HUMAN CAPITAL IN LIFE SCIENCE FIRM VALUATION: A THEORETICAL MODEL

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Master of Science Degree in Applied and Commercial Biotechnology

HEDMARK UNIVERSITY COLLEGE

2014

ACKNOWLEDGEMENT

This thesis work was carried out at Hedmark University College, Department of Natural Science and Technology, in a partial fulfillment of requirements for Master of Science Degree in Applied and Commercial Biotechnology under the supervision of Jørn Ulheim.

First of all, I would like to take this privilege to express my profound gratitude to my supervisor Jørn Ulheim for his invaluable guidance, constructive and meticulous supervision, and tones of encouragement throughout this thesis work. I would also like to express my sincere gratitude to Sverre Bjørnstad, General Manager at Geno SA; Idun Christie, Administrative Director at Graminor; Tina Bjørnlund Bønsdorff, Chief Executive Officer at Oncoinvent; and Nils Christian Steig, Managing Director at Spermvital AS for their time during the data collection process.

I owe a debt of gratitude to Svein Birger Wærvågen for his continuous support and direction during the thesis work. I also wish to express my sincere thanks to all the faculty members of Department of Natural Science and Technology, and library staffs for their supportive work during the period.

I am thankful to all my colleagues for their kind cooperation. Finally, my special indebtedness goes to my esteemed parents for their everlasting support.

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LIST OF ABBREVIATIONS

CCA:	Contingent Claim Analysis
CEO:	Chief Executive Officer
CV:	Curriculum Vitae
DCF:	Discounted Cash Flow
DTA:	Decision Tree Analysis
EBITA:	Earning Before deduction of Interest, Taxes and Amortization
EBITDA:	Earning Before deduction of Interest, Taxes, Depreciation and Amortization
FCF:	Free Cash Flow
HR:	Human Resource
hrf:	human resource factor
IMA:	Institute of Management Accountants
IP:	Intellectual Property
IPO:	Initial Public Offering
MBA:	Master of Business Administration
NOPLAT:	Net Operating Profit Less Adjusted Tax
OECD:	Organization for Economic Co-operation and Development
PE:	Private Equity
R&D:	Research and Development
rNPV:	risk adjusted Net Present Value
ROIC:	Return On Invested Capital
RSA:	Royal and Sun Alliance
UEC:	Union of European Accounting Experts
WACC:	Weighted Average Cost of Capital

ABSTRACT

Value of biotechnology firms relies upon the complex interplay between human capital and IP assets, where, human capital translates the market potential of IP asset to the true market value. This study aims to introduce the human capital of biotech firms into already existing valuation models in form of human resource factor (hrf). Built as an extension on available literature, a theoretical linear model consisting six parameters, viz.; breed of managers, star scientists, knowledge continuity, human resource interaction and CEO effect, was developed to estimate the human capital. The human capital determines the translational efficiency of firm's potential to market values. In order to evaluate the relevance of the model, a pilot scale study of five biotech companies, based in Hamar and Oslo, was carried out through the use of questionnaire-based interview. Findings from interview showed that Company B has highest hrf value, while Company D has the lowest. Finally, implementing a scorecard based on this linear model could prove to be fruitful in enhancing firm's market value.

Keywords: human resource factor, translational efficiency, valuation.

1 INTRODUCTION

Field of biotechnology was emanated with the main aim of enhancing human life through research, development and commercialization. This industry involves capital-intensive research and development (R&D) programs where venture capital, public funding, private funding, government sources and grants are the sources of sustenance. However, these sources should be attracted through lucrative value proposition.

Biotechnology institutions are often involved in technology transfer, fund raising, Initial Public Offering (IPO), licensing strategies and revenue generation, portfolio management, joint venture agreements, collaborative research, investment decisions, merger and acquisition as a part of their strategic steps to achieve the goals (Bogdan & Villiger, 2010). All these activities rely on the value of the company or a project. Arojarvi (2001) argues that the turbulence in the stock market around the globe is the outcome of the fact that no one knows the exact value of present day economy. This situation is more prominent in the field of biotech. Stock prices can fluctuate dramatically, in response to news developments particularly concerning failure or success of particular drug or product under trial. Investors must carefully consider a possible stock market reaction such as risk and reward associated with a particular product. They have few metrics to base their investment decision in biotech firms (Bogdan & Villiger, 2010). Thus, the investment in biotech firms is largely suited to risk tolerant investors (Maharaj, 2013). Therefore, valuation is a crucial financial issue for every biotech company.

