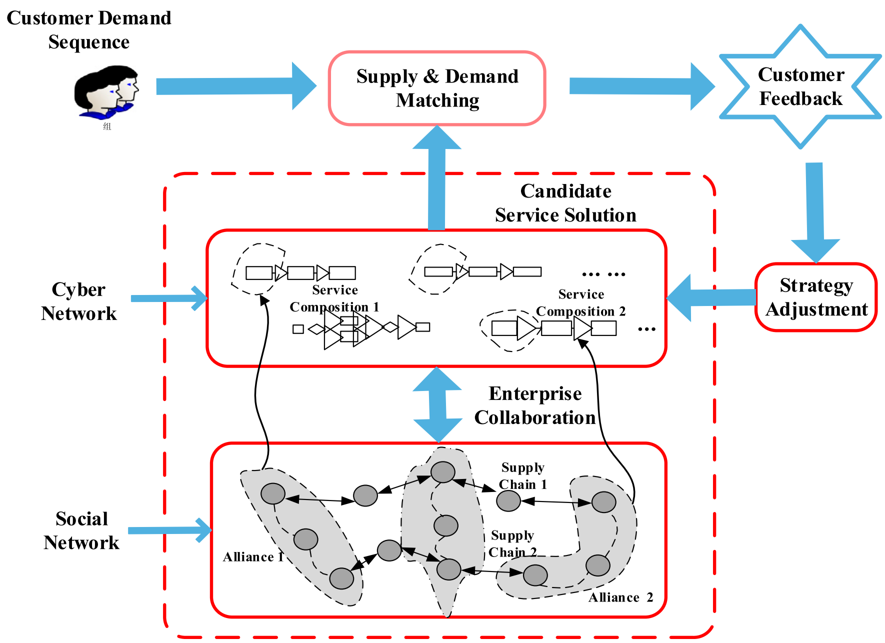

Fig. 1. Operation Diagram of Social Manufacturing in Cloud Environment.

production [2,3]. The social network reflects the actual operation of social manufacturing in different links of industrial chain, such as raw material procurement, part processing, integrated manufacturing, logistics distribution, product sales and so on. **(2)** Service-oriented transformation. It gains appreciation through integrating service into the manufacturing process and products. An increasing number of manufacturers begin to encapsulate and release their own business capability in the form of "service", including R&D capability, processing capability, logistics capability, simulation capability and other business resources [4,5]. **(3)** IoT-oriented production structure [6,7]. Under the support of IoT system, the manufacturing service composition solution can be implemented in real time, which can promote the production flexibility and dynamic response capability of enterprises.

The output of cyber layer is used to control the operation of physical layer and satisfy user's demands. The user feedback can further affect the adjustment of enterprise social network. As a result, a close-loop service ecosystem is ultimately formed. Service operators use a variety of service matching strategies to integrate the business services of different manufacturers so as to provide users with candidate service solutions. The advantages and disadvantages of service matching strategy are essential to the sustainable development of social manufacturing. The poor service matching will not only reduce the utilization rate of enterprise service resources in the community, but also will get lower user satisfaction; while the good service matching can not only meet the users' diversified needs, but also enable the whole community to be in a healthy state of operation.

Therefore, how to evaluate and optimize these strategies becomes a challenge that is urgently needs to be solved in the field. For traditional methods, the challenges of solving the problem lie in two aspects: ① The objects of comparison is with dynamic characteristic. The matching and mapping relationship between user demand and service supply is always in dynamic change. The service matching strategy needs to have the ability of self-adjustment according to the fed back of operation situation. Researchers have done a lot of work in improving the adaptivity of service strategy [8–25]. These improvement measures may have different performance in various environments. It is difficult to give a comprehensive comparison of their effectiveness in real world. ② The environment of comparison is difficult to build. The environment of implementing service strategy is complex. Social manufacturing is a complex network with the characteristics of self-organization and co-evolution. On the one hand, the supply source of enterprise services is social, and this sociality intensifies the diversity, uncertainty and dynamics of service supply. On the other hand, the demand of different users varies greatly, meanwhile, the user's demand is not fixed and it will change with the change of market and its own condition. As a result, it is difficult to build the same environment to compare different strategies in real world.

In order to solve current problem, this paper proposes a computational experiment-based evaluation framework of service matching strategy. Compared with traditional methods, the computational experiments has a series of advantages, such as precise control, easy operation, designability, repeatability, etc., especially suitable for the study of some systems with high risk, high cost or that cannot be directly experimented in reality. Therefore, it is convenient to design a variety of social manufacturing scenarios to evaluate the performance of different service matching strategies. The method includes three parts: **(1)** design of supply & demand matching strategy; **(2)** construction of computational experiment system; **(3)** performance evaluation of different service strategies in different experiment environments.

The rest of this paper is composed of the following sections. Section 2 focuses on research background and related work. Section 3 introduces the design and optimization of service matching strategy. Section 4 presents the construction of the experiment system. Section 5 introduces the evaluation and optimization of service strategy. Finally, Section 6 concludes the paper.

2. Background and motivation

The concept "social manufacturing" was first proposed by the journal "The Economist" in a special report on the Third Industrial Revolution in 2012, meaning that everyone can participate in the manufacturing of products by means of 3D printing and other productive services [26]. Wang Feiyue pointed out that social needs and social production capacity would be effectively combined to achieve "from mind to product" driven by 3D printing technology