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Research on Value Network Model of Energy Service Industry Based on System Dynamics

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Abstract. Energy service industry is a complex network system, which involves many subjects, products, technologies and valuable industries. In this network system, the main enterprises of each value network are interrelated and value is added to form value network. Value Network is a new and effective form of organizational management of industrial value chain, which can increase the value added of the network. In the value network of energy service industry, this paper analyzes the elements of value network, constructs the structure model of the value network of energy service industry, constructs the quantitative subsystem model by using the system dynamics, and analyses the internal linkage relationship, and puts forward some countermeasures and suggestions for the development of energy service industry.

1. Introduction

In the past ten years, China's energy services industry has experienced a process from no, little to large, especially since the reform of electricity, China's energy service industry has been developing in a positive way, which has been characterized by rapid expansion of the industry scale, intensifying industrial competition and the gradual expansion of the energy service market. Today's enterprises have entered the "industrialization" era, the industrial development of synergy and clustering has gradually changed the traditional form of value network. Value network is a new way for enterprises to gain market competitive advantage, and it is also a new way of value-added of enterprises, which can promote the operation design to the macroscopic level and help the healthy development of industrial activities. Zhu Xuefei on the energy service company financial management system for a comprehensive analysis, which was from the value chain point of view, on this basis, the energy service service value model was put forward, and the value chain framework of energy saving service enterprise was constructed [1]. On the basis of creating shared value theory, Liu Na analyzes the cooperative relationship between the main body of energy service companies [2]. Canes M E, France N discusses the special economic issues under federal energy management through the application of linear programming techniques [3]. Chen Jian constructed the value network of energy services industry by using the theory of value network, and studied the value creation mechanism and value distribution strategy of value net in depth [4]. Zhang Chaobin analyzes the relationship between the modules in the modular value network, and sums up the following points: cooperation is to improve the core competitiveness, competition is for better cooperation, value creation and distribution mechanism can effectively promote the mechanism network the stable operation [5]. After analyzing



the micro-foundation of industry based on modularity and value chain theory, Hu Xiaopeng constructs the theory paradigm of industrial organization which can adapt to different characteristics [6]. Adrian Slywotz in his famous monograph "Profit Zone" (profit area), pointed out that the core of value network lies in users, in order to create the best customer's overall value [7]. Satyaveer S. Chauhan, Marie Proth proposed a vendor-retailer partnership profit distribution model. In addition, the method of profit distribution based on the amount of each investment is presented [8]. Value network has become an important subject in the fields of industrial economy, regional economy and network economy, and system dynamics is a theory and method of computer simulation of nonlinear systems with multiple information feedback in the social and economic field. It can look for and study the relevant factors from the whole system, Analyze the dynamic change and causality in the system. Sun Xiaohua proposed the system dynamics model of industrial agglomeration effect [9]. Zhang Fuwei, and Xiao, who has established a system dynamics model for sustainable power development through the application of system dynamics, which includes 3 sub models of power and economic society, power and power generation energy structure, power and environment. The principle of establishing the evaluation Index system of sustainable electric power development is briefly expounded and some indexes are listed [10]. He Hongbo studied the system Dynamics model of power generation investment in electricity market environment, and validated the correctness and validity of the system Dynamics model by simulation results and sensitivity analysis [11].

2. Construction of value network of energy service industry

2.1. Components of Value network of energy service industry

In the value network, energy service industry Value Network is a new form of organization. Among them, the energy service industry relies on the direct extensive service object resources, the large-scale platform and the infrastructure, the rich and diversified energy service basic business and the value-added service, the Energy service company has become the core role of the energy service industry. At the same time, energy services companies can not do without the help of its value network of internal enterprises, such as energy-saving equipment suppliers, financing intermediaries, terminal energy enterprises, third-party assessment agencies and other large and small enterprises have close business contacts, mainly include.