Biotech industries are characterized by certain industry factors which are unique to them, such as, companies' product development pipeline, capital burn rate (level and rate of expenditure required for R&D), survival index (measurement of the relationship between net cash in hand and burn rate), uncertainty etc (Bratic, Tilton, & Balakrishnan, 1997). These factors play a major role in valuation of biotechnology companies. However, fewer studies have been carried out in biotech valuations. There have been some efforts to incorporate managerial flexibility in valuation models but human resource component has been rarely captured by already existing models. Thus, attractive and widely acceptable valuation model that incorporates the human capital of a firm is a present day essence in the field of biotechnology. This study is an effort towards introducing human capital in life science valuation models.

1.1 Valuation in biotechnology

Financial management is a major issue on every company. Small biotech companies need cash for their growth and development, and their existence is jeopardized if the management team cannot be prudent enough to muster investment sources. Furthermore, during licensing activities, mergers and acquisitions, it is important to demonstrate the valuation work to other concerned stakeholders and partners (Lalandes, 2012). Valuation should reflect a sum of the total assets that may be tangible or intangible. Mostly, the value of Biotech Company relies on their intangible assets they possess. A company value lies in its potential to generate a stream of profits in the future through proper utilization of its intangible assets. Thus, the intangible assets play an important role in valuation of biotechnology sector.

Valuation theoretically guides the investment choice and profitability. In biotechnology, valuation is the sum of existing company value, market position and opportunity, and future products based on present intangible assets. Valuing the present intangible assets based on their future potential and market opportunities is a major challenge in biotechnology valuation. Furthermore, uncertainty in R&D outcomes along with future market unpredictability makes the task more arduous (Ljumović, Cvijanović, & Lazi, 2012). Jovanović, Matović, & Petrović (2011) emphasized on greater value of intangible assets in business activities and stated that the intangible assets share in business activities has risen from 5% in 1970s to 90% in 2004. Thus, business valuation has become more and more complex up to the present day with the increasing share of intangible assets. This complexity has entangled the biotechnology valuation more than any other sectors.

In biotechnology sector, Discounted Cash Flow (DCF) and Real options are the two major quantitative valuation techniques (Bogdan & Villiger, 2010). DCF has been used for a long time as the major valuation techniques because of its simplicity in application. This trend could not continue to remain as a gold standard until present day business where greater value is applied in intangible assets, and there is more uncertainty associated with it. Furthermore, this valuation technique shows negative valuation for early stage developing companies. Real options valuation technique was developed to overcome the pitfalls associated with DCF. It is more complicated to apply, but it is considered to be a more flexible valuation technique.

1.2 Human capital in valuation

Life cycle of life science companies, as shown by Collingham (2004) resembles a golden triangle of finance, intellectual property and management. Scientists with IP assets need complementary financial and commercial skills. On the other hand, an ideal management team may need better technologies and better scientists for commercial exploitation. According to Edvinsson & Malone (1999), the corporate value cannot be derived directly from any one of the components of intellectual capital (structural capital, relational capital and human capital) but it is an outcome of complex interplay between all these factors. The trilateral equilibrium is essential for proper translation of intellectual capital into corporate value. No matter how strong are two factors, if the remaining third is weak, the firm has no potential to translate its intellectual capital into actual market value. The biotech company valuation models such as DCF and real options models have well-incorporated relational capital and structural capital for their future value projection. However, they fail to incorporate the human capital and thus are unable to maintain the trilateral equilibrium. Thus, in the following sections, human capital in terms of human resource factor is considered to overcome the shortcomings of previous valuation models.

1.3 Objectives of the study

This study aims to provide a better tool for the biotech industry to estimate their market value through better understanding of translational efficiency of their existing human resources. Thus, introduction of the translational efficiency of human resources in terms of human resource factor in life science company valuation models is the general objective of this study.

