Study on the Simulation Modeling in the Business Ecosystem of Japanese Maintenance Services

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Abstract

In recent years, third party enterprises are going into the various maintenance business actively. These firms enter into the maintenance market of the information systems, marine engines, automobile, construction machineries and elevators/escalators in Japan.

However, current state of the markets isn't desirable for manufacturers and customers, since there are problems in the maintenance quality provided by third party enterprises.

The supply of inexpensive and low-quality maintenance service has a negative influence on the business ecosystem which consists of manufacturers, customers and third party enterprises. The negative influence damages the reliability of the whole products.

Thus, this research elucidates the business ecosystem in the maintenance business and derives the activities each player should carry out for quality improvement. As a result of system dynamics and case analysis, we found the importance of the exchange of quality information between manufacturer and third party enterprises. When quality information exchange is carried out, it is expected that the business ecosystem of maintenance service will expand.

Keywords: Business Ecosystem, System Dynamics, Third Party, Maintenance Service

1. Introduction

Long-term use of products and services need maintenance. That is the reason why the products and services deteriorate over time. The replacement of many components, repairs and updating are needed for the customers to use products safely.

Because customers often purchase maintenance services from manufacturers, it's difficult for competition to occur to maintenance service. Therefore, maintenance service is the profit-making sources for manufacturers (Osanai and Sakakibara, 2012 [1]). In recent years, third party enterprises are going into the various maintenance business actively. These firms enter into the maintenance market of the information systems, marine engines, automobile, construction machineries and elevators/escalators in Japan.

However, current state of the markets isn't desirable for product manufacturers and customers, since there are problems in the maintenance quality provided by third party enterprises. It is for this reason that the firms offer maintenance service without being possible to know design and quality information made by products manufacturers in detail.

Fig.1 illustrates above mentioned situation using a concept of the “Business Ecosystem.” The concept applied the natural ecosystem to the business and includes keywords such as competition and cooperation and network relationship between stakeholders. (Moore, 1993 [2], Moore 1996 [3], Iansiti and Levien [4]).

observation suggests that the customers can purchase high quality and expensive maintenance service from the manufacturers or attractive price and improvable the services from third party enterprises.

With respect to third party enterprise activities, it has had many discussions.

Cohen and Wang (1997) [5] discusses the actions that determine the price and quality of manufacturers based on game theory when entering the third party. Miyazaki (2004) [6] proposes a new business model in the printer consumables business. Funakoshi (2004) [7] discusses the role of maintenance services and the relationship between customers and entrepreneurs using interviews. Fujiwara (2013) [8] argues the collapse of the business model of manufacturer-controlled domestic consumables of inkjet printers.

Most studies, however, have not focus on the business ecosystem growth of Japanese maintenance services.

2. Hypothetical View

This research makes a hypothesis based on the business ecosystem. In Fig. 1, the relationship between the manufacturers and the third party enterprises were illustrated as only competition. However, if there are competition and cooperation in those relationships, the customers can receive proper maintenance with the required quality. And because cooperation can contribute to expansion of business ecosystem and business opportunities.

Fig. 2 summarizes the above discussion.
3. System Dynamics Simulation

In order to verify the hypothesis, we simulate the impact of competition and cooperation in the business ecosystem of Japanese maintenance services. System dynamics can be used to represent the relationship between manufacturers and third party enterprises and customers quantitatively.

3.1 Concept of System Dynamics and the Notations of the Software

System dynamics is a simulation capable of observing the time change of a system composed of various elements. Forrester (1961) [9] is a pioneering research applying system dynamics to the business field. To use the system dynamics, STELLA which is the simulation software is used. Table 1 shows the meanings of the symbols used in the software.

