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IMPROVING R&D EFFICIENCY IN VIENEMESE PHARMACIEUTICAL ENTERPRISESES

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INTRODUCTION

1. Significance of the research

Research and development (R&D) is a function which is gradually attended and more invested to create new products or improved technological capabilities of enterprises, improve competitive position, ensure sustainable increase of business profit.

The pharmaceutical industry is one of the sectors with highest R&D investment, but, according to a survey by WHO / UNIDO (Drug Administration, 2014) investment of Vietnam pharmaceutical companies for R&D is very low. In spite of pharmaceutical development objectives are defined at a high level, limited investment for R&D leads to limited result of R&D, and consequentially the ability to execute the goals is very low. Drug firms are scrupulous in investment decisions for R&D so that it is necessary to research and evaluate R&D efficiency; develop appropriate solutions to improve the efficiency of R&D; and provide theoretical system for suitably approach and evaluation of R&D efficiency for businesses and authorities. There are not many studies worldwide on R&D efficiency evaluation in the pharmaceutical industry. In the country, studies of Hoang Hieu Tri (2014), Drug Enforcement Administration (2014) are concerned with R&D in the industry. However, these are integrated studies, mentioning drug R&D generally and qualitatively without deeply and quantitatively analysis. The deficiency of scientific research of R&D efficiency, instruction on approach and tools to assess R&D efficiency of pharmaceutical enterprises in Vietnam are study gaps about which the author concerned.

The research named: "***Improving R&D efficiency in Vietnamese pharmaceutical enterprises***" has great significance in terms of science and practice, in Vietnam and over the world.

2. Research Objective

- *In theory*: (i) To provide theoretical framework of R&D, R&D management and R&D efficiency mesurement in pharmacieutical enterprises, and (ii) To propose a valuable and suitable tool for R&D

efficiency mesurement in pharmacieutical enterprises in Vietnam context.

- *In practice*: (i) To analyse the actual situation of pharmacieutical enterprises in Vietnam; (ii) To analyse and evaluate comprehensively R&D efficiency of drug enterprises in Vietnam; (iii) To propose some solutions to improve R&D efficiency of drug enterprises in Vietnam.

3. Subjects and scope of the research

- *Subjects Research*: R&D efficiency and the factors affecting the R&D efficiency of pharmaceutical companies;

- *Scope of the study*: pharmaceutical enterprises in Vietnam in the preliminary research; and human drug enterprises in Vietnam which has conducted R&D activities at least from 2012 to 2014 in the official study. Data were collected in many years and most concentrated in 2012-2014.

4. Research methodology

This study was performed in two steps: preliminary study and official study. ***The preliminary study*** was conducted with a range of methodologies including documents research, observation techniques combined with in-depth interviews and group discussions. AHP technique is also used to assist in the investigation and assessment at this stage. ***The official study*** was carried out by the method of quantitative research with secondary and primary data sources, divided into two phases : estimate the technical efficiency of R&D activities by combined BSC-DEA model, then, analyze the factors affecting R&D efficiency with Tobit model.

5. Contributions of Dissertation

In terms of theory, the dissertation has assembled and systematized the basic theories related to R&D activities, R&D management, R&D efficiency mesurement; Develop and apply combined model BSC-DEA in evaluating R&D efficiency of pharmaceutical enterprises in Vietnam; And, provide a pattern for thinking about solutions for R&D efficiency improvement to researchers and managers.

In terms of practice, the dissertation analyzes and evaluate business situation of pharmaceutical enterprises in Vietnam; And, analysis

and in-depth assess R&D efficiency, analysis influencing factors as extra basis for proposing solutions to improve R&D efficiency of pharmaceutical enterprises in Vietnam.

6. Chapter Layout of Dissertation

The main contain of dissertation is organized in 6 chapters:

Chapter 1: Review of related literature

Chapter 2: Theory

Chapter 3: Research design

Chapter 4: Results

Chapter 5: Discussion and solution implication for improvement R&D efficiency of pharmacieutical enterprises in Vietnam

CHAPTER 1
REVIEW OF RELATED LITERATURE

2.1. Some significant researches on R&D and R&D management

Researches of Roussel et al. (1991), Rothwell (1994), Miller and Morris (1998), Chiesa (2001), Nobelius (2003), Jain and Triandis (1990), and Frascati Manual of OECD (2002), and Vu Que Huong (2001) and Le Anh Cuong (editor) (2005) have supplied overview but comprehensive theories about R&D and R&D management, including basic theories and limitations to identify R&D activities in reality; classification and characteristics; process and activities; needed elements; key effecters and relations in R&D organization; the development of R&D management generations.

2.2. Some significant researches on R&D efficiency mesurement

Researches of Brown and Svenson (1988), Drongelen and Cook (1997), Ruegg et al. (1997), García-Valderrama and Mulero (2005), Cooper and Kleinschmidt (1996), Tipping và ctg (1995), và Schwartz et al. (2011), and Nguyễn Khắc Minh (editor) (2007) have supplied necessary introductions to approach, choose and build a R&D efficiency mesurement model.

2.3. Some significant researches on use intergrated tool BSC-DEA in efficiency mesurement

Summarization of researches of Rouse et al. (2002), Chen and Chen (2007), Min et al. (2008), Chiang and Lin (2009), Marcelo et al. (2009), Amado et al. (2012) proves intergrated tool of BSC and DEA can be suitably used to measure efficiency. Such researches were done in different industries, for different assessment objectives; at different measurement level: industry, firm, function, or project.

2.4. Some significant researches on solutions to improve R&D efficiency

Although the problems of enterprises surveyed will be the most important basis to discuss and suggest solutions to improve their R&D efficiency, the study of the problems and how to solve such problems in prior studies and in fact make sense of orientation.

CHAPTER 2
THEORY

2.1. Research and development

2.1.1. Definition of research and development (R&D)

According to OECD (2002), *Research and development (R&D) comprise creative work undertaken on a systematic basis in order toincrease the stock of knowledge, including knowledge of man,culture and society, and the use of this stock of knowledge todevise new applications.*

2.1.2. Strategic roles of R&D in business

To Roussel et al. (1991), industrial R&D has three key roles: support the present business; open new business; and develop technological capacity of enterprise (in scale or level).