Specific objectives of the study are;

- To explain the dynamics of product development pipelines in the biotech sector
- To discuss and identify key value drivers in the biotech sectors
- To provide a brief introduction on already existing valuation models in biotechnology
- To analyze the shortcoming of existing models
- To introduce a new model for scoring the value of human capital in the biotechnology sector
- To introduce human resource factor in existing models
- To test the hypothesis with real life data in pilot scale

1.4 Rational of the study

Valuation is an integral part of biotech product life cycle. In each stage of biotech company life cycle, such as, external fundraising, licensing out, mergers and acquisitions, during IPO plan, value of a company needs to be assessed. High attrition rate, high burn rate, lengthy timeline and highly regulated nature of biotech business add uniqueness and complexity in its valuation approaches. Despite these associated complexities, various models have been introduced for valuation. These efforts range from early 1880s practice of measurement of lab footage, counting the number scientists and PhD employed to highly theoretical nature of real option valuation models in 21st century (Stewart, Allison, & Johnson, 2001).

With the increasing importance of intangibles, value estimation based on the market potential of intellectual capital has also been taken into consideration. These estimations are based on structural component (relational and IP assets) of intellectual capital. The human resource component of intellectual capital has been missing or not properly explained in the existing literature related to biotech valuation models. Therefore, this research focuses on the analysis of appropriate human resource that can maintain trilateral equilibrium in the golden triangle of biotech life cycle as explained by (Collingham, 2004). Human capital with high translation efficiency can only create the market value of other intellectual capital (structural and relational) to its full potential. Thus, this study aims in incorporating the human capital as an essential component of biotech valuation model.

1.5 Disposition

This dissertation work is organized in different sections. Section 1 deals with an introduction on life science company valuation, role of human capital in firm's value and the rationale behind this research that attempts to link the human capital with firm's market value. Section 2 briefly introduces the field of biotechnology product development pipelines, key value drivers in the biotech industry and different practices of valuation models. In section 3, key determinants of human resource factors are presented along with the better model for scoring human capital in biotech valuation was introduced. Section 4 discusses the research methods used in this study. Section 5 deals with the results of the questionnaire based study; presentation of findings, and also discusses the rational of using various parameters to compute the value of human resource factor. Some limitations and criticism to the developed models are also discussed in this section. Section 6 concludes the study with recommendation for further research.

2 THEORY

Valuation in life science is the hybridization of science and art. Here, biotechnology valuation deviates from that of mainstream economics and finance due to some inherent characteristics of biotechnology firms. The inherent characteristics of biotech companies can be better explored through the common language of product development cycles. Common language of product development cycle will enable various stakeholders to better understand this industry. Well defined path of product development will help financial community, collaborators, and licensors to value the product; helps the regulators to understand the pros and cons of the product; and helps the product developing start up Biotech Company to achieve their goals or to terminate the project. Based on the traits of R&D subjects, technological advancement, and characteristics of finished products, the financial community evaluates the product opportunity and makes investment decision (McElroy, 2004). The following Figure 1 represents the well-defined product development pipelines of biotech product.

