Research on the Blocking Factors for the Promotion of Shared Manufacturing Model in Marine Industry

DongYu Ji(✉)

Jiangsu University of Science and Technology, Zhenjiang 212114, JiangSu, China
lovemkp@126.com

Abstract. This paper proposes to apply the shared manufacturing mode to ship collaborative manufacturing in response to the problems of unbalanced resource allocation and low resource utilization in the shipbuilding industry, first analyzes and identifies the blocking elements affecting the advancement of the shared manufacturing mode, and explores the key elements and fundamental elements and finds out the hierarchical relationship among them through the DEMATEL-ISM method, and then puts forward relevant countermeasures and suggestions for the advancement of the shared manufacturing mode in the shipbuilding industry.

Keywords: Shipbuilding industry · Shared manufacturing · Blocking factors · DEMATEL-ISM

1 Introduction

In the field of shipbuilding, China is already a major shipbuilding country in the world, but there are also many problems. The shipbuilding industry has low standardization of supply chain management and information asymmetry. Therefore, in order to ensure the smooth operation of shipbuilding tasks, there is an urgent need to establish a shared manufacturing system led by ship assembly and manufacturing enterprises.

The ship construction materials are dominated by non-standard parts, which need a lot of customization and cannot form an assembly line operation mode [1]. Xiang Kun et al. introduced in detail the driving and constraining factors of shared manufacturing, etc. [2]. He [3] and Song Xinyue [4] pointed out the problems and obstacles of shared manufacturing in China. Chen Junlong and others studied the development efficiency of shared manufacturing enterprises in China using three-stage DEA-Malmquist, pointing out the reasons for inefficiency and giving suggestions for improvement [5].

In summary, The development of shared manufacturing in China still faces many problems. There are few studies on the landing of the shared manufacturing model in existing studies. In this paper, we will study the blocking elements affecting the implementation of the shared manufacturing model with the characteristics of China's shipbuilding industry, with a view to the application of the model in the shipbuilding industry.

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Table 1. Category of factors affecting shared manufacturing advancement blockage

Tier 1 Indicators	Element category	Number of papers	Percentage of the total number of papers
Internal Elements	Funding	19	33.33%
	Manpower	12	21.05%
	Technology	21	36.84%
	Resources	23	40.35%
External Elements	Industry Environment	19	33.33%
	Government Policy	14	24.56%
Others	Others	16	29.82%

2 Blocking Element Identification

2.1 Acquisition of Blocking Elements

Shared manufacturing is a relatively new concept, and there is little research on the factors that hinder the advancement of shared manufacturing models. As of April 30, 2022, CNKI searched for articles on the topics of "cloud manufacturing" and "sharing", and the search results were 204 articles. 57 articles with a high degree of consistency with the research objectives were selected as reference objects. We extracted and summarized the factors of blockage in the sharing of manufacturing resources and intellectual property, such as technology, effect and evaluation, and formed a set of factors of blockage in the promotion of shared manufacturing model. The specific elements are shown in Table 1.

2.2 Blocking Element System Construction

Li Mengyuan [6] and Meng Fansheng [7] argue that whenever transitioning to a new manufacturing or business model, it will not only be influenced by elements from the company's own capital, manpower, technology, and resources, but also by the government's promotion efforts and the development of similar enterprises in the industry. Therefore, this section analyzes the impediments to promoting the shared manufacturing model in the shipbuilding industry based on six aspects.

The basic framework of the factors influencing the advancement of shared manufacturing blockage is shown in Table 2.