2.1.3. R&D activites and process

According to OECD (2002), the term R&D expresses a process of three activities: basic research, applied research and experimental development.

According to Brown and Svenson (1988), an R&D organization is cosidered a productable system that has inputs, process of change, and outputs. Beaside, there are receiving systems called internal customers of R&D system using the output of it (Marketing, planning, production …) and external user (community, researchers, …).

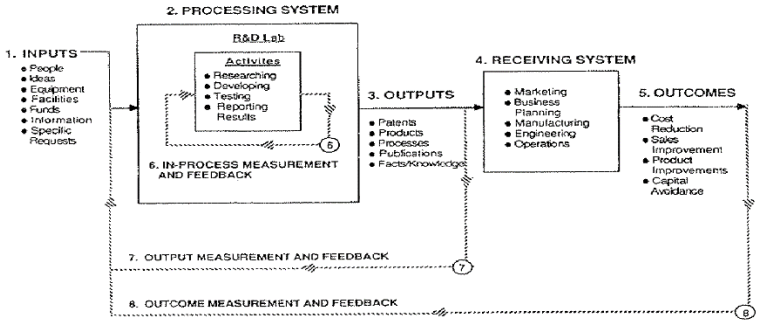

Figure 2.1. R&D process

Source: Brown and Svenson (1988)

2.1.4. Elements needed for an R&D organization

According to Jain et al. (2010), an R&D organization need such essential elements as: R&D people, specialization, staffing, ideas, funds, communication networks, a culture for an R&D organization, …

2.1.5. R&D in pharmacieutical enterprises

Pharmacieutical research and development is health-related research and development (Rick Ng, 2015).

Drugs is open classified into 2 groups: brand-name drugs and generic drugs. Brand-name drug has too complex, difficult and costly R&D process so it is very expensive in the market. Generic (the drug which is bio-equivalent as brand-name drug for pharmacokinetic properties and pharmacodynamic) is produced when the industrial property rights of brand-name drug have expired, so that is usually sold at lower price. The process and activities of the generics R&D process may vary depending on specific situation in each country.

In Vietnam, R&D process of traditional medicine is not too

harsh, and according to Dinh Thanh Ha (2015) also experienced three stages (basic research, applied research, development declaration) with distinguish contents of research and findings.

Three most important factors in investment for R&D are: Money, time and risk. Pharmaceutical companies invest money for R&D to benefit in the future. The less money paid, and the more money earned in the future, the higher efficiency of investment is.

2.2. R&D management

2.2.1. Definition of R&D management

R&D management is the discipline of designing and leading R&D processes, managing R&D organizations, and ensuring smooth transfer of new know-how and technology to other groups or departments involved in innovation. (Chiesa, V., 2001)

2.2.2. Contain of R&D management

According to Jain and Triandis (1989), the essential factors of an R&D organization includung R&D people, ideas, funding and culture are combined together by the skillful R&D management will help R&D organization achieve high productivity and the excellence.

The skills and methods of R&D management mentioned by many different researches are planning and linking R&D with the business strategy; establishing efficient R&D organization; designing R&D works; managing R&D projects; promoting and encouraging R&D personnels; managing intellectual property; R&D new products; research and reduce costs; R&D and innovating technology; assess R&D performance; evaluate R&D efficiency...

2.2.3. The development of R&D management science

By researches of Nobelius, D. (2003) and previous studies of Roussel (1991), Rothwell (1994), Miller and Morris (1998), Chiesa (2001), it is able to systemazing the development of R&D and R&D management science that last 6 periods. And, according to Nobelius, D. (2003) , to manage the sixth generation of R&D - a multitechnology,

multiproject system is really a difficult and challenge mission.

2.3. R&D efficiency assessment

2.3.1. Definition of efficiency

Efficiency, in general sense, express the relationship between total value of outputs and total value of inputs spent to get those outputs.

Technical efficiency is the ability to generate a given amount of outputs from a minimum amount of inputs or the ability to generate a maximum amount of outputs from a given amount of inputs, with a certain level of technology . (Compiled from Koopmans, (1951), Debreu (1951) and Farrell (1957))

2.3.2. The need of business 's R&D efficiency measurement

Enterprises pay much attention to R&D efficiency measurement because of such key objectives as: providing a basis for forecasting, controling R&D process and evaluating the profitability of R&D projects; encouraging employees; promoting communication and cooperation in R&D; increasing learning; reducing risk and uncertainty of R&D activities; and, improving R&D activities.

2.3.3. Difficulties and challenges in R&D efficiency measurement

R&D efficiency measurement is difficult and complicated work. It is because: The impact of R&D is very difficult to be observedand the success is uncertain; It's hard to use financial index as ROI, ROA, ROE,...; Delay in the time between the R&D efforts and the potential rewards from R&D; It's hard to determine the exact criteria to compare because of the characteristics that R&D projects are unique and do not repeat; It's hard to control implicit factors which prevent the creation of scientists and technicians (Brown and Swenson, 1988).

2.4. The development of R&D efficiency measurement methods

R&D efficiency assessing is performed at different levels: individuals (scientists/technicians), R&D projects, R&D function, R&D

organization; and R&D firms. To implement my dissertation, I focus on theories of R&D efficiency measurement at level of R&D.

The theories are summarized in the system of main contains: perspectives and criterion using in R&D efficiency assessment; Approaches and tools used in R&D efficiency assessment.

2.5. Intergrated BSC – DEA in R&D efficiency measurement

2.5.1. The concept and perspectives of Balance Scorecard (BSC)

Balanced Scorecard (BSC), a set of performance measures derived from the vision and strategy of the organization, expressed through a scorecard system was stratified to the level of management and individuals. BSC was first introduced in 1992 by Dr. Robert Kaplan and David Norton as a measurement system that allows additional non-financial metrics in the system of traditional financial metrics to deliver administrators and operators a more balanced approach on evaluation of the activities of the organization.

