Developing R&D Business Aspect Evaluation Model

Kwang Hyuk Im[1]*, Sang Chan Park*[2]*, Seok-Hun Kim*[1] *and Hyun-Jin Yeo*[3,*]

[1] Department of Electronic Commerce, Paichai University, Daejeon, Korea
[2] School of Management, Kyunghee University, Seoul, Korea
[3] Division of Digital Contents, Dongseo University, Busan, Korea

Abstract: The purpose of this research is to develop R&D validity evaluation model in business model aspect with Korean patent data for variety applicable criteria such as investment decision making. The model in this research has four core analysis modules: market, growth pattern, competitive and financial those analyze nine BMC(Business Model Components) clarified in this research with classified keywords within patent specification database categorized by industry: Value proposition, Customer segments, Channels, Customer relationship, Key activities, Key resources, Key partnerships, Cost structure, and Revenue stream. This model suggests the key notations for four modules to systemize R&D validity evaluation model which facilitates effective company R&D investment, and governments industrial R&D investment by representing standardized nine BMC. Hence, the model in this research is applicable to common and matured company or industry not to special purpose or start-up one.

Keywords: Research and Development, R&D, Business Validity, Business Model

1 Introduction

A R&D (Research and Development) has been recognized as a key activity of company and industry for innovation facilitating market share, new product for market extension, and other purpose related to sustainable growth in competitive business environment. Today, R&D activity leads to obtain domestic and international patent to protect ones knowledge asset because knowledge has been issued as a core property especially in technology based company and industry. Patent has long been considered to represents a trade-off between incentives to innovate on one hand, and competition in the market and diffusion of technology on the other [9].

Although evaluation model of one patent or one R&D technology has been widely studied, almost all models are base on not business approach but technology approach. According to the APO innovation Strategy and Frame work [1], innovation shall be viewed from a broad perspective, not merely as technological improvement. Hence, this research utilizes business model aspect approach to evaluate R&D validity with respect to OECE and APO concepts with Korean patent data.

The purpose of this study is development of R&D business validity evaluation model which comprised of four major analyze notation step with nine classified BMC(Business Model Component).

2 Background

2.1 Business model

Even various former studies have been conducted on business models to date, standard agreement on definition of business model is not settled. Osterwalder et al.[10] defines business model as a conceptual tool containing a set of factors and their relationships and allows expressing the business logic of a specific company. Hedman and Kalling [5] offers an outline for conceptual business models and proposes that it should include customers and competitors, the offering, activities and organization, resources and factor market interactions. Reviewing previous two studies, Morris et al.[8] proposes that diversity in the available definition of business model poses substantive challenges for delimiting the nature and components of a model and determining what constitutes a good model. Furthermore, with general review of literature, they propose an integrative definition: A business model is a concise representation of how an

---

* Corresponding author e-mail: yeochi79@gmail.com

Table 1: Business model components

Pillar	BMC	Definition
Product	Value Propositions	A Value Proposition is an overall view of a company's bundle of products and services that are of value to the customer.
Customer Interface	Customer Segments	The Target Customer is a segment of customers a company wants to offer value to.
	Channels	A Distribution Channel is a means of getting in touch with the customer.
	Customer Relationships	The Relationship describes the kind of link a company establishes between itself and the customer.
Infrastructure Management	Key Activities	The Value Configuration describes the arrangement of activities and resources that are necessary to create value for the customer.
	Key Resources	A capability is the ability to execute a repeatable pattern of actions that is necessary in order to create value for the customer.
	Key Partnerships	A Partnership is a voluntarily initiated cooperative agreement between two or more companies in order to create value for the customer.
Financial Aspects	Cost Structure	The Cost Structure is the representation in money of all the means employed in the business model.
	Revenue Stream	The Revenue Model describes the way a company makes money through a variety of revenue flows.

interrelated set of decision variables in the areas of venture strategy, architecture, and economies are addressed to create sustainable competitive advantage in defined markets.

