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Simulation Model for Evaluating Business Values of New Business Model Using Pattern Analysis

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Abstract: Objective: The purpose of this paper is to develop the simulation model for evaluating business values of new BM adopting new R&D technologies using pattern analysis. Method: Through the pattern analysis, the cost-based pricing and price elasticity of demand, this paper proposes the methods for evaluating business value of new R&D and how it can change the existing market Conclusions: The simulation model consisted of four modules, such as 1) calculate the quantity of sales, 2) predict the price according to cost-based pricing, 3) calculate the cost and 4) analyse the changes of the traditional market based on the formula of price. Finally, based on the modules, this conducted the simulation model, where control variables are the pattern of the growth rate and the price.Based on the above equation, this paper develops a simulation model and adapts it to a Korean service company.

Keywords: Business Model Evaluation, Simulation Model, New R&D Value Evaluation, R&D Feasibility

1 Introduction

With the proliferation of current advanced IT technologies, such as wireless internet, RFID, DBM, and IPTV, etc., enterprises are devoting their efforts to develop new Research & Development (R&D) technologies, but only 10% of R&D projects reveals to be successful. The reason is these R&D projects concern only the development of technologies, rather than the value brought by the technologies. Thus, it is necessary to figure out what kind of business should R&D technology be used and how the value of R&D technology can be maximized in developing a business model (BM) before the R&D technology is invested.

Recently, the new methodology from business perspectives reveals in the developed countries, named Research & Business Development (R&BD) focused on BM adopting new R&D technologies. BM defines the manner by which the business enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit [1,2,3]. Therefore, it is necessary to evaluate business value of new BM adopting new R&D technologies before they are on market.

However, previous studies for an evaluation tool of R&D feasibility are limited to estimate a value of BM because they conducted from technological perspectives, such as cost approach methods, market approach methods, income approach methods, and real options [4, 5,6,7]. Additionally, previous study for a BM cannot evaluate new BM because it establishes an evaluation model for business value of a companys existing patents portfolio [8].

The purpose of this paper is to develop the simulation model for evaluating business values of new BM adopting new R&D technologies using pattern analysis. For this purpose, this paper is divided into three parts.

First, this paper estimates the probability of market growth patterns and evaluates the value of each pattern. Although most studies use Compound Annual Growth Rate (CAGR) as the market growth rate, but market is not grown equally. Using pattern analysis, this paper proposes the method for estimating the value of each pattern.

Second, this paper develops the simulation model based on formula of revenue, i.e., quantity, price and cost. This paper reveals that when deciding the value of new business models, the price of new products or services should be considered, and at the same time, to what extent the new BM can be developed from the existing ones should be analyzed.

Third, this paper shows how new BM can change the existing market based on Price Elasticity of Demand. Based on the procedure and simulation model, this paper

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develops a simulation model and adapts it to Korean service company.

2 Literature Review

2.1 Evaluation Method of BM

A business model can be comprehended as demonstrating how an organization purchases and sells goods and services as well as obtains profits [8]. Timmers [9] defines a BM as the architecture for the product, service and information flows. Amit and Zott [10] have defined the business model as depicting the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities. Magretta [11] defines a BM is like a story that explains how an enterprise works. Ostenwalder et al. [2] defines business model as a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. Although various studies have been conducted on business models to date, no general agreement on a standard definition of business model exists [8].

Therefore, rather than conducting studies on the definition of business models, recent studies take more efforts to study the components of business models [2,12, 13,14][2,12,13,14] and to estimate value of BM [8]. Lee [8] establishes an evaluation model for business value of a companys existing patents portfolio to improve the performance of the technology development and the companys competitiveness through identifying the right direction for technology development. Although this study analyzes the directions for development in the future, it cannot evaluate a new BM because it focuses on existing patents portfolio.

2.2 Pattern Analysis

According to the product life cycle, the lifecycle is repeated as form of introduction growth maturity decline whenever a new product appears. Diffusion of Innovations of Rogers [15] defines an adopter category as a classification of individuals within a social system on the basis of innovativeness. It suggests a total of five categories of adopters in order to standardize the usage of adopter categories. It should be noted that the adoption of an innovation follows a normal distribution curve when plotted over a length of time [15].

