

Research on the System Dynamics of Service-oriented Manufacturing Level

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Abstract. Service-oriented manufacturing is the product of China's industrial transformation, and is suitable for the new form of business of China's industrial upgrading. Starting from the value chain theory, the system dynamics theory is applied to build the three subsystems of service-oriented industry, analyze the factors affecting the service-oriented manufacturing level, establish the causal relationship diagram of service-oriented manufacturing level, construct the system dynamics flow chart of service-oriented manufacturing level, and provide a new theoretical model for the research of service-oriented manufacturing level.

Keywords: Service-oriented manufacturing, system dynamics, value chain.

1. Introduction

Service-oriented manufacturing is a new model of the integrated development of advanced manufacturing industry and modern service industry, and a new business form of the integrated development of manufacturing and service [1]. The domestic research on service-oriented manufacturing began ten years ago, when Sun Lingyan from Xi'an Jiaotong University and other scholars first proposed the concept of [2] of service-oriented manufacturing. Service-oriented manufacturing is the inevitable result in the process of industrial upgrading and optimization of the industrial structure. It is the product of the extension of the manufacturing industry to both ends of the value chain and the penetration and development of the service industry to the manufacturing industry. Service-oriented manufacturing is a concept derived from the foreign concepts of "service-based manufacturing", "service-enhanced manufacturing", "service-oriented manufacturing" and "product and service system", combined with the development status of China's manufacturing industry and service industry, with prominent Chinese characteristics. Li Bizhen et al. [3](2018)has constructed a service-oriented manufacturing research architecture, including innovation-driven, service model innovation, enterprise competitiveness promotion and value realization, and studied on the transformation process of Anta Group Co., LTD., to service-oriented manufacturing. Li Qiang et al. [4] (2017)uses the influencing factors of service-oriented selection in the process of data needle service-oriented manufacturing transformation of listed Chinese manufacturing companies to study. Qi Liangqun et al [5] (2017)studies the influencing factors of input service and output service in the transformation process of advanced manufacturing to service-oriented manufacturing. At present, a large number of research achievements on service-oriented manufacturing have been accumulated in China. The factors affecting the level of service-oriented manufacturing are mainly studied through the construction of logical models and measurement models, and the application of system dynamics theory on the transformation process of enterprises to service-oriented manufacturing has not been involved. This paper analyzes the development process of the service manufacturing level, defines the influence elements of the system dynamics theory, determines the boundary of the service manufacturing level system, establishes the causal relationship diagram of the service manufacturing level, builds the system dynamics flow diagram, and provides the theoretical basis for the periodic characteristics of the service manufacturing level evolution.

2. Boundary Analysis of Service Manufacturing System Based on System View

2.1. Selecting a Template

Based on the value chain theory, the service-oriented manufacturing system is composed of the upstream value chain, the middle value chain and the downstream value chain. This paper considers the upstream, midstream and downstream value chain enterprises as a single enterprise. Service-oriented manufacturing system is composed of enterprise subsystem in the upstream of the value chain, enterprise subsystem in the middle of the value chain and enterprise subsystem in the downstream of the value chain.

2.2. Value chain upstream enterprise subsystem

The enterprise subsystem of the upstream value chain is mainly composed of raw material research and development, product design, third-party procurement services, logistics and transportation and other enterprises. Based on the system dynamics value chain upstream enterprise subsystem how to affect the service manufacturing level evolution, need to value chain upstream enterprise subsystem in providing a comprehensive solution level is the influencing factors of the evolution process, including the existing raw material research and development level, raw material research and development investment level, raw material research and development equipment level, product design level, third party purchasing operation ability level, logistics and transportation capacity level, etc.

2.3. Enterprise subsystem in the midstream of the value chain

The enterprise subsystem of the middle reaches of the value chain is mainly manufacturing enterprises, including spare parts manufacturing enterprises and assembly enterprises. The core part of the comprehensive solution provided by service-oriented manufacturing is the most important part of tangible product quality assurance. Enterprise management ability, science and technology investment level, talent training investment, quality control ability, etc.

2.4. Composition of the enterprise subsystem downstream of the value chain

The downstream enterprise subsystem of the value chain mainly consists of sales channel enterprises, logistics and transportation enterprises, after-sales service enterprises, etc. Service-oriented manufacturing provides customers with the final part of a comprehensive solution, interacts with customers with the highest frequency, and can collect sensitive information about customer needs. The above factors affecting the evolution of service-oriented manufacturing level include sales capacity, customer relationship management ability, logistics and transportation capacity, after-sales service ability, etc.