2.2 Business Model Component

In this research, we suggest that business model can be comprehended as demonstrating how an organization purchases and sells goods and services as well as obtains profits in the sense of above literature review, and via recent research trend to study the components of business models rather than definition of business models [13][4][7][10], we get to a consensus that even if there are divers terms defining BMC, most of them share certain similarities in meaning.

Table 1 shows framework of the nine components with four pillars. Firstly, Product implies the type of project, product or value proposition offered to the market. Secondly, Customer Interface defines the target customer, and methodology of contents delivery to those customers while establish strong relations. Third pillar Infrastructure Management concerns how a business entity deals with infrastructure efficiency issues and partner participation. Lastly, Financial Aspect defines the profit model and sustainability of the cost structure and business [10][11].

3 Evaluation Model

3.1 Process

Fig1 shows evaluation process for company or industry which has two DB extract steps and four analysis steps,

and two adjustment factors which used when analyzer want to reflect target company or industrys present issue or professional.
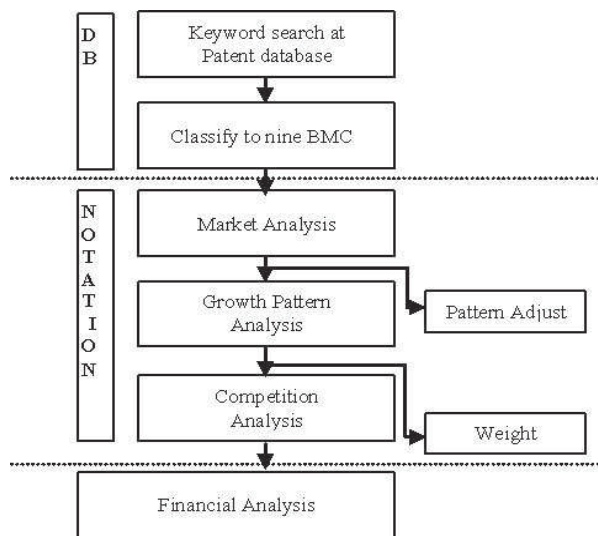
Fig. 1: Process

3.2 BMC Keywords

In order to classify patent data to nine business components, we clarify the general keywords for each nine BMC based on definition at table 1. Table 2 shows the representative keywords for each BMC acquirable from Korean patent database at Korea Intellectual

Property Rights Information Service (http://www.kipris.or.kr) that has almost all Korean patent information.

BMC volume is calculated while count number of patents those having keywords constructing BMC at proposal or contents including its specification that target company or industry owns. Since one patent has multiple BMC, we count with true/false (1/0) method. For example, if one patent has two Channel BMC keyword and three Cost Structure BMC, we count one for Channel and Cost Structure.

Table 2: BMC Keywords

BMC	Keywords
Value Propositions	Product Difference, Value Proposition, Strategy, Branding, Business Opportunity, Sustainability, Destructive Technology, Operation Paradigm Change, Identity upward, Sales Improvement, Loss Protection, Performance Improvement, Quick response to requirement, Cost Reduction, Operation Effectiveness, ...
Customer Segments	Customer, Customer Information, User, Potential Customer, Asymmetric Platform, Mass market, Niche market, ...
Channels	Value Network, Supply Chain, Transaction Result, Transaction Governance, Transaction Structure, Online, Offline, ...
Customer Relationships	Customer Relationship, Customer benefit, Customer Interface, Community, Activity Support Service, Self Service, Cooperation, Joint Venture, Dedicated personal assistance, Automated services, ...
Key Activities	Process/Activity, Product(Service) Innovation, Product(Service) Function, Product(Service) Management, Production(Service) Problem Solving, Platform and Network Construction, ...
Key Resources	Resource, Execution and Support, Culture, Environment, Human Resource, Knowledge Recourse, Capital, other physical factors, ...
Key Partnerships	Competitor, Optimization and economy of scale, Reduction of risk and uncertainty, Acquisition of particular resources and activities, ...
Cost Structure	Accounting, Cash Flow, Cost Management, Value Management, Fixed Cost, Variable Cost, Scale of Economy, Scope of Economy, ...
Revenue Stream	Import/Price, Revenue, Economical Revenue, Asset sale, Usage fee, Subscription Fees, Lending/Renting/Leasing, Licensing, ...

