A Case-Study-Based Discussion of Business Process Analysis and Modeling for Re-Engineering Small and Medium-Sized Enterprises

Masa-aki Hashimoto*, Kei-ichi Katamine* and Toyohiko Hirota*
{hasimoto, katamine, hirota}@ai.kyutech.ac.jp

Abstract: This paper discusses various technical problems of business process analysis and modeling in order to make clear the themes of future study. We are now in the age of an economic revolution which has brought about by the information technologies and post-mass production systems. However, the profits of several existing small and medium-sized enterprises have decreased because they have not kept up with the revolution. Therefore, we take one of them as an example and discusses the results of an analysis of the business process of the enterprise.

Key Words: business process modeling, business process analysis, business process re-engineering, small and medium-sized enterprise

1 Introduction

We are now in the age of an economic revolution called the information technology revolution. This revolution has been brought about by information technologies such as low-priced personal computers and the world wide Internet, and by post-mass production systems such as diversified and small-scale production systems.

However, several enterprises have not kept up with the revolution. In particular, several small and medium-sized enterprises, although they want to, cannot keep up with the revolution because of their own limitations.

Therefore, we studied the technology of business process analysis and modeling for re-engineering small and medium-sized enterprises. As the first step of the study, we took one enterprise as an example. Then, we analyzed it for a few months. After discussing the results of the analysis, we made an interim report for further analysis.

In this paper, section 2 outlines the background of the discussion. Section 3 describes the interim results of the analysis. Section 4 discusses the results.

2 Background

This section describes the background of the discussions in this paper.

(1) Post-mass production

Japan achieved economic prosperity by the mass production of cars, television sets and so on in the 1980’s. However, mass production has gradually been replaced with diversified and small-scale production in the present.

Diversified and small-scale production has applied the pull-type SCM (Supply Chain Management) instead of the push-type SCM for mass production. The push-type SCM is efficient for manufacturing great many products with the same specifications. On the contrary, the pull-type SCM avoids making half-finished products for which there is no demand because the needs of customers are rapidly changing in the present.

* Department of Artificial Intelligence, Faculty of Computer Science and Systems Engineering, Kyushu Institute of Technology, 680-4 Kawazu, Iizuka, 820-8502 Japan
In order to manage such customers, CRM (Customer Relationship Management) has been introduced. Of course, ERP (Enterprise Resource Planning) is necessary for efficient business processes. For the same reason, the concept of Six Sigma is also inevitable. According to this concept, a wide deviation in product quality is one of the serious problems of business. Moreover, the Lean Thinking concept for removing waste in business processes along a value stream has been applied because much waste is found in the current production methods.

(2) Information technology revolution
The price of personal computers has been remarkably reduced. Moreover, the Internet has spread throughout the world. The information technologies have incorporated the above-mentioned diversified and small-scale production and have been revolutionizing the economic and social systems in the world.

(3) IDS (Information-Driven Systems) engineering
In order to revolutionize the economic and social systems, a need-oriented development of information systems is necessary. Therefore, we have been developing a framework of research and education for this need-oriented development. We call the framework “IDS engineering” [1].

(4) Small and medium-sized enterprises
In order to revolutionize the economic systems in Japan, it is very important to activate the existing small and medium-sized enterprises because they support the Japanese economic systems as well as the large-sized enterprises. Therefore, we analyzed an example of small and medium-sized enterprise.

The sample enterprise employs about 70 workers. It is one of the typical small and medium-sized enterprises. It manufactures a small amount of various cleansers.

3 Analysis
This section describes the interim results of the analysis of the sample enterprise according to the dimensions of business process re-engineering [2].

3.1 Physical Technical Layer
This layer describes the visible structure of technology, organization and process in an enterprise. This structure greatly depends on the production method applied by the enterprise. Therefore, we first explain two typical methods of diversified and small-scale production which seem to be efficient in Japan. Then, we discuss the problem of this layer in the sample enterprise in comparison with typical enterprises.