Energy service companies. The Energy service company is the goal-makers of the whole value network, it can identify and define energy-saving services such as energy-saving diagnosis, transformation, design, operation management and financing, and obtain the corresponding agreement energy-saving benefits, and create business opportunities for energy-consuming company related industries.

Energy-consuming enterprises. Energy-consuming enterprises play the main role in the value network of energy service industry, and in the process of production and operation of enterprises, energy-consuming enterprises focus on the efficiency of resource utilization, while consumption costs are accompanied with a certain amount of resources and energy loss. Under the macroscopic background of encouraging the development of energy-saving industry in our country, energy-consuming enterprises have become potential customers of energy-saving service.

Financing side. As a party providing support for energy services, the financing side has an important position within the value net, and the relaxed financing environment is conducive to the successful completion of the Energy service project.

Energy-saving equipment providers. Energy-efficient equipment providers provide low-power equipment for energy-consuming enterprise customers, before energy service companies sign energy-saving contracts with energy-consuming enterprise customers, energy services companies will test the equipment of energy-consuming customers to determine which devices are energy-consuming and what energy-saving equipment to replace. It will also provide energy services companies with information on energy-efficient equipment to help energy services companies provide more comprehensive technology and equipment analysis for energy consumers.

Government departments. The government is an important power to ensure better and healthier development of energy service industry, and the energy-saving transformation needs the support of relevant policies.

2.2. *Network structure model of energy service industry value*

In the value network, energy service value network is a complete new form of organization. Energy service industry value network consists of stakeholders on the network node, namely, energy service companies, energy-consuming enterprises, government, grid companies, financing side, equipment suppliers, energy efficiency evaluation agencies, etc. The relationship between these nodes has a dynamic process of mutual influence and cooperation, resulting in value creation, distribution transformation and its structure. The Energy Services Industry Value Network enables energy services companies to integrate resources from energy services and expand the impact of them. The node element is the "gene" for value chain. The value chain is the "genome" that consists of a set of group elements according to certain rules. Industrial value network is a dynamic process that decompose and integrate a complex system. Through the decomposition and integration of the system genome, the complex system will be decomposed into multiple independent genomes. Then combine these independent genomes according to a connection rule and constitute a more complex value chain system through making a contract between them. Ultimately form a industrial value network. This value network is a macro cross-type organization including two levels.

a. internal value network. The competency of enterprises can be divided into core competency and general ability. As the scale of enterprise expanding, more complex market relations would be introduced into the internal modules of the organization. The internal value chain would extend, be integrated and be networking. The enterprises combined different value chains and value models with one or more core competencies as the center. So the internal value network system was formed.

b. external value network between enterprises. To improve the competitiveness, the enterprises need to share resources and information and establish an interdependent relationship. Enterprises in different value chains have adopted a corporate alliance strategy in response to the impact of economic globalization. Businesses are connected and an intertwined value system was built for the mutual influence between enterprises, that was, external value network between enterprises.

Value network is a macro concept. It can be unified or be incessant. Energy service value network develops through the mutual influence and mutual cooperation between the elements above. The value of customer can't be achieved by the energy service companies alone It also need the cooperation from energy consumption enterprises, equipment suppliers, technical service providers and governments. For the energy service industry, its value network consists of energy service companies, equipment suppliers and energy-consuming enterprises. Energy service companies provide customers energy saving services and energy saving technological transformation to improve energy efficiency. Equipment suppliers as a link to energy service companies and energy consumption enterprises, will provide technical support for energy companies and equipment support for energy consumption enterprises. Other components, such as energy efficiency management platform, government agencies and financing side are the important constituent part in the value network to support the tripartite party. As show in Fig. 1, the value network structure.