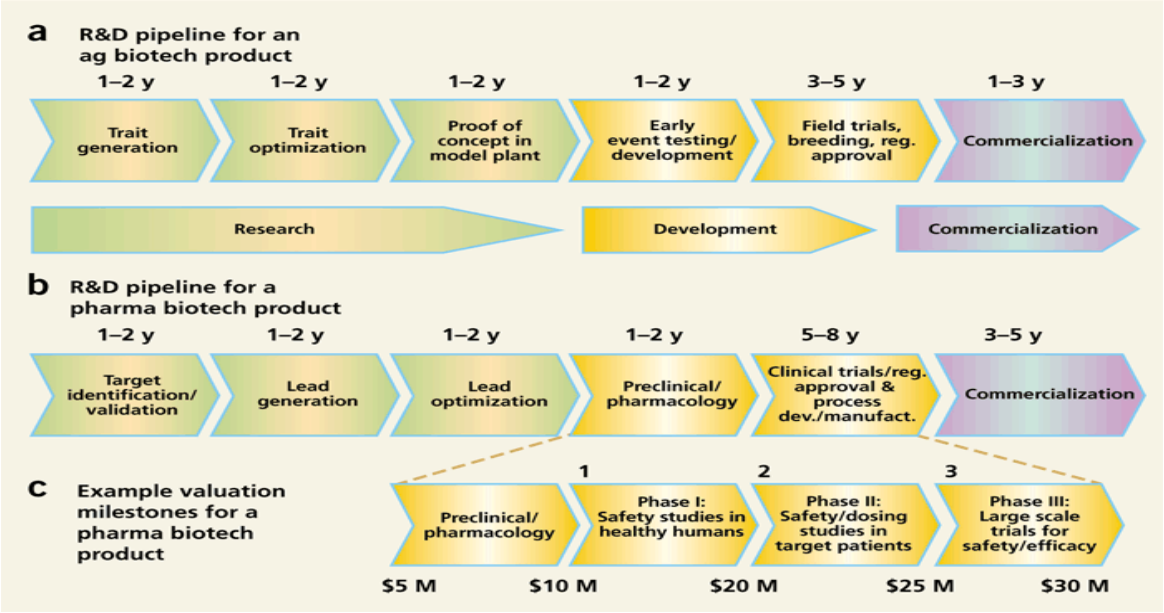

Figure 1: R&D pipeline for agriculture and pharma biotech product (McElroy, 2004).

2.1 Unique industry factors

Biotech firms are characterized by certain unique features that add complexity in valuation methodologies. Some complexities in valuating biotech companies include; high capital burn rate, lower survival index, uncertainty in input parameters, no availability of universally accepted

standard valuation methodology, interpretation etc. For biotech firms already having their product in the market, the valuation techniques can be applied with comparative ease. For newly developing firms, some complexities that need to be considered during the valuation process are as follows:

Lengthy period: Long time period from inception of seminal idea to regulatory approval and commercialization of product is unique to biotech industry.

State of pipeline: Number of products in the developing phase and their stage of development in product development pipeline determine the mortgage value of a company. Furthermore, Bratic, Tilton, & Balakrishnan (1997) have noted that any company, whose success and failure depends on only one product has a higher risk than company with diversified products in product development pipeline.

Burn rate: High cost in developing and testing new technology results into R&D costs and thus the high capital burn rate. Despite the higher burn rate, success rate of biotech companies is low (Ratliff, 2003). This indicates a higher risk for the investors.

Survival index: Smaller biotech companies have smaller survival index with minimum cash for R&D whereas larger companies have greater survival index and have more cash in hand to carry out lengthy and costly R&D phase.

Strategic collaboration: Clustering and strategic alliances are dominant phenomenon in a biotech industry which has positive effect to the biotech companies. Very few companies have cash in hand to complete their lengthy R&D phase and enter the commercialization phase. So, in order to sustain in R&D phase requiring the significant amount of capital resources, establish strategic alliance with larger companies can be an option. This feature of biotech firm makes the valuation process more complex (Bratic, Tilton, & Balakrishnan, 1997). Strategic alliance formation influences internal flexibility during R&D phase as well as in external flexibility during a commercialization phase (Jagle, 1999). This flexibility adds more complexity to the valuation process.

Changing technical, commercial and regulatory environment: National and international regulatory climate, competition on R&D, and market access often have some implications on the product pipelines of biotech companies. The changing environment increases the risk and that in

turn brings deviation in discount rates and success probabilities. Finally, it influences the valuation process, and the value of the company (Arojarvi, 2001).

Patents/ Intellectual property: Patent as the most important intangible asset has several implications in industrial dynamics. For example, it has positive impact on R&D activities and encourages innovation. Exclusive exercise of patent right provides market monopoly for limited duration which is the competitive advantage for firms holding patents. It affects the product life cycle and thus future cash flow. Thus, valuation depends largely on the market potential of patents (Arojarvi, 2001).

