

Fuzzy regression model of R&D project evaluation

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Abstract

Engineering and technology play an important role in strengthening the competitive power of a company and in surviving a severe competition in the world. About 70% of the total R&D investment in Japan comes from the private sector. It is the most important to decide which research projects have to be adopted for a future research out of proposals from divisions and sections in a company. The objective of this paper is to analyze the results of experts' evaluation in selecting submitted proposals for R&D and to model the experts' evaluation. This paper analyzes a research and development of a certain manufacturing company in a heavy metallurgy industry.

We employed a principal component model, dual scaling, AHP and fuzzy regression analysis to analyze the results that experts evaluated proposed research projects for single or plural of fiscal years. The experts' evaluation was pursued on the basis of (1) the objective of a research project, (2) its background, (3) its research contents, (4) the expected effect, (5) the possibility of obtaining patents, (6) project schedule, (7) developing cost, etc. The obtained model results in the same selection of projects as the experts did.

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1. Introduction

In an economically high-growth period of Japan after the Second World War, companies competed with each other to manufacture and market products more efficiently and effectively than another companies. Therefore, the companies in Japan employed production control, new manufacturing methods, quality control and so on in their factories. Various excellent methods of production are created and developed such as just-in-time, automation, smoothening of production, etc. as a result. It is also necessary to reengineer a business process. In recent years, a company is required to provide products according to “needs” and “wants” of a market. Therefore, it is essential for a business to grasp the “needs” and “wants” of a market. It can run a business to cultivate products and services according to them.

Generally, a company is evaluated based on the knowledge it possesses, and the creation and application of knowledge should be changed into a business. The company is not directly

evaluated only by customers themselves, but also assessed in various markets indirectly. Every company should not only realize the efficiency and strength of management, but also grasp the market change and movement under the consideration that all companies are sorted through the severe evaluation in the market. This forces every company to continue and accelerate the acquisition of new technology and knowledge. Therefore, the research and development play an important role in a company. If the result of R&D leads a company to acquiring very profitable technology, the company would effectively utilize patents as an intellectual property. Of course, judging from an efficiency of fund management, an R&D expenditure and a royalty frequently forces us to accept the situation where they should abandon their own research and development.

Here, we have to pay attention to the application of intellectual property rights such as patents [1,2]. We focus on one company that endeavors to get the basic and inclusive patents on the business basis through early technical development. Presently, R&D is actively and widely executed with industry–university–government cooperation propulsion business and technology promotions policy, etc. It is strongly desired to enforce R&D sufficiently as competitiveness and to get excellent results. On the other hand, a company realizes the effective and efficient management of research and development.

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The objective of this paper is to understand the evaluation structure of R&D projects at one comprehensive production company. In this paper, we analyze which projects proposed should be really selected, and find the structure how to evaluate R&D projects.

2. R&D project

The survival of a company depends on the acceleration of its technical development and the realization of the creative R&D which can start one new business. Therefore, R&D is a driving force of a company, and it is not only sufficient to build up the firm foundation of R&D in order to make the company expand but also to pursue wide activities in order to realize technical development.

One of the important strategies for a company is to make clear the way to execute R&D, the rule to select R&D projects and set priority levels to projects, etc. It depends on the knowledge of an administrator and the thinking of the executive in most cases. The objective of this paper is to make the rule of evaluating R&D projects clear by analyzing data obtained from a company and to effectively select R&D projects that are required to achieve the company's goal.

2.1. R&D project and evaluation indices

Table 1 shows eighteen R&D projects proposed in the company in 1998 that are scrutinized and studied in this paper. Table 2 illustrates indices that are used to evaluate the R&D projects. Each index is assessed into five levels of ranking.

Table 1
R&D project in 1998

No.	R&D project
1	Development of electronic furnace control model based on fuzzy neural network
2	Prototype development of 3 layer client server system
3	Establishment of a foundation technology of Windows NT server on internet
4	Development of new MINBAT control system
5	Development of an application system of image processing
6	Commercialization of checking device for coming off a character string
7	Development of application software for Windows NT
8	Development of intelligent Ethernet module for IBM PC/AT compatibles
9	Development of reduction system of the peak electricity demand (1)
10	Development of a charge-discharge electricity system for an electric car (2)
11	Development of transportable cycle tester
12	Development of an optical cutting profile meter
13	Development of new automatic checker
14	Development of X-ray fluoroscope
15	Development of low price thickness measure for a small size and a thin board
16	Development of X-ray CT system (1st step)
17	Commercialization of low cost X-ray CT system
18	Development of application software for an account

Table 2
The evaluation indices of R&D projects

No.	The evaluate indices	Note
1	Objective of R&D	Fitness of business objective
2	Necessity	Necessity of the R&D
3	Technological difficulty	Technological difficulty
4	Period	Required period for R&D
5	Cost	Research fund
6	Expected sales volume	The growing volume received order
7	Possibility to get a patent	Possibility to get a patent

Index 1: "Objective of R&D" is to evaluate the objective fitting to a company's mission, and projects included in each category are emphasized by the area pursued by the company and set a high valuation.

Index 2: "Necessity" is to evaluate the necessity to start a project.

Index 3: "Technological difficulty" is to evaluate the technological difficulty that a project faces.

Index 4: "Period" is to evaluate the duration required until obtaining some results of a project since the start of the project.

Index 5: "Cost" is to evaluate the research fund required.

Index 6: "Expected sales volume" is to indicate how many achievements will be obtained, that means the evaluation of the growing volume received orders in the future. In other words, this means the project can create a product which will be sold largely.

Index 7: "Possibility to get patents" is to evaluate the possibility to get patents.

These indices are evaluated using five levels of ranking.

Table 3 shows the evaluation results of these indices.

2.2. Evaluation of R&D project

In the company concerned, the proposal of each R&D project is evaluated on the basis of the evaluation indices shown in Tables 2 and 3. R&D projects get their priority according to the evaluation. Then, R&D projects are selected within the budget. Table 4 shows the total value, that is, the sum of evaluated values of the indices. Therefore, an R&D project is highly evaluated and has a high priority, when it has a large total value.

In this paper, this evaluating method is named "a conventional method" in order to distinguish from AHP and principal component models in Section 4.

3. Feature extraction by principal component analysis

In this section, Table 4 shows R&D projects analyzed by a principal component model. Since Index 1 has the same value of Index 3 for all projects in Table 4, Index 1 is removed from the analysis.

Tables 5 and 6 show correlation coefficient obtained and factor loading by the principal component analysis, respectively. Since the accumulated proportion is 68.7% up to the 2nd

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