Based on this theory, pattern analysis is used to examine the growth pattern of a new market. The critical thing in pattern analysis is to analyze how the market changes following the time flow. The market growth patterns are divided into five patterns (see Fig.1). It is used in R&D analysis, future technology roadmap analysis and keyword roadmap analysis [16].

3 Method and Procedure

3.1 Simulation Model

This paper develops the simulation model for evaluating business values of new BM, based on formula of revenue as follow:

$$R_t = (Q_t \times P_N) - C_t - L_t \tag{1}$$

where t denotes time, R_t is the revenue, Q_t is the quantity of sales, P_N is the new price, C_t is the cost and L_t is the loss of current market at time t.

1) Calculate the quantity of sales Q_t

$$Q_t = \sum_{i=1}^{n} M_{it-1} \times \triangle GR_t \tag{2}$$

where $\sum_{i=1}^{n} M_{it-1}$ is the total quantity of market i at time $t-1$ and $\triangle GR_t$ is the change of market growth rate at time t.

$$\triangle GR_t = \frac{GR_t}{GR_{t-1}} \tag{3}$$

GR_t is the market growth rate at time t.

$$GR_t = \frac{nPT_{t-1} + nPT_t}{NPT} \tag{4}$$

where nPT is a number of patents at time t and NPT is a total number of patents.

2) Calculate the price P

$$P_N = \frac{UC}{1-RS} \tag{5}$$

where P_N is the new price, RS is the return on sales and UC is the per-unit cost.

$$UC = VC - \frac{FC}{Q} \tag{6}$$

where VC is the per-unit variable cost and FC is the fixed cost.

3) Calculate the cost C

$$C_t = OC_t + MC_t + PC_t \tag{7}$$

where OC_t is the operation cost, MC_t is the maintenance cost and PC_t is the market promotion cost.

4) Calculate loss of the current market L

$$L_t = (P_C - P_N) \times (Q_C - Q_N) \tag{8}$$

where P_C is the current price, P_N is the new price, Q_C is the current quantity of sales and Q_N is the new quantity of sales in current market.

$$Q_N = \frac{Q_C}{1 + (Ed \times Pd)} \tag{9}$$

where Q_N is the quantity of sales of new BM, Q_C is the quantity of sales of current market, Ed is the coefficient of price elasticity of demand and Pd is the change of price.

3.2 Procedure

The procedure evaluating business values of new BM is as follows.

1) Analysis on growing pattern: pattern analysis is used to identify the new market and its growing pattern

2) Predictive analysis on the quantity of sales: analyze the quantity of sales to be used per year through market growth rate

3) Predictive analysis on the price: predict the price according to cost-based pricing

4) Analysis on the loss of the current market: analysis on how the sales amount changes in the current market following the changes of cost

5) Predictive analysis on the cost: longitudinal analysis on the cost

6) Simulation on the revenue: carry out a simulation of the revenue following each pattern

4 Simulation Study on the Evaluation Model

4.1 Analysis on growing pattern

To estimate the probability of a new market growth patterns and evaluate the change of market growth rate $\triangle GR_t$, ten relative keywords are used for patent analysis. To estimate the market growth rate GR, the number of patents of each keyword nPT is calculated by the equation (4). The result shows that there are five keywords in pattern 2 (50%), four keywords in pattern 3 (40%), and one keyword in pattern 4(10%).

The market growth rate (%) in each pattern is shown as Table 1. The market growth rate at time t is an average of keywords in pattern. Average pattern is a weighted average considering of probability of each pattern by the equation (3).