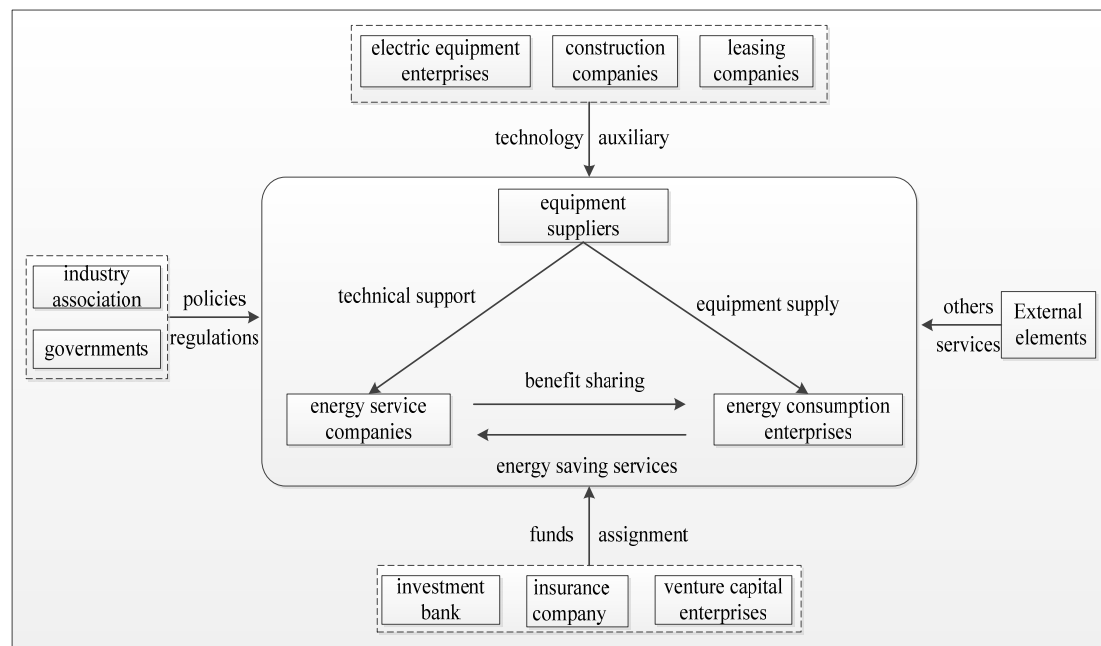


Figure 1. Structure diagram of energy service industry value network.

3. Dynamic model of energy service industry value network system dynamics

Analysis of the Dynamic Structure of Energy Service Industry by Using System Dynamics, the model consists of three subsystems: Energy services enterprise subsystems, energy consumption enterprise subsystems and equipment supplier subsystems. These three subsystems interact and constrain each other by inputting and outputting variables and Interaction, mutual cause and effect, Constitute a multiple positive and negative feedback relationship. Firstly, the equipment supplier subsystem shows the impact on the quality of the service quality for energy service enterprise; Secondly, it discusses the factors that affect the service quality of energy service enterprises in the equipment supplier subsystem, including equipment technological innovation, technological innovation investment and internal staff construction; In addition, the energy consumption enterprise subsystem, including the energy efficiency, and energy companies how to get income, and through the revenue sharing mechanism to the energy service enterprises.

a. Energy consumption enterprise dynamic subsystem

The existence of energy consumption enterprises is the premise of the existence and development of energy service industry value network system, there is no point in the system without the existence of energy consumption enterprises. This paper chooses the brand effect to affect the customer service acceptance of energy consumption enterprise, the overall quality of service depends on: professional service skills, advanced equipment and service content richness and other factors. As show in Fig. 2, flow diagram of Energy consumption enterprise subsystem.