BSC introduced an evaluation of 4 perspectives: financial, customer, internal processes and learning & develop; development of performance metrics; and collect and analyse relevant information.

According to Kaplan and Norton (1996), the BSC retains traditional measures but these measures only reflect the results of operations in the past. To have a full picture of the long-time business that reflects from the performance of the investments in the long-term potential to the customer relationship for success, financial perpective and measures are added to the model.

Balancing charater in the BSC approach embodied in: Balancing the evaluative criteria of success in terms of financial and non-financial; Balance between the elements inside and outside of the organization; And, the balance between evaluative criteria of the results of operations and factors that generate such results.

2.5.2. Data Envelop Analysic (DEA)

Simply, efficency (technical) of the use of inputs xi to obtain outputs yj can be measured according to the formula:

$$TE = \frac{\text{Total outputs}}{\text{Total inputs}} = \frac{\sum_{i=1}^{m} p_i y_i}{\sum_{j=1}^{k} w_j x_j}$$

Generally, in situation of n DMU, each DMU uses k inputs called x_k to produces m outputs called y_m, technical efficiency (TE_o) of certain DMU_o is calculated in this way:

$$\max_{u,v} TE_o$$

In condition:

$$TE_o = \frac{\sum_{i=1}^{m} u_{oi} y_{oi}}{\sum_{j=1}^{k} v_{oj} x_{oj}}$$

$$TE_\alpha = \frac{\sum_{i=1}^{m} u_{\alpha i} y_{\alpha i}}{\sum_{j=1}^{k} v_{\alpha j} x_{\alpha j}} \leq 1, \ \alpha = 1,\ldots, n; U_i, V_j \geq 0, i = 1, \ldots, m, j = 1, \ldots, k$$

For assessing technical efficiency of a set of DMUs, DEA finds out efficient DMUs – the best done DMUs (called efficient frontier) and calculate TE by comparing the level of performance of each DMU with the level of performance of such efficient DMUs.

2.5.3. Intergrated BSC – DEA in R&D efficiency measurement

BSC and DEA have many advantages in evaluating the effectiveness of the organization, but they both have great limitations in this evaluation. The combination of BSC and DEA in evaluating the effectiveness in a variety of research has been promoting the advantages and overcome the disadvantages of both techniques.

DEA can change performance measures to managerial information, while BSC can supply suitable inputs for DEA, by the way, combinations of different inputs and outputs produce different efficiency measurement models. (Serrance-Cinca và ctg, 2005). This nature makes integrated BCS-DEA the ideal tool for efficiency assessment for such a complicated activity as R&D.

The combination of BSC and DEA has offered a new and improved approach for efficiency analysis. It supports complex efficiency measurement system that can solve simuntaneously information of many

inputs and outputs as well as show necessary adjustments of inputs and outputs to achieve efficient status. (Rickards, 2003)

CHAPTER 3
RESEARCH DESIGN

3.1. Research process and times table

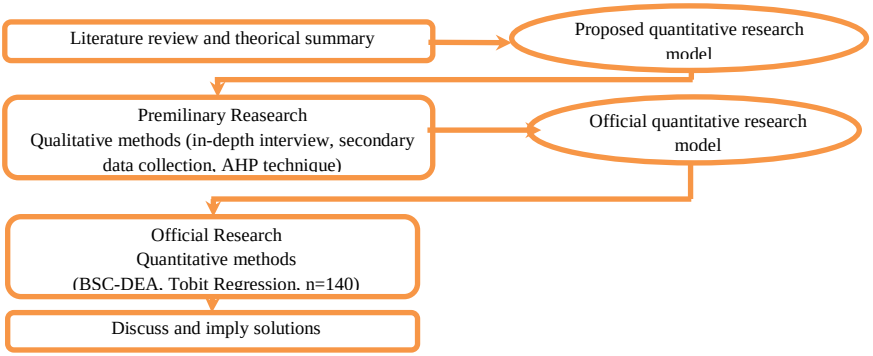

Figure 3.1. Research process

The research has planned for 4 - year performance. Nevertheless, difficulties in approaching and recapitulating literatures, and survey data made the time plan extended more than a years longer. Five - year research for my dissertation is performed with the time arrangement.

Table 3.1. Times table of my research for dissertation

Step	Method	Tools	Place	Duration
Step 1: Literature review and theorical summary	Qualitative	Collect and read printed documents in libraries, e-documents on databases and write literature review and theorical summary.	University	18 months (3/2012 – 9/2013)
Step 2: Preliminary Research by qualitative methods	Qualitative	- In-depth interview (30 interviewees), secondary data collection, survey with questionnaire (10 peoples) AHP technique and observe in the field	25 firms, offices	3 months (tháng 10 – 12/2013
Step 3: Collect datas for official research	Quantitative	Collect datas by face-to-face interview, telephone, airmail, email, reading reports of firms and offices.	University, firms, offices	24 months (01/2014 –
Step 4: Analysic and process datas for official	Quantitative	Datas processing by Stata software, intergrated BSC-DEA tool, TOBIT.	University	3 months (1-3/2016)
Step 5: Dicuss on results and imply solutions	Qualitative	Analysis datas and results, discuss bilateraly and in group for building solutions.	University, firms,offices	3 months (4-6/2016)

3.2. Research model

3.2.1. Foundation of research model proposal

Targets of R&D efficiency assessement; Analysis of the superiority of combinated BSC-DEA technic in evaluating efficiency; Success and limitations of the studies used combinated BSC-DEA model in measuring technical efficiency; Synthesis of indicators in measuring R&D efficiency; And, the advantages of the censored regression model - Tobit versus OLS regression model.

3.2.2. Intergrated BSC-DEA model proposed for estimating R&D efficiency

Major limitation in the study of Amado et all (2012) is handling the relationship between the dimensions unidirectionally therefore it can not reflect the two-dimensional and diverse relationship of the model's aspects. Therefore, the research model is suggested to further evaluate the relationship between the financial results with the resources for improvement of their ability to learn and develop and that creates a closed cycle of input - result.