3.3 Notation

While BMC keyword extraction method only support to systemize BMC clustering from patent database, we developed business validity evaluation model which divides the R&D business value to two categories: Return and Risk (1). As one can see at Fig.1 the return category has two steps: market analysis and growth pattern analysis (2) while the risk considers competition analysis (3). In that, the analysis has four steps: Market, Growth Pattern, Competition and Finance.

$$Value = f(Return, Risk) \qquad (1)$$

$$Return = f(Market, Growth pattern) \qquad (2)$$

$$Risk = f(competiton) \qquad (3)$$

As keyword method we discussed above, we measure BMC market scale $BMC_{(M)}$ as number of patents having keywords paired to component definition. We assumed that comparable market pie is similar to number of patents(Npatent) that analysis target has.

$$MarketPie = \cong \sum Npatent \qquad (4)$$

$$BMC_{(M)} = \sum BMC_{(M)} Npatent \qquad (5)$$

$$BMC_{(M)} = \sum_t BMC_{(M)}(VP_t + CS_t + CH_t + CR_t \\ + KA_t + KR_t CS_t + RS_t) \qquad (6)$$

where VP is Value Position, CS is Customer Segments, CH is Channels, CR is Customer Relationships, KA is Key Activities, KR is Key Resources, CS is Cost Structure and RS is Revenue Stream at time t(t=year).

As a result of notation, we could calculate $BMC_{(M)}$ (Business Model market Pie) as a summation of $BMC_{(M)}$ which means the targets comparable R&D value at t year. The notation (4)-(6) represent t year R&D business value of company or industrys which would utilize for targets present value with summation of past ten years and how many years a analyzer use depends on company or industrys specification such as history.

The notation (7)-(9) show growth rate for future business value which use CAGR(Compound Annual Growth Rate) to each keyword and average of keywords CAGR in each BMC. In this research, we use past ten years patent data for $BMC_{(M)}$ and calculate ten years future through that with a sample data.

$$KCAGR = \left[\left(\frac{EYPQ}{BYPQ} \right)^{\left(\frac{1}{EY-BY+1} \right)} - 1 \right] \qquad (7)$$

where KCAGR is Keyword CAGR, EYPQ is End Year Patent Quantity, BYPQ is Beginning Year Papent Quantity, EY is End Year and BY is Beginning Year.

$$BMC_{CAGR} = Avg(KCAGR) \qquad (8)$$

$$BMC_{(M)} = BMC_{(M)t-1} + (BMC_{(M)t-1} \times BMC_{CAGR}) \quad (9)$$

Although the market analysis simulates future market pie of target company or industry, it suggests only linear growth pattern which is not suitable for real growth pattern. The Diffusion of innovations theory [12] and other growth pattern studies shows that market or customer growth follows similar technology market pattern [6]. Hence, the notation (10),(11) show t year $BMC_{(C)}$ which means adjusted business value via log function pattern with analyzer input constant as a growth pattern adjustment. This step does not change t year simulated future business value of R&D but adjust process years for pattern that analyzer could adjust based on targets past pattern or future plan.

$$BMC_{(L)} = \frac{(BMC_{(M)10} - BMC_{(M)0})}{BMC_{(M)0}^{10}} \qquad (10)$$

$$BMC_{(C)t} = BMC_{(M)10} + BMC_{(L)} \times BMC_{(M)t}^{P} \qquad (11)$$

A company endlessly compare ones market share, sales, and other managerial factors to competition companies for sustainability and improvement those are one of core reason of R&D investment. Competition analysis in this research compares targets BMC portfolio to competitor or ones upper levels portfolio. The notation (12)-(16) show example notation comparing companys Value Proposition BMC portion (BMCR(c)) to industrys (BMCR(i)) to reflect industry level competition to company Value Proposition BMC value at t year(BMC(v)t). This notation reflect competitive environment because growth of R&D could be increased or reduced while other competitors BMC portfolio competitiveness.