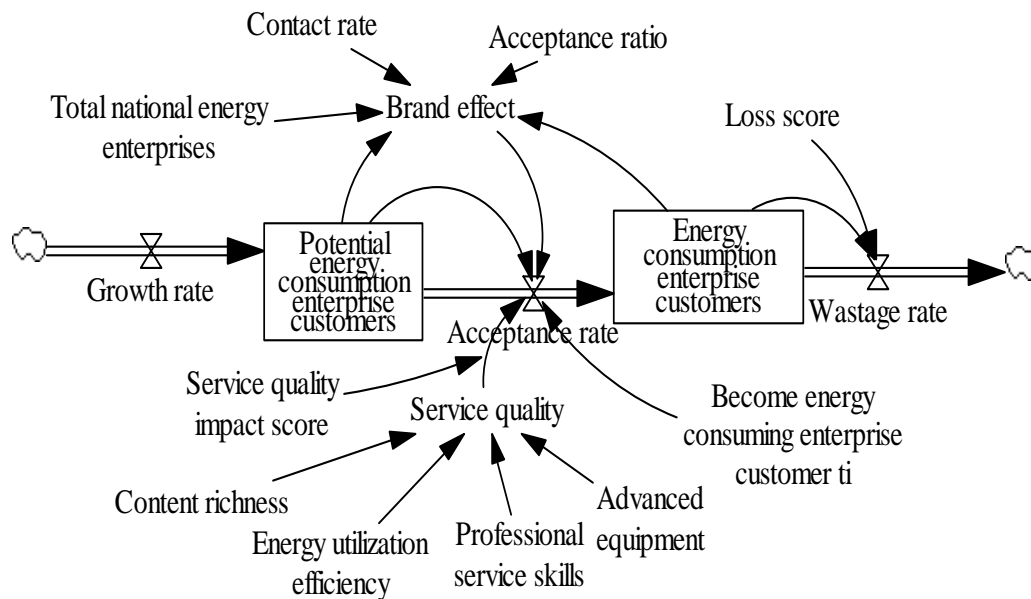


Figure 2. Flow diagram of Energy consumption enterprise subsystem.

b. Equipment supplier dynamic subsystem

In the equipment supplier subsystem, The cost of purchasing equipment from energy consuming enterprises is the main income of equipment suppliers, Energy service enterprises pre-technology, equipment consulting costs is also the source of equipment suppliers. At the level of operator spending, it mainly includes: equipment R&D production expenses, construction expenses, sales expenses and management expenses. As show in Fig. 3, flow diagram of Equipment supplier subsystem.

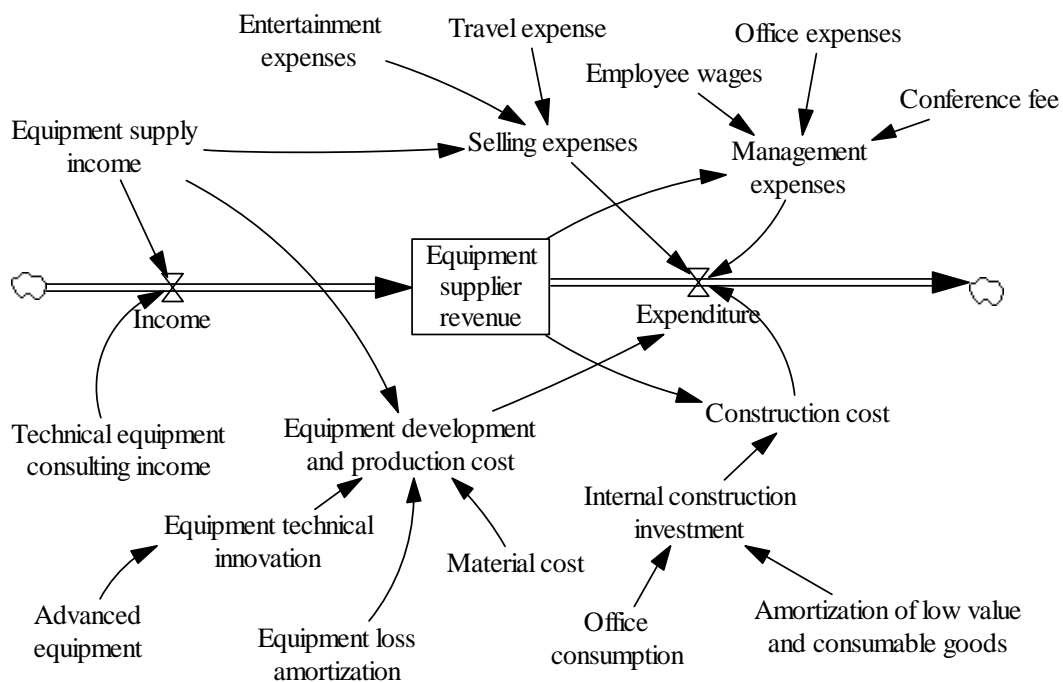


Figure 3. Flow diagram of Equipment supplier subsystem.