Table 1: The market growth rate in each pattern

type	t+1	t+2	t+3	t+4	t+5
Pattern2	5.1	14.7	28.0	44.5	59.5
Pattern3	0.7	1.3	2.7	5.4	10.1
Pattern4	0.2	0.3	0.3	0.5	1.4
Average	3.0	8.5	16.1	26.1	36.9

4.2 Predictive analysis on the quantity of sales

It is predicted that the new BM service will not only be used in the current market, it can also be adapted to the new markets. For example, Table 2 shows the predicted market share to be used following the growth rate from Pattern 2. The equation of the quantity of sales Q_t is estimated by the equation (2)

Table 2: The predicted market share in Pattern 2

	t	t+1	t+2	t+3	t+4	t+5
growth rate	1	5.1	14.7	28.0	44.5	59.5
M1	10.7	48	138	265	420	561
M2	6.7	30	87	165	263	351
M3	6.1	28	79	151	240	321
M4	4.3	20	56	107	171	228
M5	49.5	223	641	1,224	1,945	2,597
Total	77	125	360	689	1,094	1,461
Accumulation	77	203	563	1,252	2,346	3,807

4.3 Predictive analysis on the price

The methodology of cost-based pricing is used for deciding the price P of new BM. Cost-based pricing means to set prices by adding a markup to its costs. Companies estimate its cost of offering a product or service and add some percentage of the cost to the cost for its profit. This markup can be a function of the return on sales or return on investment [17]. A measure of the profitability of R&D business model is its return on sales, that is, profits divided by sales. Based on the following assumption, the analysis is conducted by equation (5) and (6).

1) rate of profit : 10%

2) period : five years

3) fixed cost : KRW 2.131 billion

4) per-unit variable cost : nothing

5) predicted sales: 1,612,000

Changes in price according to sales amount is shown as Table 3.

Table 3: Predictive analysis on the price

Q	FC	UC	RS	P	Note
1,000	2,131	2,131	2,368	2,368	
1,435	2,131	1,485	2,368	1,650	KRW 1,650
1,500	2,131	1,421	2,368	1,579	
1,612	2,131	1,322	2,368	1,469	Pattern in average
2,000	2,131	1,066	2,368	1,184	
2,492	2,131	855	2,368	950	KRW 950
3,000	2,131	710	2,368	789	

4.4 Analysis on the loss of the current market

Service based on the new BM is predicted to reveal a fall in price, which in turn brings the shrink of the demanding from the current market. This paper analyzes the loss of the current market in the case that the new price is the only factor changed. Price elasticity of demand is used to

predict the changes of current market according to the changes of price. Perceived elasticity of price is a measure of the sensitivity of the quantity of a good or service demanded to changes in its price [18]. The formula for the coefficient of price elasticity of demand is as follows [19,20].

$$Ed = \frac{Qd}{Pd} = \frac{(Q_{max} - Q_{min})/Q_{min}}{(P_{min} - P_{max})/P_{max}} \quad (10)$$

where Ed is the price elasticity of demand, Qd is the change of quantity and Pd is the change of price.

Based on the above formula, this paper estimates the Ed using previous data (see Table 4).

Table 4: The results of elasticity of price

P_{max}	P_{min}	Q_{max}	Q_{max}	Pd	Qd	Ed
2,750	2,720	5,170	5,352	0.01	0.04	3.23

Based on the equation (8) and (9), this paper evaluates the loss of the current market (see Table 5).

Table 5: Predictive analysis on the price

Q_C	P_C	P_N	$(P_C - P_N)$	Q_N	$(Q_C - Q_N)$	Change rate
116,557	1,750	1,650	100	113,176	3,381	2.90%
		1,500	250	108,457	8,100	6.95%
		1,250	500	101,410	15,147	13.00%
		950	800	94,075	22,482	19.29%
		500	1,250	84,867	31,690	27.19%

4.5 Analysis on predicted cost

This paper predicts the cost for system set-up, operation, maintenance, and promotion for the new BM. The total cost is estimated by equation (7).

4.6 Simulation on the revenue

In order to identify the predicted revenue of the new BM, this paper conducts a simulation model, where control variables are the pattern of the growth rate and the price. Based on pattern analysis and simulation model, many scenarios are developed and the business value of each scenario is estimated (see Table 6). In total, there are eight simulations. Taking the pattern 2 at KRW 1,650 as an example (e.g., scenario1 in Table 7), the result is shown as follows. It is predicted that the break-even of the profit will be accomplished at $t + 4$.