2.2 Literature on valuation

Valuation of a company is an indispensible part of company's life because valuation not only provides basic information for companies' deal with other partners for mergers and acquisitions but also forms the basis for economic value creation of the product or the company. Some of the common valuation methodologies that have been used in the field of finance and economics are based on balance sheet (book value, adjusted book value, liquidation value and substantial value), income statement (Value of earning, Value of multiples, Sales Multiples etc), mixed/ goodwill (Classic valuation method, Abbreviated goodwill income/Simplified Union of European Accounting Experts (UEC) method, UEC method, Indirect method, Anglo-Saxon Method/Direct Method, Annual Profit Purchase Method, Risk Bearing and Risk Free rate Method), cash flow discounting (based on free cash flow, equity cash flow and debt cash flow), value creation and options based methods such as real option methods (Fernandez, 2004). Decision tree method, binomial lattice and simulation methods are also used to provide more flexibility to DCF and Real Options valuation techniques (Bogdan & Villiger, 2010).

2.2.1 Income based approach in business valuation

Income approach is the most fundamental approach to valuation and is based on the economic principle of expectation. Primarily, it estimates the future returns of a business and then matches them with the risk associated along with the time. The value of a business lies in its intrinsic capacity of generating positive cash flow. This fundamental aspect of value is captured wisely by income based valuation approach (Flignor & Orozco, 2006). The value of a company is greatly driven by its potential higher financial return on invested capital and its potential to growth.

Thus, Koller, Goedhart, & Wessels (2010) have explained that the future cash flow projection depends upon possibility of its financial return and growth options potentials. Higher return and growth result in improved positive cash flow which in turn drives the business value. Thus, the cash flow measures the value of the company.

There are three major components of income based method for business valuation, cash flow projection, IP asset's economic life, and the discount rate equivalent to the investment risk along the time value of the capital invested. Income method is highly analytical as it is based on the future cash flow generating potential of present days IP assets (Flignor & Orozco, 2006).

Discounted Cash Flow (DCF) is a method for the valuation of an attractiveness of investment opportunity of the company. Valuation based on DCF is carried out by estimating all free cash flows for a given period and then discounting the associated risks to find the present value for the future sum. It depends on detailed, careful forecast of financial items related to the business operations for specific period of time. The discount rate determination remains one of the important tasks in DCF and depends upon the associated risks and historic volatilities (Fernandez, 2004). There are various models based on discounted cash flow. All these models result into a same value of a company when applied properly. Koller, Goedhart, & Wessels (2010) have classified these DCF based models into the following types;

- Entreprise Discounted Cash Flow,
- Economic Profit,
- Adjusted Present Value,
- Capital Cash Flow, and,
- Equity Cash Flow.

2.2.1.1 **Enterprise discounted cash flow**

Company's operating cash flow forms the basis for Enterprise discounted cash flow. In other terms, it is the sum total of equity value and debt value of a company. Valuing business or operations by enterprise cash flow involves three major steps which can be presented as follows:

- Analysis of company's historical performance: Return On Invested Capital (ROIC), Free Cash Flow (FCF), Net Operating Profit Less Adjusted Tax (NOPLAT), growth, competitive position, Intellectual Property (IP) assets

- Projecting free cash flows after defining company's operations and life of assets
- Discounting projected the cash flow with Weighted Average Cost of Capital (WACC)[1]

During the analysis of historical performance, it is possible to include illiquid investment from inside, but it is limited to rough guess for outside valuators. This limitation to outsiders is due to the fact that companies do not disclose discounted operations, excess real state, non consolidated subsidiaries and other non equity investments. Separation of operating and nonoperating assets is also advisable in order to make the risk of investment equivalent to the discount rate. When debt does not appear in the balance sheet, then the value of equity is overestimated which may turn into the company collapsing events (Koller, Goedhart, & Wessels, 2010).

2.2.1.2 **Economic profit based valuation model**

It is a performance based valuation technique where economic profit is obtained as the difference between revenues (ROIC) and cost, including cost of capital (WACC). WACC is the average of after tax cost of all components of capital structure of a company.