3. Service-oriented manufacturing industry development system modeling

3.1. Causal relationship diagram of the service-oriented manufacturing level

Service-oriented manufacturing level is a systematic engineering of the whole value chain. Influenced by the subsystem level of upstream, middle and downstream enterprises in the value chain, the causal diagram of service-based manufacturing level based on system grammatics should comprehensively consider the influence of the three subsystems. The level of service-based manufacturing depends on the enterprise service-oriented investment, and the main factors include: enterprise cost, enterprise r & d investment, enterprise market share, enterprise age, enterprise size, enterprise capital and labor ratio, enterprise ownership, industry attribute, market competition degree and other [4]. Symbol assumptions were made about the influencing factors of each subsystem, as shown in Table 1. Obviously, there are many factors affecting the service of enterprises. In order to clarify the influence of each factor on the service-oriented manufacturing level and the relationship

between each factor, it is necessary to establish a systematic GIF causality diagram. As shown in Figure 1:

Table 1. Impact factor symbol

factor	abbreviation	factor	abbreviation	factor	abbreviation
Service-oriented manufacturing level	SOML	Midstream enterprise subsystem level	MEL	Downstream enterprise subsystem level	DEL
Upstream enterprise subsystem level	UEL	Midstream enterprise cost	MEC	Downstream enterprise cost	DEC
Upstream enterprise cost	UEC	Midstream enterprise R & D investment	MERD	Downstream enterprise R & D investment	DERD
Upstream enterprise R & D investment	UERD	Midstream enterprise market share	MEMS	Downstream enterprise market share	DEMS
Upstream enterprise market share	UEMS	Midstream enterprise age	MEA	Downstream enterprise age	DEA
Upstream enterprise age	UEA	Midstream enterprise scale	MEQ	Downstream enterprise scale	DEQ
Upstream enterprise scale	UEQ	Midstream enterprise capital-labor ratio	MECLA	Downstream enterprise capital-labor ratio	DECLA
Upstream enterprise capital-labor ratio	UECLA	Midstream enterprise ownership	MEG	Downstream enterprise ownership	DEG
Upstream enterprise ownership	UEG	Midstream industry attributes	MEIA	Downstream industry attributes	DEIA
Upstream industry attributes	UEIA	Midstream market Competition level	MECT	Downstream market Competition level	DECT
upstream market Competition level	UECT	Midstream subsystem horizontal growth rate	MELGR	Downstream subsystem horizontal growth rate	DELGR
Upstream subsystem horizontal growth rate	UELGR	Midstream subsystem level promotion rate	MELPR	Downstream subsystem level promotion rate	DELPR
Upstream subsystem level promotion rate	UELPR				

From figure 1, the upstream enterprise subsystem level by the upstream enterprise cost, upstream enterprise r & d investment, upstream enterprise market share, upstream enterprise age, upstream enterprise scale, upstream enterprise capital labor ratio, upstream enterprise ownership, upstream industry attributes, upstream market competition factors, and affected by the level of both service-oriented manufacturing. midstream enterprise marketshare, midstream enterprise age, midstream enterprise scale, midstream enterprise capital labor ratio, midstream enterprise ownership, midstream industry attribute, midstream market competition degree, and affected by the upstream system enterprise level. Downstream enterprise subsystem level by the downstream enterprise cost, downstream enterprise r & d investment, downstream enterprise market share, downstream enterprise age, downstream enterprise scale, downstream enterprise capital and labor ratio, downstream enterprise ownership, downstream industry attributes, downstream marketcompetition factors, and affected by the midstream manufacturing enterprise level. The service-oriented manufacturing level is affected by the level of the midstream enterprise subsystem and the downstream enterprise subsystem level.

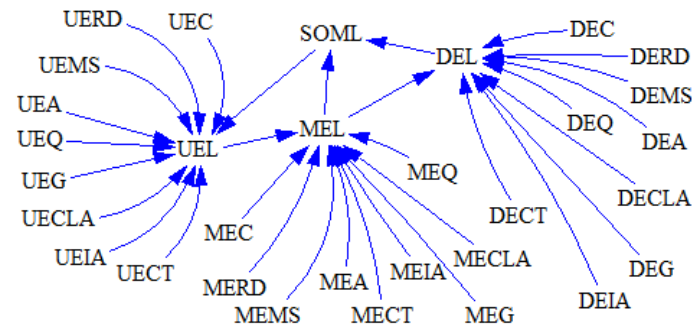


Figure 1. Causal relationship diagram of the service-oriented manufacturing level

From figure 1, the upstream enterprise subsystem level by the upstream enterprise cost, upstream enterprise r & d investment, upstream enterprise market share, upstream enterprise age, upstream enterprise scale, upstream enterprise capital labor ratio, upstream enterprise ownership, upstream industry attributes, upstream market competition factors, and affected by the level of both service-oriented manufacturing. Midstream enterprise subsystem level by midstream enterprise cost, midstream enterprise r & d investment, midstream enterprise marketshare, midstream enterprise age, midstream enterprise scale, midstream enterprise capital labor ratio, midstream enterprise ownership, midstream industry attribute, midstream market competition degree, and affected by the upstream system enterprise level. Downstream enterprise subsystem level by the downstream enterprise cost, downstream enterprise r & d investment, downstream enterprise market share, downstream enterprise age, downstream enterprise scale, downstream enterprise capital and labor ratio, downstream enterprise ownership, downstream industry attributes, downstream market competition factors, and affected by the midstream manufacturing enterprise level. The service-oriented manufacturing level is affected by the level of the midstream enterprise subsystem and the downstream enterprise subsystem level.