3 DEMATEL-ISM Analysis

3.1 DEMATEL Analysis

Based on the constructed blocking factor system, one academic expert and five managers who have been working in shipbuilding companies for more than 10 years were interviewed and studied. Experts were asked to score the relationships between the factors

Table 2. Summary of shared manufacturing advancement blocking factors

Tier 1 Indicators	Secondary indicators	Tertiary indicators
Internal Elements	Funding F_1	Financing Sources F_{11}
		Cost Control F_{12}
		Funding Operations F_{13}
	Manpower F_2	Human Resources Deployment F_{21}
		Staff expertise F_{22}
		Corporate training F_{23}
		Related Experts F_{24}
	Technology F_3	Web Resources F_{31}
		Manufacturing Technology F_{32}
		Facility Informatization F_{33}
	Resources F_4	Equipment versatility F_{41}
		Logistics supply F_{42}
		Advanced Equipment F_{43}
		Land Resources F_{44}
External Elements	Industry Competitive Environment F_5	Industry Homogenization F_{51}
		Shared willingness of partners F_{52}
	Government PolicyF_6	Introductory Policy F_{61}
		Preferential incentives F_{62}
		Talent Services F_{63}

using a five-level Likert scale, and the results obtained were used to obtain a relationship matrix and, in turn, a composite impact matrix.

The combined impact influence matrix was further calculated to obtain the influence degree, influenced degree, centrality degree, cause degree and element attributes of each blocking element, which are summarized as shown in Table 3.

3.2 ISM Analysis Based on DEMATEL

Based on the results of the above DEMATEL analysis, this section further considers the analysis of the Z-action mechanism between the elements using ISM. Transforming the DEMATEL model into an ISM model requires processing the integrated influence matrix to obtain the overall influence matrix and introducing the threshold λ to obtain the reachability matrix, which is set to 0.17 in this paper, j and thus the reachability matrix.

Hierarchy of elements based on reachability matrix, the reachable set of blocking factors for shared manufacturing advancement in shipbuilding companies Koda set R(Fij) and first setA(Fij),It is verified that ij = 11,41,43,44,51,62,63 is satisfied when R(Fij)

Table 3. Calculation results of DEMATEL method

	Impact degree	Influenced degree	Centrality	Reason degree	Center Degree	Element Properties
F_{11}	1.464	1.841	3.305	−0.377	18	Resulting elements
F_{12}	2.394	1.585	3.979	0.809	16	Causal Elements
F_{13}	2.614	1.601	4.214	1.013	15	Causal Elements
F_{21}	2.543	2.045	4.589	0.498	11	Causal Elements
F_{22}	2.493	2.451	4.944	0.042	6	Causal Elements
F_{23}	2.462	2.728	5.19	−0.265	4	Resulting elements
F_{24}	2.909	3.21	6.119	−0.301	2	Resulting elements
F_{31}	3.157	1.656	4.813	1.5	8	Causal Elements
F_{32}	3.286	2.073	5.359	1.214	3	Causal Elements
F_{33}	2.719	2.239	4.958	0.479	5	Causal Elements
F_{41}	1.699	3.106	4.805	−1.406	9	Resulting elements
F_{42}	2.56	2.133	4.693	0.427	10	Causal Elements
F_{43}	2.008	2.259	4.267	−0.251	14	Resulting elements
F_{44}	1.327	0.94	2.267	0.387	19	Causal Elements
F_{51}	1.754	2.826	4.58	−1.072	13	Resulting elements
F_{52}	2.948	3.256	6.204	−0.309	1	Resulting elements
F_{61}	1.889	2.932	4.821	−1.043	7	Resulting elements
F_{62}	1.643	2.134	3.778	−0.491	17	Resulting elements

(*continued*)

Table 3. (*continued*)

	Impact degree	Influenced degree	Centrality	Reason degree	Center Degree	Element Properties
F_{63}	1.865	2.719	4.584	−0.854	12	Resulting elements