Fig. 1. Present Situation in the Business Ecosystem of Japanese Maintenance Services

Fig. 2. Hypothetical View Based on Business Ecosystem
Table 1 Descriptions of STELLA Symbols

| name     | symbol | description                                                                 |
|----------|--------|-----------------------------------------------------------------------------|
| stock    | ![stock] | It means “box” where resources and information gather.                      |
| flow     | ![flow] | It means the flow of elements. Since it is a flow of objects, both ends become stocks or cloud marks at both ends. The valve in the middle of the flow shows the control of flow. |
| converter | ![converter] | It defines the conversion of numerical values and information necessary for the system. |
| connector | ![connector] | Arrows are defined using root elements.                                      |

Source: Morita, M. et al (1997) [10]

3.2 Simulation Modeling

The relationship shown in Fig. 2 is described in the simulation model. Fig. 3 describes the behavior of manufacturers and third party enterprises and customers based on system dynamics. In this figure, the upper left part shows the manufacturer's activities, and the lower left part shows the activities of third parties. Competition and cooperation are expressed in the information exchange rate between the manufacturer and the third party. In the absence of cooperation, the information exchange rate is 0, which means that there is no information exchange. In the case of cooperation, the information exchange rate becomes larger than 0. In addition, customer activities are expressed in the right part.

Since this simulation aims to measure the impact of competition and cooperation, explanation of numerical setting other than information exchange rate is omitted.

![Fig. 3. Simulation Model](image)

3.3 Simulation Result

Fig. 4 and Fig. 5 show the results of the simulation.

Fig. 4 is a simulation result of accumulated number of products and customer satisfaction when the information exchange ratio is set to 0.

Fig. 5 is a simulation result of accumulated number of products and customer satisfaction when the information exchange ratio is set to 0.1.

The two figures show that when the information exchange ratio is high, the accumulated product number and customer satisfaction degree increase.

From the simulation results, it is understood that information exchange between the manufacturer and the third party increases the business ecosystem and raises customer satisfaction.
4. Empirical Analyses

It is necessary to verify the validity of the simulation result. Therefore, we survey the maintenance business of construction machines and marine engines in Japan. Since both products need maintenance, they are set as targets to be verified.

4.1 Construction Machinery

Construction machinery is a machine indispensable for infrastructure development such as hydraulic excavators and bulldozers. There are manufacturers such as Caterpillar, Komatsu and Hitachi Construction Machinery.

Fig. 6 shows main parts of the construction machine. The machine consists of various vital/functional parts and consumable parts.

The business model in Japan has a method of using an agency and a method of doing it directly by a company. Recently, the rental ratio has increased, and there are many transactions with independent rental companies. In the maintenance market of Japanese construction machinery, consumables have third parties. Due to the severe deterioration of construction machines, third parties are structured to generate revenue even if only consumable items are handled.

Table 2 summarizes the handling services and maintenance parts of manufacturers and third parties in Japanese construction machinery.

In domestic construction machinery, there was no coordination between the manufacturer and the third party. However, in Southeast Asia, we can observe certification of third party parts.
4.2 Marine Engine

Marine engines are collectively called outboard motors and inboard engines. Mainly refers to boats less than 20 tons such as pleasure boat and motor boat. There are manufacturers such as Yamaha Motor and Suzuki in Japan.

Fig. 7 shows the structure and maintenance parts of the outboard motor. The machine also consists of various vital/functional parts and consumable parts.

The maker's business model in the Japanese domestic marine engine is done through distributors and via third parties. Manufacturers not only supply products and genuine parts to distributors, but also dispatched mechanics to maintain safety. And, the manufacturer hands the business to the third party, passing genuine parts and external recommended items list. Meanwhile, third parties handle genuine parts, non-genuine parts besides external recommended parts lists, and maintaining services with the quality desired by customers.

In addition, regular inspections of marine engines are conducted by the Japan Craft Inspection Organization under the law, so manufacturers and third parties cannot do it. The above discussion is summarized in Table 3.
In the field of marine engines, sharing of quality information that is considered to be cooperative is carried out through an external recommendation list.

5. Conclusion

This research analyzed the relationship between manufacturers, third parties and customers using the business ecosystem. We made a hypothesis that competition and cooperation between manufacturers and third party enterprises will be important for the development of that business ecosystem.

In order to verify the hypothesis, simulation was carried out using system dynamics. As a result, we were able to verify the correctness of this research hypothesis. In addition, in case analysis of construction machinery and marine engines in Japan, we were able to observe cooperation from a global perspective. Based on the above analysis, it became clear that cooperation between manufacturer and third party maintenance service contributes to expansion of business ecosystem.

The future step is to verify the hypothesis in more cases and confirm its effectiveness.

On the other hand, it is important to strengthen relationships between manufacturers and third party enterprises in the future. To realize that, balanced profit distribution and improvement of the quality of the business ecosystem are indispensable, so manufacturers need to make strategies in consideration of the two points.

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