5 Conclusion

This paper develops the simulation model for evaluating business value of new business models (BM) before they are on market. The simulation model consisted of four modules, such as 1) calculate the quantity of sales, 2) predict the price according to cost-based pricing, 3) calculate the cost and 4) analyze the changes of the traditional market based on the formula of price. Finally, based on the modules, this conducted the simulation model, where control variables are the pattern of the growth rate and the price.

This model helps R&D managers find out what kind of BMs are successful. In particular, instead of CAGR, this paper proposes the method for estimating the value of each pattern using pattern analysis. This paper shows how new BM can change the existing market.

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References

[1] Hedman J. and Kalling T., The business model concept: theoretical underpinnings and empirical illustrations, European Journal of Information Systems. 12 (2003) 49-59.
[2] Ostenwalder, A., Pigneur, Y. and Tucci, C.L., Clarifying Business Modelsorigins, present, and future of the concept, Communications of the Association for Information Systems. 15 (2005) 1-40.
[3] Shafer, S.M., Smith, H.J. and Linder, J.C., The power of business models. Business Horizons 48 (2005) 199-207.
[4] Reilly, R.F. and Schweihs, R.P., Valuing Intangible Assets. New York, McGraw-Hill (1998).
[5] Boer, F.P., The Valuation of Technology. New York, John Wiley & Sons (1999).
[6] Smith, G.V. and Parr, R.L., Valuation of Intellectual Property and Intangible Assets (3rd edition). New York, John Wiley & Sons (2000).
[7] Copeland, T. and Antikarov, V., Real Options: A Practitioners Guide. London, Texere (2001).
[8] Lee, S.C., Im, K.H, Park, S.C and Fan, L., An evaluation model of business value for research and development of technology to improve the competitiveness of companies. Asian Journal on Quality. 13 (2012) 22-36.
[9] Timmers, P., Business Model for Electronic Markets, Electronic Markets. 8 (1998) 3-8.
[10] Amit, R. and Zott C., Value creation in e-business, Strategic Management Journal. 22 (2001) 493-520.
[11] Magretta, J., Why Business Models Matter, Harvard Business Review. May (2002) 86-92.

Table 6: Predictive analysis on the price

		t0	t+1	t+2	t+3	t+4	t+5
	Quantity	0	77	125	360	689	1,094
Scenario 1	Sales	0	128	207	595	1,136	1,806
GR=Pattern2	Cost	996	249	222	222	222	222
P=1,650	Loss	34	34	34	34	34	34
	Revenue	-1,030	-155	-49	339	881	1,550
	Cumulative R	-1,030	-1,185	-1,234	-894	-13	1,537
	Quantity	0	77	125	360	689	1,094
Scenario 2	Sales	0	73	119	342	654	1,040
GR=Pattern2	Cost	996	249	222	222	222	222
P=950	Loss	1,799	1,799	1,799	1,799 1,799	1,799	
	Revenue	-2,795	-1,974	-1,901	-1,678	-1,366	-980
	Cumulative R	-2,795	-4,769	-6,670	-8,347	-9,713	-10,693
...							
Scenario(n)							

[12] Sthler, P., Business Models as an Unit of Analysis for Strategizing, International Workshop on Business Models. Lausanne, Switzerland (2002).

[13] Hamel, G., Leading the revolution, Boston, Harvard Business School Press (2000).

[14] Linder, J. and Cantrell, S., Changing Business Models: Surveying the Landscape, Accenture Institute for Strategic Change (2000).

[15] Rogers., E.M., Diffusion of Innovations, Glencoe: Free Press. (1964).

[16] Kim, G.K, Suh, J.H. and Park, S. C., Visualization of patent analysis for emerging technology, Expert Systems with Applications. (2008) 1804-1812.

[17] Afuah, A., Business Model, McGraw-Hil. (2001).

[18] Ivan, P., Managerial Economics, Blackwell, ISBN 9780631225164, (1999). In http://books.google.co.uk/books? id=SecBA0uR71MC, Retrieved 28 February 2010.

[19] Parkin, M., Powell, M. and Matthews, K., Economics, Harlow, Addison-Wesley. (2002).

[20] Gillespie, A., Foundations of Economics, Oxford University Press. (2007).

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