(1) Two typical methods of diversified and small-scale production
The cost of human power is very high in Japan. Therefore, waste of human power must be eliminated for the sake of efficient production. We can see two typical methods which eliminate this waste. These are illustrated in Figure 1.

The first is a highly automated production method which is applied, for example, by the Toyota car enterprise. A single conveyer-type production line produces various kinds of cars using many robots. The line is controlled by computers that treat various kinds of cars. If job requires considerable expense in order to treat various kinds of cars in a fully automated manner, it is performed by workers for the sake of efficient production. Their work process is
precisely scheduled and controlled to eliminate the waste of human power. Of course, the investment in a highly automated production is expensive.

The second can be called a worker self-driven production method which is applied, for example, by the Showa enterprise. The conveyer-type production lines were removed in Showa. A group of production machines is arranged in a work sequence along a circle. A worker operates all the machines in their sequence in the group by himself/herself. Therefore, the worker has no idle time. Machines are permitted to be idle at times because they are less expensive in comparison with human power. When one of the production lines becomes busy, some workers from other lines move to the busy line. Of course, the workers are versatile. Worker versatility is required in many sectors of Japanese industry. This versatility can be used to treat various kinds of products. Of course, the investment in a worker self-driven production does not require a great expense.

(2) Situation of the sample enterprise

The sample enterprise has various production lines. Some of the lines have conveyers which are not long. The other lines have no conveyers. A group of two, three or four workers belongs to each production line. Each worker group includes both full-time and part-time employees. One of the full-time skillful employees works as a leader of his production line.

The production method of the sample enterprise is unsatisfactory from the viewpoint of the above-mentioned two typical methods for efficient production. The reason is as follows. A worker self-driven production method cannot be applied because more than two workers must closely cooperate in the same production line. Moreover, a highly automated production
method cannot be applied because investing in it requires a considerable expense for a small and medium-sized enterprise.

3) Problem of the sample enterprise
The above-mentioned unsatisfactory situation of the sample enterprise causes the following problems: The skillful leader manages only one, two or three workers in his group although he can lead more workers. Besides his small amount of management work, he must do the work which does not require his skill. Therefore, he cannot make full use of his skill although the cost of his human power is high. This is an example of waste of skillful human power.

Diversified and small-scale production requires frequent re-arrangement of the production line. The re-arrangement should be performed in a short time by a small amount of human power for the sake of efficient production. However, the sample enterprise involves a production line which requires a skillful leader and a long time for its re-arrangement.

Another problem is the unreliability of products. According to the concept of Six Sigma, the unreliability of products is an enemy of enterprise management. However, the sample enterprise has produced a considerable amount of unreliable products because of machines and workers.

In the near future, the above-mentioned problems should be solved by the introduction of a technology, process and organization structure suitable for diversified and small-scale production, and for the concept of Six Sigma.

3.2 Infrastructure Layer
This layer describes management the methods, measurement systems and reward structure. Concerning the management methods, the sample enterprise has a principle that all orders from the customers should be satisfied. When an order is received from a customer in the morning, the products are manufactured in the afternoon if the product is not in stock. Then, the products are shipped by a truck in the evening. Therefore, the customer can get the products before opening his/her shop in the next morning. The principle is very efficient for increasing orders from the customers. Therefore, the principle should be preserved. However, the rate of product errors is considerably high. This decreases the profits of the enterprise according to the concept of Six Sigma.

Measurement systems of the enterprise are unsatisfactory at this point in the study. For example, the cost price calculation has not been introduced yet. Therefore, the effect of the business process re-engineering cannot be evaluated. The reward structure has not been examined yet.

3.3 Value layer
This layer describes the organizational culture, individual belief systems and political power. The sample enterprise has increased its number of employees in a short period. However, the enterprise has an organizational culture that depends not on systems but on individual skills. Therefore, the infrastructure layer of the enterprise is not systematic as mentioned above. The organizational culture generates various problems as mentioned above.