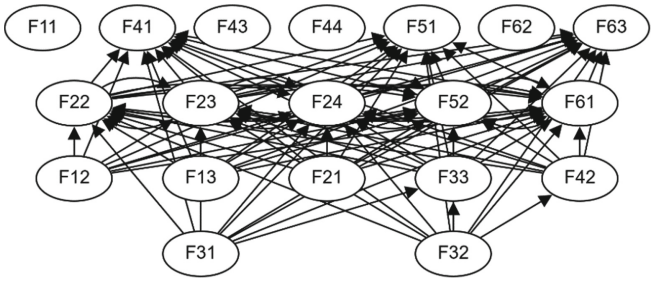

Fig. 1. Schematic diagram of the hierarchy of blocking elements

∩ A(Fij) = R(Fij), are the first layer formation factors.And so on, The second layer elements of the system model are F22, F23, F24, F52, F61,The third layer of elements are F12,F13,F21,F33,F42, Underlying elements are F31, F32. Therefore, the hierarchical relationship is schematically drawn based on the reachability matrix (As shown in Fig. 1).

3.3 Analysis of Results

3.3.1 Centrality and Causality Analysis

According to Table 3 to draw the graph of centrality and reason degree (as Fig. 2), it can be found that F22, F23, F24, F31, F32, F33, F52, and F61 have higher centrality and play a higher role in shared manufacturing play a leading role in the promotion process of shared manufacturing.

In terms of cause degree, F31, F32, F13, and F12 have higher cause degree and have greater influence on other factors as cause factors; F41, F51, F61, and F63 have lower cause degree and are more likely to be influenced by other factors as cause factors. Elements as the result elements.

3.3.2 Analysis of ISM Results

The ISM model divides the blocking elements of shared manufacturing advancement into four tiers: direct elements (top tier), indirect elements (second tier), deep indirect elements (third tier), and fundamental elements (bottom tier), and the following is an analysis of each tier.

The impediments located at the top are direct factors that have a direct impact on whether the shared manufacturing model can move forward.

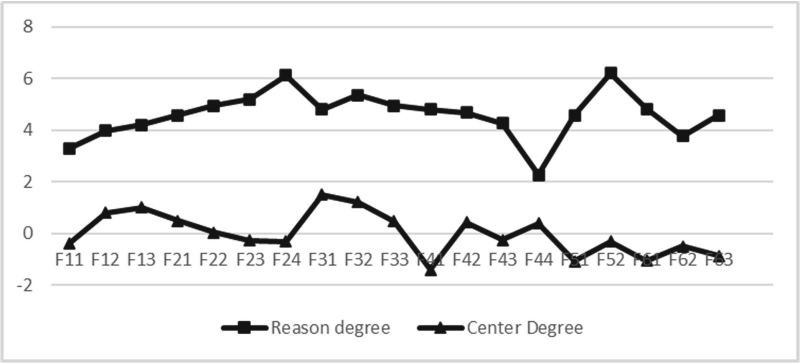

Fig. 2. Centrality and reasonableness

The elements located in the second and third levels are indirect elements, which affect the top-level elements and are influenced by the bottom-level elements at the same time, while the elements affect each other and need to be considered comprehensively when making improvements.

The underlying blocking elements are fundamental, and both are technological elements, indicating that for the company technology is the foundation and will continue to influence the other elements of the system over time.

4 Conclusions

This paper summarizes the key elements affecting the advancement of shared manufacturing mode by using DEMATEL method and divides each blocking element into levels by ISM model. Based on the obtained results, this paper gives the following suggestions:

(1) Create incentives. As a large discrete manufacturing industry, shipbuilding companies should establish an incentive mechanism for shared manufacturing to strengthen the willingness of each supplier to participate in shared manufacturing.
(2) Improve the quality of human resources. Companies should establish a good talent recruitment mechanism, improve the professional skills of employees, and hire experts to coordinate communication and sharing among departments and coordinate resource scheduling among suppliers.
(3) Grasp government policies. Enterprises should grasp the incentive policies introduced by the government, open up financing channels and realize the transformation to the shared manufacturing model; strengthen the cooperation between schools and enterprises and use the talent incentive policy to attract x-related experts to engage in research in related fields.

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