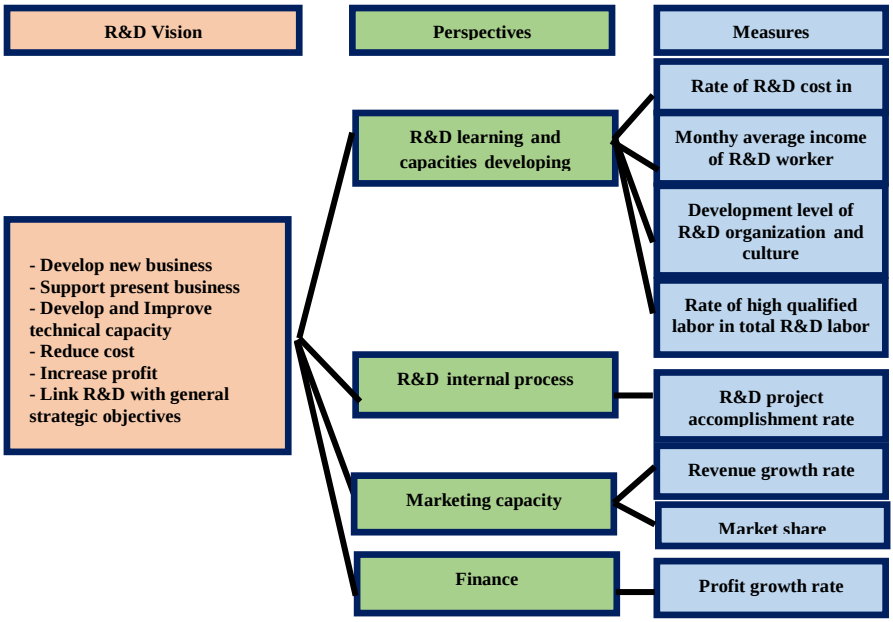

Figure 3.2. Proposed BSC model

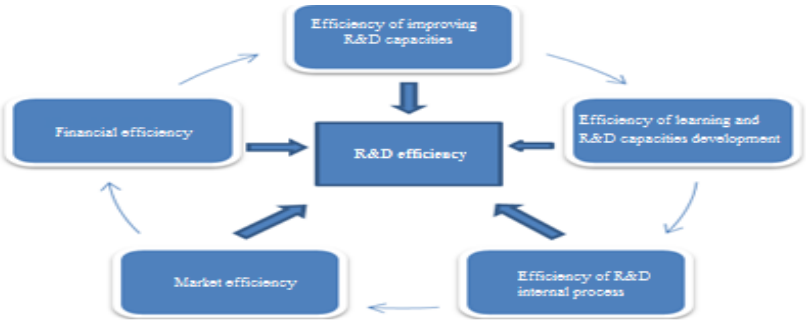

Figure 3.3. DEA models

AHP technique is used to survey and calculate importance of explanatory variables of the variable "development level of R&D organization and culture".

3.2.3. Tobit model proposed for analysis of factors influencing

When analyzing the factors affecting the efficiency of R&D, the author use the Tobit model instead the common regression method because the technical efficiency index values from 0 to 1, that means dependent variable is under censorship. The author found the marginal influence of independent variables to technical efficiency through the following criteria:

+ If X_k is continuous variable, marginal influence of X_k on dependent variable is detemined by: $\frac{\partial E(Y|X)}{\partial X_k} = \beta_k . \Phi(\frac{X\beta}{\sigma})$

Among them, Y is dependent variable that indicate technical efficiency index, β_k is estimated coefficient of the Tobit model for dependent variable X_k, Φ is distribution function of standardized random variable.

+ If X_k is discrete variable, marginal influence of X_k on dependent variable is detemined by:

$$\frac{\partial E(Y|X)}{\partial X_k} = E(Y|\bar{X}, X_k = 1) - E(Y|\bar{X}, X_k = 0)$$

3.3. Research methods selection

3.3.1. Qualitative research

A preliminary research was conducted in October-December of 2013 in pharmaceutical enterprises Binh Dinh, Phu Yen and Gia Lai, Quang Nam and Da Nang. I conducted two surveys, and select in-depth interview combined with secondary data collection.

By reality of business and reults of professional survey, the author summarized main ideas, proposed adjustment of research model and limit range of official research.

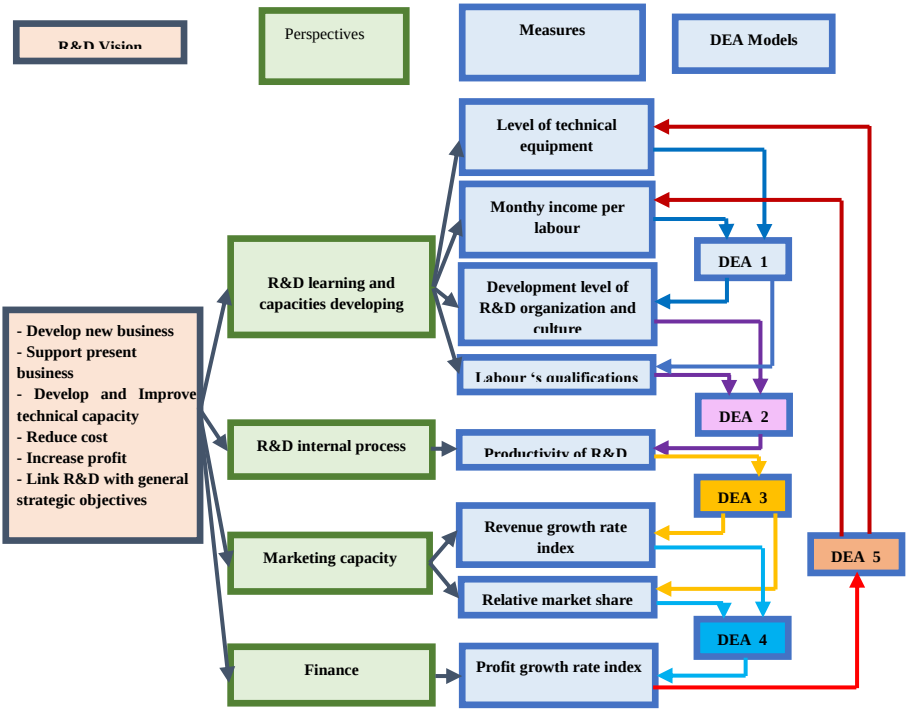

Figure 3.4. The Intergrated BSC-DEA model in estimating R&D efficiency

The variables of the model are selected from the synthesis of previous studies evaluating the effectiveness of R&D, theoretical studies on R&D and R&D management, and the opinions of experts and opinions of the author.