$$VPBMCR_{(i)} = \frac{VPBMCR_{(i)0}}{\sum BMR_{(i)0}} \qquad (12)$$

$$VPBMCR_{(c)} = \frac{VPBMCR_{(c)0}}{\sum BMR_{(c)0}} \qquad (13)$$

If $VPBMCR_{(i)} > VPBMCR_{(C)}$ then

$$VPBMC_{(v)t} = VPBMC_{(c)t} \times \frac{VPBMCR_{(c)}}{\sum BMR_{(i)}} \qquad (14)$$

else if $VPBMCR_{(i)} < VPBMCR_{(C)}$ then

$$VPBMR_{(v)t} = VPBMC_{(c)t} \times \frac{VPBMCR_{(i)}}{\sum BMR_{(c)}} \qquad (15)$$

else

$$VPBMC_{(v)t} = VPBMC_{(c)t} \qquad (16)$$

However, the notation (12)-(16) are not suitable when incomparable environment such as industrial monopoly company or comparable data is not acquirable. In that case, analyzer should consider each BMCs portion (UIweight) adjustment with professional and proper base such as companys R&D investment plan and others.

$$VPBMCR_{(v)t} = VPBMCR_{(c)t} \times UI_{weight} \qquad (17)$$

Through above three analysis, one could find target companys R&D BMP(Business Model Price) at t year with summation of each BMC value at t year. In Financial Analysis, one should know that BMP is not imperative financial value of R&D but relative. The Financial Analysis has two meanings: comparable score to other competitors and growth possibility of analysis target. The comparable score supports relative score of analysis target to other competitors and growth possibility propose targets potential R&D improvement possibility in business aspect while these facilitate to analyze ones SWOT(Strength Weakness Opportunity Threat) analysis and other decision making and strategy analysis for R&D improvement.

4 Case Study

on notation, this research developed prototype system for validation with sample Korean medicine industry data to analyze D company (Korean medicine company) ten years patent data. In this prototype system, not whole industry data is not used because ten years patent data of whole Korean medicine industry is too huge to prototype system. Table.3 shows the result of competition analysis on D company with above notations which has quite similar BMC portfolio to Korea medicine industry after expected ten years.

The D company has Revenue Stream and Customer Segments based BMC portfolio while Korean medicine industry has high portion at Revenue Stream and Cost Structure. Although Customer Segment BMC portion is more higher then Cost Structure, growth rate changes its portion after ten years analysis by jump to seven times improvement while customer segment grow up only 9.91%.

Even after consider competition in industry, D companys expected BMP grow up 0.8% which means D company has competitive in industry until she keeps present R&D activity and other competitor in the industry does either. This result also shows that future investment in R&D for D company is better to consider Cost Structure and Revenue Stream BMC while its growth rate is quite much higher than other BMC.

Table 3: Competition Analysis Result

BMC	Present	Distribution Ratio	Before Competition		After Competition	
			After ten years	Growth Rate	After ten years	Growth Rate
Value Propositions	107	17.04%	224.6	209.91%	222.4	207.85%
Customer Segments	117	18.63%	128.6	109.91%	129.9	111.03%
Channels	101	16.08%	140.2	138.81%	141.5	140.10%
Customer Relationships	2	0.32%	2.0	100.00%	2.0	100.00%
Key Activities	11	1.75%	7.2	65.45%	7.3	66.36%
Key Resources	45	7.17%	77.7	172.67%	78.4	174.22%
Key Partnerships	24	3.82%	69.4	289.17%	70.1	292.08%
Cost Structure	92	14.65%	664.1	721.85%	670.7	729.02%
Revenue Stream	129	20.54%	685.8	531.63%	692.7	536.98%
SUMMMATION	628	100.00%	1999.5	318.39%	2015.0	320.86%

5 Conclusion

This research suggests R&D evaluation in business validity aspect with patent data to systemize the model. The R&D business validity evaluation model could offer comparable value of company R&D activities which support decision making to R&D investment such as when, what kind of and how much one invest to R&D and also support to government which industry she invest for maximize future value of own country.