3.2. Flow diagram of system dynamics for the horizontal evolution of service-type manufacturing

According to the causality diagram of service manufacturing level, map the system dynamics of service manufacturing level evolution, as shown in Figure 2.

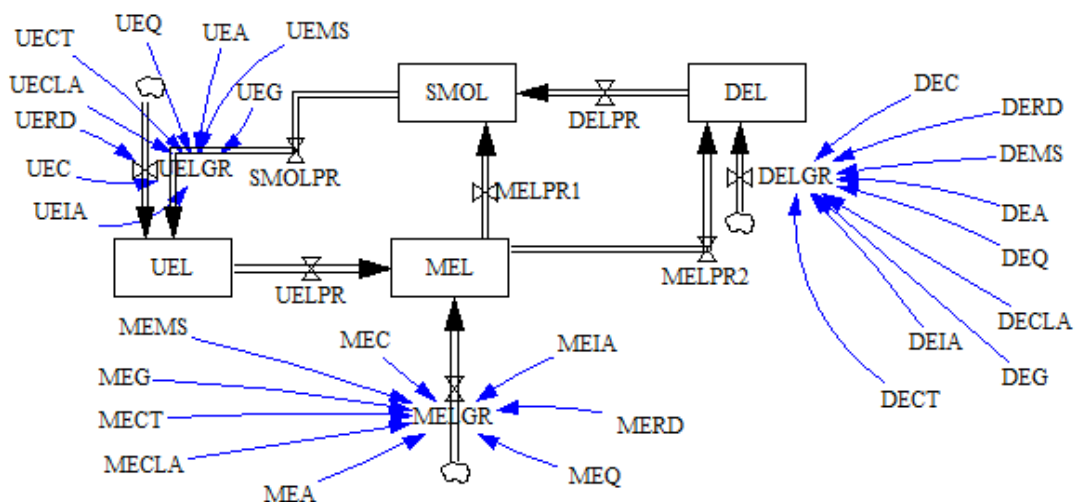


Figure 2. System dynamics flow diagram of the horizontal evolution of service-oriented manufacturing

According to Figure 2, the development rate of the service manufacturing level is determined by the influence rate of the midstream enterprise subsystem and the influence rate of the downstream enterprise subsystem is determined by the influence rate of the downstream enterprise itself, and by the influence factors of the upstream enterprise itself and the existing level of service

manufacturing. By establishing the function relationship of each causal relationship, and analyzing the sensitivity of some factors, the evolution path of service-oriented manufacturing development level can be developed, so as to make full use of limited resources to formulate development strategies and achieve rapid development.

4. Conclusion

The driving mechanism of the development level of service-oriented manufacturing is crucial to correctly formulate relevant strategies to promote the transformation of enterprises to service-oriented manufacturing. This paper defines the system boundary of service-oriented manufacturing based on the view of system, and believes that service-oriented manufacturing is constructed by upstream enterprise subsystem, midstream enterprise subsystem and downstream enterprise subsystem of value chain. The system GIF theory is applied to establish the causality diagram of the evolution process of the service manufacturing level, and then construct the system dynamics flow diagram, and analyze the influence rate index of the system. The research results are conducive to enterprises to master the evolution mechanism of the transformation process to service-oriented manufacturing, correctly formulate strategies, and promote the rapid transformation of enterprises.

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References

- [1] Chen Xu, Jiao Kai, Wang Pengfei. From the scene to the ecology: the enterprise operation and management reform of service-oriented manufacturing [J]. Frontier of Technology, Engineering Management, 2022, 41 (1): 82 - 99.
- [2] Sun Lingyan, Li Gang, Jiang Zhibin, He Zhe. The Advanced Manufacturing Model in the 21st Century-Service-oriented Manufacturing [J]. China Mechanical Engineering, 2007 (19): 2307 - 2312.
- [3] Li Bizhen, Chen Ruofang, Wang Zhenzhen, Yang Shaoxiong. Research on driving factors and Innovation Mode of Fujian Sports Goods Service Manufacturing- -Take Anta as an example [J]. Journal of Fujian Normal University (Philosophy and Social Sciences edition), 2018 (01): 46 - 56+169.
- [4] Qi Liangqun, Cui Yueying, Wang Jin. Analysis of the influencing factors of China's advanced manufacturing industry [J]. Industrial economics, 2021, (6): 15 - 19.
- [5] Li Qiang, Yuan Yijun, Sun Jia. Drivers of the service of manufacturing enterprises [J]. Economic and Management Research, 2017, 38 (12): 55 - 62.