Table 3.4. Explanation of variables in the intergrated BSC-DEA model

Measures	Calculation	Reference
Level of technical equipment (muctb)	The ratio of the total value of fixed assets and a total workforce.	Tipping et al. (1995), adjustments proposed by the author and experts 'opinions
Monthy income per labour (tntb)	The ratio of of the total cost of salaries, salary-like-expenses, other expenses of employees and a total average employment in the enterprise	Chiang & Lin (2009)
Development level of R&D organization and culture (mdtc_vh)	Value of the variable is counted with data collected from surveyed enterprises and the levels of importance of the explanatory variables counted with data from another small survey of the author with support of AHP technique.	Schein (1985), Roussel, P., et al. (1991), Jain et al. (2010)
Labour 's qualifications (tdld)	Ratio (%) of the number of highly qualified labor in the total labor force	Schwart & ctg (2011), Chen & Chen (2007)
Productivity of R&D system (nsRD)	The ratio between the number of R&D completed and successful registrated products and the average number of highly qualified workers in the same period	Adjustments proposed by the author and experts 'opinions
Revenue growth rate index (cstdtdtt)	Revenue growth rate index is net revenue growth rate. Revenue growth rate index is calculated by comparing net revenue growth rate of a certain enterprise with the highest and lowest net revenue growth rate of the surveyed enterprises.	Cooper & Kleinschmidt (1996), adjustments proposed by the author and experts 'opinions
Relative market share (tptd)	The ratio of the average net sales of each enterprise and the average net sales respectively of the strongest competitors in the market	Tipping & ctg (1995), Schwart & ctg (2011), Chen &Chen (2007)
Profit growth rate index (cstdtlnt)	Profit growth rate index is net profit growth rate. Profit growth rate index is calculated by comparing net profit growth rate of a certain enterprise with the highest and lowest net profit growth rate of the surveyed enterprises.	Cooper & Kleinschmidt (1996), adjustments proposed by the author and experts 'opinions

Value of the variable "Development level of R&D organization and culture" is calculated by the formula:

$$mdtc\_vh_{DMUi} = \sum_{i=1}^{5} Value\ of\ explanatory\ variable\ i\ X\ a_i$$

In that, weights of explanatory variables are displayed in Table 3.10.

Table 3.10. Collection of weights of the explanatory variables

Explanation variable (i)	Weight (a_i)
Having R&D department or center	**0.379**
Having clear R&D objectives	**0.269**
Having professional R&D leader	**0.192**
Having possitive R&D policies	**0.119**
Having R&D results statistics	**0.041**

Source: Survey and calculation of the author

3.3.2. Quantitative research

Quantitative methods are used for the official research. Data sources are diversified including business survey data conducted in 2012-2015 of the General Department of Statistics; data from the government administrative offices such as the Department of Intellectual property, Drug Administration, the General Department of Taxation; data compiled from financial statements and annual report of enterprises; and, data obtained originally from the author ‘s surveys: go & search, telephone interview, e-mail exchange with question table.

After cleaning the data and having a list of business for official survey as well as secondary data as listed, the author collected primary data to calculate the value of the variable "Development level of R&D organization and culture"

Results of qualitative research helps to determine scope of the research that focus on human drug enterprises including traditional drug enterprises and modern drug ones that the total number of surveyed enterprises is 140 (count for 77,78% in total number of human drug enterprises in over the country).

Technical efficiency of R&D activities is estimated by model combined BSC-DEA. Then estimated results is adjusted and used to analysis influencing factors in the regression Tobit model with 11 independent variables aims to provide the basis of solutions for improvement of R&D efficiency of pharmaceutical enterprises.

3.3.3. Technical efficiency estimating model

A combined BSC-DEA model is used for estimating technical efficiency index. In that, constituent technical efficiency indices are estimated by a causal system of 5 DEA models presented in Table 3.11.

Table 3.11. DEA models used for estimating efficiency index

Name of model	Outputs	Inputs	Efficiency rate
DEA-1	Development level of R&D organization and culture; Labour 's qualifications	Level of technical equipment; Monthy income per labour	$H(R\text{-}P) = \frac{\text{Environment, R\&D tools and skills}}{\text{R\&D resources}}$
DEA-2	Productivity of R&D system	Development level of R&D organization and culture; Labour 's qualifications	$H(P\text{-}OP) = \frac{\text{Output of R\&D process}}{\text{Environment, R\&D tools and skills}}$
DEA-3	Revenue growth rate index; Relative market share	Productivity of R&D system	$H(OP\text{-}OC) = \frac{\text{Improvement of market capacity}}{\text{Output of R\&D process}}$
DEA-4	Profit growth rate index	Revenue growth rate index; Relative market share	$H(OC\text{-}F) = \frac{\text{Improvement of financial results}}{\text{Improvement of market capacity}}$
DEA-5	Level of technical equipment; Monthy income per labour	Profit growth rate index	$H(F\text{-}R) = \frac{\text{R\&D resources}}{\text{Improvement of financial results}}$

Source: Assessment models estabilshed by the author

3.3.4. Model for analysing and assessing influential factors

To survey the factors that affect R&D efficiency in the case the efficiency index values in the interval [0,1], the authors use censored regression models Tobit.