4 Discussions

4.1 Dimensions of business process re-engineering
We have analyzed the sample enterprise using the dimensions of business process re-engineering. The dimensions are discussed in the following:
(1) Sufficient dimensions as viewpoints of analysis
The dimensions [2] seem to be sufficient as the viewpoints for analyzing the sample enterprise. The various problems uncovered by the analysis of the enterprise can be arranged in the dimensions.

(2) Important dimensions: management methods and organizational culture

We are now in the age of an information technology revolution. The management methods and organizational culture are rapidly changing. Therefore, the two dimensions are more important than others for re-engineering enterprises. Most problems of an enterprise are caused by its out-of-date management methods. Moreover, out-of-date management methods are preserved by the organizational culture of an enterprise.

4.2 Current Management Methods

Management methods are rapidly changing in the present. Some small and medium-sized enterprises cannot keep up with the change. Therefore, analyzing an enterprise from the viewpoint of the current management methods mentioned in the following is effective for uncovering its problems:

(1) Six Sigma

One of the most serious problems of the sample enterprise was the high ratio of product errors. This problem decreased the profits of the enterprise. The problem seemed to have various causes. However, the real cause should be determined by analysis in order to solve the problem.

(2) Pull-type SCM

The sample enterprise was carrying out the pull-type SCM with only human power, that is, with a great amount of effort of individual workers. The enterprise had no information system supporting the pull-type SCM. Such a system should be introduced in order to improve the efficiency of production.

(3) CRM

The sample enterprise received almost all orders from the customers via facsimile and manually input the orders into computers. If the input operation were computerized, the delivery time would be shortened by about two hours.

(4) ERP

The sample enterprise did not make good use of its skillful workers. Therefore, the strategy of human resources should be planned again. Moreover, the data for cost accounting were not recorded. Therefore, planning itself was difficult. The data for cost accounting should be recorded in computers.

(5) Lean Thinking

The sample enterprise had various sources of waste in the processes, such as depositing and changing arrangements for production. The real value for the enterprise, for example, the low prices of products and the short time for delivery, should be made clear. Then, the processes should be designed again according to the real value stream.

4.3 Conditions of Small and Medium-Sized Enterprises

The following conditions should be considered in the business process analysis and modeling of small and medium-sized enterprises:

(1) Insufficient experts

A small or medium-sized enterprise cannot employ many experts because of their expensive salaries. Therefore, the enterprise may lack the experts necessary for its efficient operation. The sample enterprise had not employed technology experts for its production systems. Of course, no expert in information technologies was working for the enterprise. In order to improve its production systems mainly by applying the concept of Six Sigma, the enterprise
employed a technology expert in production systems, who temporarily moved from a large enterprise in the same industry sector.

From the viewpoint of business process analysis and modeling, one of the most serious problems is the difficulty of arriving at a mutual understanding between the enterprise staffs and information technology engineers. Experts in an area can give information technology engineers the total view and abstract structure of that area, which is indispensable for analysis and modeling. Therefore, the information technology engineers must first find an expert in the area in which they are working. In the case of the sample enterprise, we were able to establish a mutual understanding with the technology expert.

(2) Small capacity of investment
Small and medium-sized enterprises cannot invest much money. This condition prevents the development of business process models and software fully specific to the individual enterprises. A technology for developing such models and software should be studied.

(3) Various characteristics of many enterprises
Each small and medium-sized enterprise can exist because of its own particular strength. That is, small and medium-sized enterprises have their own various characteristics. The sample enterprise has the following characteristics: The delivery time is short. This is one of the major current trends mentioned above.

From the viewpoint of business process modeling, it may be hard to apply standardized models in spite of the small size and great number of the enterprises. If standardized models are applied, their individual characteristics may be subsumed. Then, they may lose their competence in the industry. Therefore, a technology for business process modeling which takes into account the various individualities of many enterprises should be studied.