c. Energy service enterprise dynamic subsystem

In the energy service enterprise subsystem, Energy service enterprises provide energy saving services for energy consumption enterprises. The increase of energy use efficiency has led to the growth of economic income. After the revenue sharing mechanism of energy consumption enterprises has been taken apart, it becomes the source of revenue for energy service enterprises. As energy service companies income increase, thus increased the upfront for equipment suppliers equipment, technology related consulting price, and determine the willingness of equipment suppliers to join this value network, The adequacy of skilled personnel and the richness of the service content increase with the increase of revenue, thus improving professional service skills and service quality, strengthening the energy consumption of energy efficiency and their own brand. As show in Fig. 4, flow diagram of energy service enterprise subsystem.

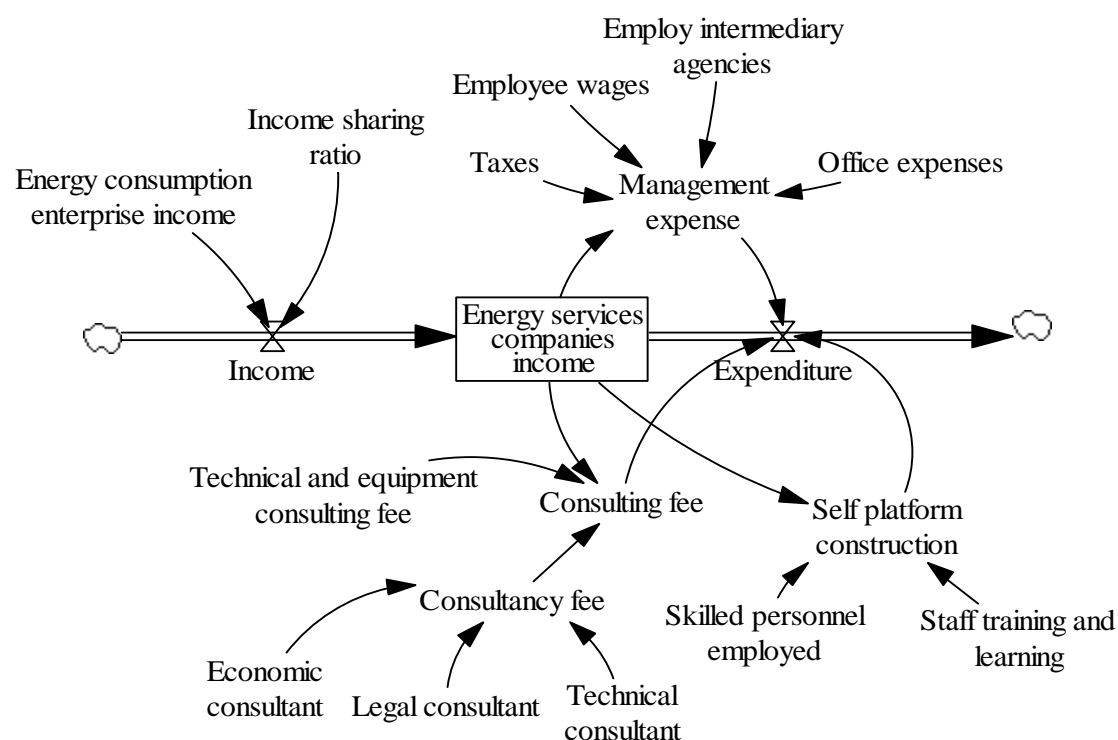


Figure 4. Flow diagram of energy service enterprise subsystem.