The regression model form is:

$$Hdc = \alpha 0 + \alpha 1\ vnkd + \alpha 2\ tsld + \alpha 3\ tuoidn + \alpha 4\ tdttn + \alpha 5\ tanduoc + \alpha 6\ cohn + \alpha 7\ cohcm + \alpha 8\ dnnn + \alpha 9\ dnfdi + \alpha 10\ gmp + \alpha 11\ coxk + \varepsilon$$

Among them, Hdc is a variable return to scale technical efficiency (VRSTE) (average and adjusted). αi ($i=1\div11$) is coefficient of independent variable i in the group of business capital (vonkd), total labors (tsld), age of business (tuoidn), growth rate of average income (tdttn), dummy variables including "Enterprise produces mainly modern drugs" (tanduoc), "Enterprise has headquarters in Hanoi" (cohn), "Enterprise has headquarters in HCM city" (cohcm), "enterprise is state-owned" (dnnn), "Enterprises is FDI business" (dnfdi), "Enterprise has GMP phant" (gmp), "Enterprise has exported products (coxk). ε is casual interference.

3.4. Data sources

From the list of 317 enterprises producing medicines nationwide in 2014, the authors review and filter out 179 enterprises which produce human drugs, conduct surveys and collect data on these enterprises. There are diverse data sources: business survey data conducted in 2012, 2013, 2014, 2015 of the General Department of Statistics; data from the government administrative offices such as the Department of Intellectual property, Drug Administration and the General Department of Taxation; data compiled from the financial statements and the annual report of the enterprise; data obtained originally from the authore ‘s surveys: go and search, telephone interview, e-mail exchange. After removal of the businesses that do not have the report, have incompleted report, are inaccessible in the author ‘s surveys, a final list of 140 human drug enterprises is used for data colleting in the main rereach.

CHAPTER 4
RESULTS

4.1. General business realality of pharmaceutical enterprises in Vietnam

According to a survey of General Statistics Office Of Vietnam (GSO, 2015), counted until 31/12/2014, Vietnam has 5,517 pharmaceutical enterprises are operating.

Table 4.1. Pharmaceutical business statistics

Fields of pharmaceutical business	Type of business			Total
	Private	Private	DN FDI	
Growing medicinal plants	5	29	0	34
Producing pharmaceutical chemistry and pharmaceutical aterials	3	72	5	80
Producing drugs	9	271	37	317
Producing equipment, medical instruments, dental	1	130	33	164
Producing orthopedic devices, rehabilitation	0	20	1	21
Wholesale of drugs	10	2698	19	2727
Wholesale of pharmaceutical of machinery, medical equipment	2	1420	21	1443
Retail sale of pharmaceutical products, medical equipment in	6	724	1	731
Total	**36**	**5364**	**117**	**5517**

Source: Summerized from data of GSO, 2015

The country has 34 growing medicinal plants enterprises (accounting for 0.62%), 582 pharmaceutical manufacturing enterprises and 4901 pharmaceutical commercial enterprises. Number of pharmaceutical commercial enterprises make up the majority, more than 8.42 times the number of manufacturing enterprises shows that Vietnam is an attractive market, but pharmaceutical companies producing drugs in the country is difficult to compete with imported drugs sew. The number of growing medicinal plants enterprises is little also revealed the limitations of pharmaceutical raw materials.

Table 4.2. The development of drug enterprises in Vietnam

Criteria	2009	2010	2011	2012	2013	2014
Number of operative enterprises	272	289	343	369	393	317
Average business capital (billion VND)	19081	24567	28355	33309	35948	39671
Total labors (to 31/12/2013, people)	34848	36306	38302	40879	43538	39279
Net business revenue (billion VND)	21780	28515	31148	38806	43056	41656
Profit before taxes (billion VND)	2137	2888	2799	3348	3905	3690

Source: Summerized from data of GSO, 2010, 2011,2012, 2013, 2014, 2015

4.2. General R&D activities of pharmaceutical enterprises in Vietnam

In Vietnam, trend of research and production of generics is the mainstream. Invented drugs are rare and mostly oriental medicines. Many pharmaceutical enterprises in Vietnam tends to upgrade plants to meet the international standards (PIC / S-GMP, EU-GMP) to produce high quality generic medicines. (Hoang Hieu Tri, 2014).

Traditional medicine production in Vietnam is mainly in households, healthcare facilities using traditional medicine and enterprises. R&D process of traditional medicine is not too harsh as modern one, however, according to Dinh Thanh Ha (2015), a traditional pharmaceutical product from being formed in the mind of researchers or people who orders the research to being applied for business undergoes

the identifical stages of R&D process.

A survey of experts of WHO / UNIDO (Drug Administration (2013) shows that investment of pharmaceutical companies for R&D is very low, 64% of companies use less than 5% of sales revenue for R&D. Most business pharmaceutical manufacturing industry (67.9% occupied) did not invest or invested at low levels, less than 5% of their revenue for R&D activities.

4.3. Overview of surveyed pharmaceutical companies

There are 140 pharmaceutical companies producing human drugs in survey list of the author.

Table 4.5. Production capacity and business results of surveyed enterprises in 2014

Norm	Drug production enterprises	Surveyed human drug production enterprises	Density (%)
Number of activity enterprises	317	140	44.16
Average business capital (billion VND)	39671	31587	79.62
Total labor (to 31/12/2013) (people)	39279	33830	86.13
Net business revenue (billion VND)	41656	35588	85.43
Net before tax profits (billion VND)	3690	3469	94.01

Source: Data of GSO (2015) and the author's survey

4.4. Results of efficiency estimation

A drug-manufacturing enterprise surveyed had average level of technical equipment for work of 457 million/person, the average labor income of 6.48 million/person. The level of development of R&D organization and culture is 76.62%.

Table 4.6. Variable statistics of 5 DEA models

Variable	Obs	Mean	Std. Dev.	Min	Max
Muctb	140	457.0511	440.3006	3.9500	3575.3900
Tntb	140	6.4800	3.5072	1.0300	19.5530
mdtc_vh	140	0.7662	0.3279	0.0000	1.0000
Tdld	140	22.5644	15.3290	0.5200	109.7500
nsRD	140	0.7713	1.2595	0.0000	7.2000
Cstdtdtt	140	0.0176	0.0869	0.0001	1.0000
Tptd	140	7.2084	12.7331	0.0000	100.0000
Cstdtlnt	140	0.5436	0.0826	0.0000	1.0000

Source: Survey and calculation of the author

The average percentage of highly qualified labor in total labor is 22.56%. A highly qualified employee in 3 years (2012-2014) created 0.77

R&D's product accomplished and successfully registrated. The average net revenue growth index was 0.0176 and the average net profit growth index was 0.5436. The average relative market share is 7.21%.