The market analysis shows present and future BMC portfolio, portion, and growth rate while the growth pattern analysis adjust the future pattern suitable for target. The competition analysis modifies the future ten years BMC value with comparing to industry or other competitors while the financial analysis proposes BMP for R&D decision making.

Although this research suggests company or industry wide business aspect on R&D validation different to former studies are based on technology based one patent analysis, it has limitations in several criteria. Firstly, the model is not suitable if there are not enough patent data such as new entry company or industry because the notations in this research are developed considering systemizing. Secondly, each patent value is not applicable because this model has company wide business model view point. For example, even if some core patents has almost all profit making portion among all patents one has, this model considers only its BMC same to other patents. Lastly, international analysis such as comparing Korean medicine industry and American medicine industry is inapplicable due to the patent character and data specification difference.

Though this research has various potential implications, it still need further study. Firstly, the study and modify this model by validating this model with real patents data in various industries and companies necessary because prototype in this research is not for model validation but for notation. Secondly, integration with former one patent evaluation model via system is necessary for diverse point of view. The individual patent character and value should be issued by technology based while R&D business validity evaluation model is focused on only business aspect for imperative value of targets technology and business R&D value.

Acknowledgement

References

[1] APO, Innovation Framework and Strategies: an APO Perspective, Asian Productivity Organization, 2009.

[2] Demil B. and Lecocq X., Business Model Evolution: In Search of Dynamic Consistency, Long Range Planning **43**, 227-246 (2010).

[3] Dubosson, M., A. Osterwalder, et al. , "eBusiness Model Design, Classification and Measurements", Thunderbird International Business Review **44(1)**, 5-23 (2002).

[4] Hamel, G., Leading the revolution, Boston, Harvard Business School Press, 2000.

[5] Hedman, J. and Kalling, T., The business model concept: theoretical underpinnings and empirical illustrations, European Journal of Information Systems **12**, 4959 (2003).

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

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

[8] Morris, M., Schindehutte, M. and Allen, J., The entrepreneurs business model: toward a unified perspective, Journal of Business Research **58**, 726 735 (2005).

[9] OECD, Measuring the Information Economy, Paris, Organization for Economic Co166 operation and Development, 2002.

[10] Osterwalder, A., Pigneur, Y. and Tucci, C.L. , Clarifying Business Models origins, present, and future of the concept, Communications of the Association for Information Systems **15**, 1-40 (2005).

[11] Osterwalder, A, Business Model Generation (A Handbook for Visionaries, Game Changers, and Challengers), 2010.

[12] Osterwalder, A, Business Model Generation (A Handbook for Visionaries, Game Changers, and Challengers), 2010.

[13] Sthler, P., Business Models as an Unit of Analysis for Strategizing, International Workshop on Business Models, 2002.

[14] Yunus, M., Moingeon, B. and Ortega, L.L. , Building Social Business Models: Lessons from the Grameen Experience, Long Range Planning **43**, 308-325 (2002).

Seok-Hun Kim received the M.S and Ph.D. degree in Computer Engineering from Hannam University in 2003 and 2006. He is an assistant professor Mobile Media at Suwon Women's University in 2012 and 2017. He is currently an assistant professor in the Electronic Commerce at Paichai University. His teaching and research specialties are in the fields Mobile computing, Web-App programming, information security.

Kwang Hyuk Im received the PhD in KAIST(Korea Advanced Institute of Science and Technology). He is currently an assistant professor of Electronic Commerce at PaiChai University. His interests are management information system, knowledge management, artificial intelligence, e-commerce, and others.

Hyun-Jin Yeo received the Business Administration Masters degree in KyungHee University in 2007. Currently he is PhD candidate at KyungHee University. His interests are management information system, financial anlaysis, knowledge management, and management quality.

Sang Chan Park received PhD in University of Illinois. He was professor of Wisconsin State University and KAIST. He is currently a professor at school of management in KyungHee University. His interests are medical business, quality management, e-commerce, knowledge mangement and others.