4. Analysis of dynamic model of energy service industry value network system

4.1. Analysis of Positive and Negative Feedback in System

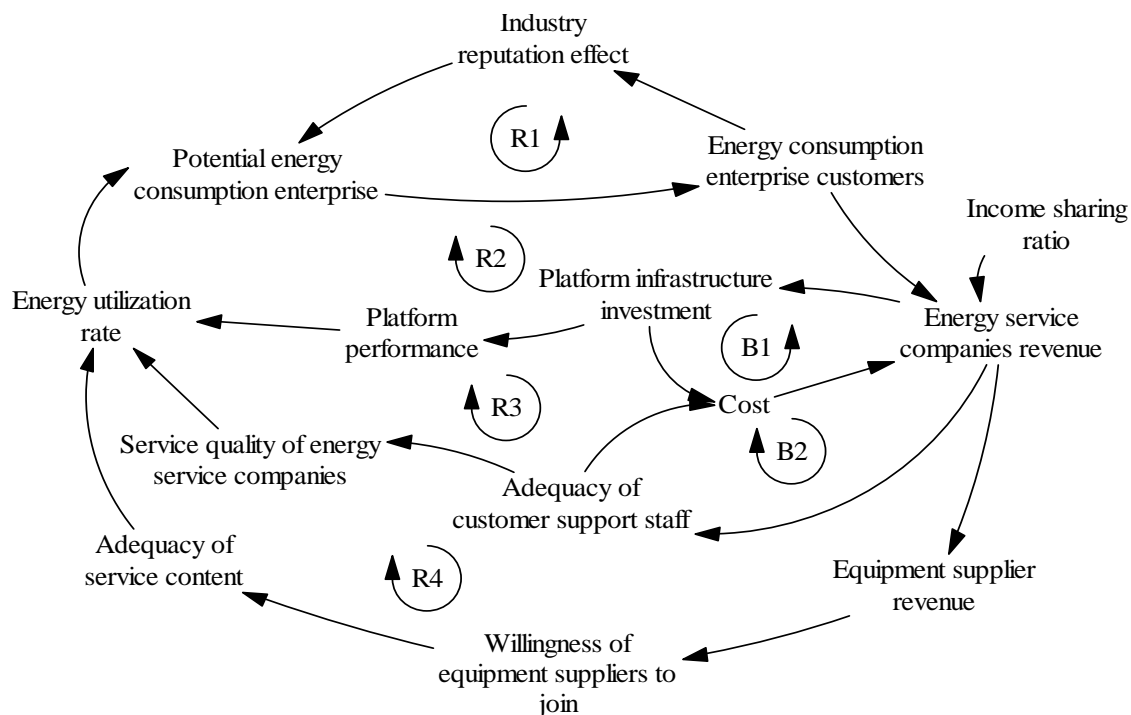
Feedback is the transmission and feedback of information, the system dynamics believes that there is an information feedback mechanism in each system (research object). Feedback is the most basic attribute of the system, with positive feedback and negative feedback. Positive feedback means that an increase in the amount of "snowball" effect, so that the amount continues to increase, usually, the role of faster and faster. In contrast to positive feedback, negative feedback tends to "steady state" over time. The existence of feedback can produce system growth, target pursuit or turbulence. For example, event A can cause event B, with positive and negative feedback. As show in Table 1, causal feedback relational.

Table 1. Causal feedback relational table

Legend	Explain
$A \rightarrow B+$	As the number of A increases (decreases), the number of B increases (decreases) at the same time
$A \rightarrow B-$	As the number of A increases (decreases), the number of B decreases (increases) at the same time

The attribute of the feedback loop depends on the sum of the + and - Numbers of the loop. If the total sum is odd, the loop is a negative feedback loop, and the system state in the loop is at any time showing an asymptotic growth (recession). On the contrary, the loop is positive feedback loop, and the system state will be presented with a continuous growth (recession). To avoid the complexity and size of the model, the internal role of energy service value network is summarized as three: Energy service enterprises, equipment providers and energy consuming enterprises.