4.4 Requirements of Information Systems
Since each small and medium-sized enterprise has its individuality, each enterprise wants information systems specific to it. However, the capacity of investment is limited. Therefore, it may be difficult to develop such information systems. Of course, it may be also difficult to buy and customize software packages supporting such information systems.

Accordingly, technologies of software engineering for solving the problem should be studied. As one of the examples, we can show the reference model for generating information systems from specifications described with comprehensible modeling languages [3].

4.5 Requirements of Analysis and Modeling Methodologies
For business process analysis and modeling, methodologies for supporting the above-mentioned concerns should be studied as follows.

(1) Requirements of model diagrams
Various data were obtained by analyzing the example enterprise according to the dimensions of business process re-engineering. The data could be arranged in the diagrams of various forms such as an organization structure, work flow and information flow diagram. Some of the forms are provided by the UML (Unified Modeling Language) [4] and the IE (Information Engineering). The organization structure and work flow diagrams were most useful at the first step of the analysis.

Novice engineers of information technologies could gather some raw data for analysis using such diagrams. Therefore, other forms and more sophisticated forms of diagrams should be studied in order that the novice engineers may gather more data for analysis. Of course, CASE (Computer Aided Software Engineering) tools of such diagrams are indispensable.

(2) Tasks of information technology engineers
The above-mentioned analysis could be carried out in the interdisciplinary area of business and information technology by the cooperation of the engineers of both domains. Of course, none of them could do it by themselves.

However, we, that is, the engineers of information technologies, could step into the interdisciplinary area more easily than the business experts. The reason is as follows. Abstract thinking is indispensable for understanding both domains. Engineers of information technology are used to abstract thinking. Therefore, engineers of information technologies should take more tasks in the interdisciplinary area.

(3) Tacit and ill-structured knowledge of domain
Novice engineers of information technologies could gather some raw data for analysis using diagrams as mentioned above. On the other hand, one of the most difficult tasks in the analysis and modeling was thinking out an abstract structure of the analysis data by considering a tacit and ill-structured knowledge of business.

This could be carried out only by the skillful engineers of information technologies. Such skillful engineers are insufficient in number and difficult to train. Therefore, this is one of the main themes of IDS engineering in our research.

(4) Modeling for considering tacit and ill-structured knowledge
It is desirable that many engineers of information technologies can carry out the task of skillful engineers. Therefore, the task of skillful engineers should be described as methodologies and tools which many engineers can use. One of the main technologies for considering tacit and ill-structured knowledge would be modeling. Such a model would be developed using an abstract structure of the tacit and ill-structured knowledge. The abstract structure should be studied in the interdisciplinary area by cooperation of skillful engineers of information technologies and domain experts.

5 Conclusions

This paper has discussed business process analysis and modeling of small and medium-sized enterprises on the basis of a case study. The dimensions of business process re-engineering seem to be sufficient viewpoints for analysis and modeling. Management methods and organizational culture are more important than other dimensions in the present age of an economic and information technology revolution.

We can uncover problems with management methods by analyzing an enterprise from the viewpoint of current methods such as ERP, pull-type SCM, CRM, Six Sigma and Lean Thinking. When we make a business process model of an enterprise by solving its problems, we should consider the conditions of small and medium-sized enterprises, such as insufficient experts, various individualities of many enterprises and their small capacity for investment.

Our case study has showed the following: We can find various problems to be analyzed and solved in the interdisciplinary area of business and information technology. However, we cannot find a sufficient number of engineers in the interdisciplinary area, especially for small and medium-sized enterprises.

In order to solve this problem, many engineers of information technologies should work in the interdisciplinary area. For this purpose, more sophisticated methodologies and tools for analysis and modeling should be developed. Therefore, a technology for modeling tacit and ill-structured knowledge of domain experts should be created. Our IDS engineering has been studying such technologies.
References