The huge standard deviation of the level of technical equipment for labor shows the difference between firms in investment and equipment for their labor. The large standard deviation of the relatively market share indicates that market positions of firms are very differentiate.

Table 4.9. Adjusted R&D average efficiency of human drug enterprises

DMU	Hdc	DMU	Hdc	DMU	Hdc	DMU	Hdc
1	0.7558	36	0.7082	71	0.6247	106	0.7241
2	0.6032	37	0.7733	72	0.5824	107	0.7957
3	0.7294	38	0.6620	73	0.4940	108	0.6935
4	0.6642	39	0.6541	74	0.6876	109	0.8274
5	0.6545	40	0.9176	75	0.6551	110	0.8563
6	0.6490	41	0.8571	76	0.5464	111	0.5721
7	0.6766	42	0.7550	77	0.8202	112	0.4991
8	0.4592	43	0.7048	78	0.6272	113	0.5082
9	0.5734	44	0.7212	79	0.7022	114	0.4783
10	0.6099	45	0.6010	80	0.6713	115	0.8872
11	0.6780	46	0.6279	81	0.7230	116	0.7274
12	1.0000	47	0.8031	82	0.4207	117	0.7230
13	0.6520	48	0.6284	83	0.6170	118	0.5532
14	0.5419	49	0.4462	84	0.7097	119	0.6653
15	0.8573	50	0.4241	85	0.6139	120	0.8779
16	0.6207	51	0.6241	86	0.6500	121	0.6530
17	0.6353	52	0.4802	87	0.6455	122	0.5573
18	0.5910	53	0.7507	88	0.6967	123	0.6076
19	0.6222	54	0.4144	89	0.6549	124	0.6690
20	0.5927	55	0.5254	90	0.6474	125	0.7443
21	0.6361	56	0.6562	91	0.7099	126	0.8279
22	0.7573	57	0.6763	92	0.6099	127	0.8786
23	0.6322	58	0.5841	93	0.4355	128	0.6215
24	0.6417	59	0.6690	94	0.5954	129	0.4594
25	0.5812	60	0.5329	95	0.6767	130	0.6433
26	0.6439	61	0.7841	96	0.6626	131	0.5716
27	0.6821	62	0.6585	97	0.6113	132	0.5500
28	0.5209	63	0.5839	98	0.6206	133	0.9020
29	0.7683	64	0.7337	99	0.6695	134	0.5652
30	0.5414	65	0.7480	100	0.6106	135	0.4562
31	0.4824	66	0.6955	101	0.8654	136	0.7100
32	0.8901	67	0.4945	102	0.5524	137	0.6211
33	0.7232	68	0.4258	103	0.5457	138	0.7545
34	0.6921	69	0.5677	104	0.4844	139	0.7527
35	0.7515	70	0.5657	105	0.7030	140	0.6596

Source: Survey and calculation of the author

$$\text{Mean } H_{dc} = \frac{1}{140}\left(\sum_{i=1}^{140} H_{dc(i)}\right) = 0{,}6520$$

4.5. Results of the analysis and assessment on influential factors

Table 4.11. Variables statistics of Tobit model

Biến	Số quan sát	Trung bình	Độ lệch	Thấp nhất	Cao nhất
Hdc	140	0.65	0.12	0.41	1.00
Vontb	140	*604.66*	977.69	1894.00	7993.58
Tsld	140	235.00	314.01	2.00	2303.00
Tdttn	140	21.95	37.09	-46.06	320.62
tuoi_dn	140	14.5	11.40	2.00	55.00
Tanduoc	140	0.67	0.47	0.00	1.00
co_hn	140	0.20	0.40	0.00	1.00
co_hcm	140	0.26	0.44	0.00	1.00
Dnnn	140	0.03	0.17	0.00	1.00
Dnfdi	140	0.19	0.39	0.00	1.00
Gmp	140	0.71	0.46	0.00	1.00
Coxk	140	0.54	0.50	0	1

Source: Survey and calculation of the author

Estimated results from censored regress Tobit that are processed in Stata 13.0 software is showed in Table 4.12.

Table 4.12. Estimated results from censored regress Tobit

Tobit regression — No. of obs = 140; LR chi2(11) = 67.91; Log likelihood = 135.06122; Prob > chi2 = 0.000

Vrstedc	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Vonk	0.000053	0.000016	3.36	0.001	0.000022	0.000084
Tsld	-0.000010	0.000053	-0.18	0.857	-0.000114	0.000095
Tuoidn	-0.001652	0.000805	-2.05	0.042	-0.003245	-0.000060
Tdttn	-0.000205	0.000221	-0.93	0.356	-0.000642	0.000233
Tanduoc	0.048137	0.020662	2.33	0.021	0.007257	0.089017
Cohn	0.028780	0.021484	1.34	0.183	-0.013727	0.071286
Cohcm	0.052683	0.019173	2.75	0.007	0.014750	0.090617
Dnnn	-0.043388	0.049004	-0.89	0.378	-0.140343	0.053568
Dnfdi	0.015837	0.022614	0.70	0.485	-0.028905	0.060580
Gmp	0.051211	0.023755	2.16	0.033	0.004212	0.098210
Coxk	-0.017806	0.020392	-0.87	0.384	-0.058152	0.022540
_cons	0.570190	0.019445	29.32	0.000	0.531718	0.608662
/sigma	0.091084	0.005467			0.080267	0.101901

Obs. summary: 0 left-censored observations at crs_te =<0; 139 uncensored observations; 1 right-censored observations at crs_te>=1

Source: Survey and calculation of the author

Marginal effects of variables including vontb, tuoidn, tanduoc,

co_hcm and gmp to VRSTE of R&D is defined as in Table 4.13.