This study divides the whole value network of energy service industry into three subsystems, including equipment suppliers, energy-consuming enterprises and energy service operators. As show in Figure 5 and Table 2, the conceptual model of the merged subsystem and loop diagram.

**Figure 5.** Positive and negative feedback diagram of the overall value network model.**Table 2.** Loop diagram.

Forward loop	Negative loop
R1: industry reputation effect	B1: platform infrastructure investment
R2: platform performance	B2: skilled personnel investment
R3: energy service quality	
R4: service content richness	

4.2. The analysis of the correlation of the system

After integrating various subsystems, a system dynamics model was constructed. In this model, it has been marked within the conceptual model of positive and negative loop, discovered the industry value

network relations of the subsystems of the internal value and value exchange, and predict the future dynamics of the energy services industry. The positive feedback loop in the model is represented by R, which represents an enhancement in action; the negative feedback loop is represented by B, which represents a function of regulation (attenuation), the loop analysis of the above subsystems is as follows.

R1: The key to energy efficiency is to transform the potential energy consumption enterprise customers into the energy consuming enterprise customers who will eventually receive the service, the increase in energy efficiency can lead to an increase in the number of consumers. As the number of energy consumption enterprise customers increases, the effect of the industry's word-of-mouth impact on the degree of service acceptance of potential energy consumers will also become larger and larger, so it formed a positive feedback loop industry Word-of-mouth effect R1.

R2 and R3: Energy consumption enterprises are more concerned about the energy efficiency of enterprises after the transformation of energy saving, and it is more inclined to make a comparison of the benefits of enterprises before and after the reform of energy conservation. Energy services enterprises sign revenue sharing contracts with energy consuming enterprises before providing services to specify the share of income. Therefore, the higher the energy efficiency, the higher the profit of energy service enterprises and the benefit share. With the increase of the income of energy service enterprises, investment in infrastructure construction and the scale of skilled personnel will also be increased, they jointly promote energy utilization, and then form positive feedback loop.

R4: The richness of service content

On the other side, equipment suppliers are sensitive to the cost of technology and equipment parameter consultation, which will affect the willingness of equipment suppliers to join. The stronger will, the more the target of energy service enterprise Energy-saving transformation of equipment technology innovation, and then provide advanced equipment, improve energy efficiency, increase energy service enterprises in income sharing revenue, the increase in income will also lead to the increase in the cost of technology, equipment parameter consulting, and thus the formation of a rich positive feedback loop R4.

B1 and B2: Energy service Enterprises in order to enhance energy efficiency of enterprises, will continue to increase the recruitment of skilled personnel and investment in the platform, to enrich their service content and service quality, so as to better serve energy consuming enterprises, but the increase in investment will also lead to cost increases and reduce the profitability of energy service providers.

5. Conclusion

Through the construction of value network, this paper probes into the cooperation among the members of value network and makes the value increase. The research model starts from the complex dynamic relationship between the Terminal Service recipient, the service provider and the service supporter, and promotes the higher module or link in the modular value network on the basis of specialization and characteristic. Expand the coverage of the value network of energy service industry, optimize the industrial structure, enhance the synergy between the network subjects and realize the value creation of the energy service industry value network.

Energy consumption enterprise customers in the energy service industry value network become the core driving force of network development. Based on the demand of diversified energy saving service, the new technical requirements are constantly put forward, and the equipment supplier must improve the existing technology and improve the performance parameters of the equipment. The supply and demand of energy consuming enterprises and the node enterprises in the service network stimulate technological innovation, it has promoted the development of the value network of energy service industry, which can help the energy service enterprises to get rid of the low-end of the value chain, which is beneficial to the optimization and upgrading of China's energy service industry, so as to integrate the energy service industry into the global value network better and faster.

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