Bảng 4.13. Kết quả ước lượng hệ số của các biến số

Variable	dy/dx	Std. Err.	Z	P>z	[95%	C.I.]	X
Vontb	0.000053	0.00002	3.36	0.001	0.000022	0.000084	627.736
Tuoidn	-0.001652	0.0008	-2.05	0.04	-0.00323	-0.000074	14.5
Tanduoc	0.0481369	0.02066	2.33	0.02	0.00764	0.088634	0.671429
co_hcm	0.0526833	0.01917	2.75	0.006	0.015105	0.090261	0.257143
Gmp	0.0512107	0.02375	2.16	0.031	0.004653	0.097769	0.707143

For dummy variables (, dy/dx is the rate of change discretely of dummy variable from 0 to 1*

Source: Survey and calculation of the author

- When the average business capital of drug production enterprise increase 1 billion, in term of other factors 'constant, the technical efficiency of R&D activities will increase 0.000053.

- When drug production enterprise has 1 year more of experience, in term of other factors 'constant, the technical efficiency of R&D will decrease 0.001652.

- When a drug production enterprise manufacture morden medicines (number of morden medicines > 50% the total number of products), in term of other factors 'constant, the technical efficiency of R&D is 0.0481369 higher than that of other enterprises.

- When a drug production enterprise is headquartered in HCM city, in term of other factors 'constant, the technical efficiency of R&D activities is 0.0526833 higher than that of other.

- When a drug production enterprise has GMP factories in term of other factors 'constant, the technical efficiency of R&D activities is 0.0512107 higher than that of enterprises without GMP factory.

CHAPTER 5
DISCUSSION AND SOLUTION IMPLICATION FOR IMPROVING OF R&D EFFICIENCY OF PHARMACIEUTICAL ENTERPRISES IN VIETNAM

5.1. Disscuss on results

The following discussions are done on research results:

- Discussion on both of studies on the general reports and secondary data;

- Discussion abaut researches on survey data, analysic and assessment of the author;

- Comments added from the practice of R&D in 5 enterprises selected conveniently from 140 surveyed ones show approriateness of research results and recommend solutions more convincing.

6.2. Implication ome solutions to improve technical efficient of R&D in pharmacieutical enterprise in Vietnam

Based onn theoretical studies, the author drawn research findings, the opinions of the author and expert, lessons from experiences, the authors have proposed many solutions to improve the efficiency of R&D in pharmaceutical enterprises in Vietnam.

- The first group of solutions focuses on improving the efficiency of the R&D process internally;

- The second group of solutions focuses on improving the customer efficiency;

- The third group of solutions raises effectively in reinvestement for R&D capacities;

- The fouth group of solutions relates to pharmaceutical administration agencies, local government, universities and research institutions related to the pharmaceutical industry.

CONCLUSION

1. Main research results of the thesis are:

- Researching, selecting and arranging relative theories on R&D, R&D management, evaluation of R&D efficiency in pharmaceutical business; Recommending frame for analysis and evaluation of R&D efficiency of pharmaceutical enterprises in the context of Vietnam.

- Overall assessing the current status of the development of

pharmaceutical enterprises in Vietnam; surveying, analysing and in-depth evaluating R&D efficiency of human drug producing firms in Vietnam.

- Conducting the actual survey of 140 pharmaceutical companies which produce human drugs and have at least 3 years of R&D performance (2012-2014).

- Proposing many solutions to improve the efficiency of R&D in pharmaceutical enterprises in Vietnam.

2. Limitations and future research directions

There are some limitations in the thesis: The research was not conducted on internal R&D process of enterprises; In-depth evaluation was performed only on human drug producing enterprises; No separated surveys for generic medicine R&D and brand new medicine R&D; Survey on open R&D model just stop at the level of case studies and qualitative; And, not to evaluate R&D efficiency at staff level.

In the future, the author will continue to implement a number of studies: (i) Research and evaluation R&D process; (ii) Perform similar studies for other sectors of the pharmaceutical industry; (iii) Implement survey to assess R&D efficiency at project level; (iv) Survey and assessment to design an open R&D model suitable for Vietnamese pharmaceutical enterprises; (v) Expand the study of R&D efficiency with approach of individual and organizational behavior./.

SCIENTIFIC PUBLICATIONS
RELATED TO THE THESIS TOPIC

1. Nguyễn Thị Hạnh và Nguyễn Trường Sơn (2011), *Đánh giá ảnh hưởng của R&D đối với kết quả kinh doanh của doanh nghiệp bằng mô hình DEA*, Tạp chí Khoa học và Công nghệ Đại học Đà Nẵng, ISSN: 1859-1531, số 1(42), trang 166-173.
2. Nguyễn Thị Hạnh (2015), *Đánh giá hiệu quả các doanh nghiệp có lợi thế xuất khẩu của tỉnh Bình Định*. Kỷ yếu Hội thảo khoa học Quản trị và Kinh doanh - COMB 2015, ISBN: 978 6044 84, Đại học Đà Nẵng và Hội Doanh nhân trẻ thành phố Đà Nẵng, trang 257-266, Đà Nẵng.
3. Nguyễn Thị Hạnh và Nguyễn Trường Sơn (2016), *Đánh giá hiệu quả của các doanh nghiệp sản xuất thuốc tại Việt Nam*. Tạp chí Kinh tế & Phát triển, 224, ISSN 1859-0012, trang 53-61.
4. Nguyễn Thị Hạnh (2016), *Sử dụng phương pháp phân tích bao số liệu và tỉ số siêu kỹ thuật trong đánh giá hiệu quả kỹ thuật - trường hợp các doanh nghiệp công nghệ thông tin tp. Đà Nẵng*, Tạp chí Khoa học trường Đại học Quy Nhơn, ISSN 1859-0357, số 1, tập 10, tháng 3/2016, trang 75-86.
5. Nguyễn Thị Hạnh (2016), *Measuring efficiency of R&D activities in drug entrepreneurs in Vietnam by integrated framework of BSC and DEA*, Proceeding of UK-ASEAN Innovation Conference (UAIC), 25th-26th Oct, 2016, Vientiane, Laos, pp. 37-57.