*Economic Profit = Invested Capital * (ROIC - WACC)*

US based multinational companies like Coca Cola, AT&T corporation evaluate and measure the management performance based on generated economic profit. Since this model relies on forecast as well as performance measurements, it can be the reliable valuation model for small as well as large scale businesses (Larrabee & Voss, 2013). Intrinsic value of a company lies in its potential to generate future cash flows. This potential is reflected through present performance. In addition to performance measurement, the economic profit model provides an insight about the way how the business can create value over a period of time, and investors future expectations are based on these values. Thus, it is also a management tool to assure the investors in their business (Koller, Goedhart, & Wessels, 2010).

ROIC and WACC are the key value drivers for economic profit. In saturated market, the ROIC will drop growth, becomes illusive and economic profit may be zero. This may drop the value of a company. For example, in early start up biotech companies, the net present value is negative

[1] WACC represents the weighted average of after tax costs of all financial resources of a company. These financial resources include; retained earnings, debt, common stocks, preferred stocks, and other different forms of equity. Weight on each source of finance is adjusted according to the risk associated with them.

and the intangible assets may not be able to generate the measurable cash flow despite their attractive market potential. In such situation, call option can be the better strategy to unlock future opportunities and attract further investment (Myers, 1977). Thus, Arojarvi (2001) has argued that this model of valuation is not feasible in case of biotechnology industry and emphasis on the valuation based on management flexibility and growth opportunities.

2.2.1.3 **Risk adjusted Net Present Value (rNPV)**

Future cash flows prediction with discount rate based on assumed constant WACC in Enterprise DCF and Economic profit model of valuation leads to another assumption that capital structure of a company is managed to a target debt to value ratio. However, more and more assumption in forecasting cash flows and little management flexibility may lead to distortion of real value. Though the capital structure of a company can be planned accordingly to manage the debt to value ratio, the process is complex and cumbersome (Koller, Goedhart, & Wessels, 2010). Thus, risk adjusted net present value can be the better option for company valuation.

rNPV adopts the same principle as DCF and the discount rate is adjusted based on the probability of occurring of specific event in product life cycle. NPV assumes that all the risks in cash flow forecast through discount rates but rNPV takes into account the probability of the cash flow to occur before discounting. In biotech and pharma industry, the project development phases are highly regulated and standardized. Furthermore, product development phases in the project are distinct with different probability for each phase to succeed. The probabilities are often called attrition rate or the success rate. Based on these success rates (though based on historical data) probability of success of each phase is multiplied to the cash flow and then appropriate discount rates are applied.

Steven Burrill, CEO of Burrill and Company, has given the real life cautionary explanation on valuation: “Notwithstanding the entire fancy math, the real way these tech companies are valued based on comparables…. the real life value is determined on the arm’s-length negotiation.” (Stewart, Allison, & Johnson, 2001). Despite this reality, Stewart, Allison, & Johnson (2001) belive on number game and argue that correct estimation lies on adequatly addressing the cost, risk and time inherent to product development. They emphasize on the fact that number game of valuation based on rNPV provides the rational basis for negotiation when the biotech entrepreneurs are approaching the venture community.

2.2.1.4 **Capital cash flow**

In free cash flows method of valuation, the interest tax shield are excluded from the cost of capital and thus, decreases the cost of capital when after tax WACC is used. Business involving highly leveraged transaction, capital restructuring, project financing from various sources results in capital structure. With the change in capital structure, the weighed average cost of capital has to be estimated. This leads to technical problems in implementation of free cash flow valuation method.

To overcome these risky cash flows, Ruback (2002) has proposed the capital cash flow method of valuation where, cash flow includes all the available cash including interest tax shield. He emphasized that, when the company manages debt-to-value ratio, free cash flow and interest tax shield are discounted at the same rate. Thus, the two flows, free cash flow and the interest tax shield can be represented by a single method known as capital cash flow (CCF).

The FCF and CCF method lead to identical result with proportional debt to value ratio but, Koller, Goedhart, & Wessels (2010) claim that FCF valuation is superior to CCF. This is because, leverage independent NOPLAT and FCF can provide a measure for performance and competition. This leads to better cash flow projection and thus better valuation results.

2.2.1.5 **Cash flow to equity valuation model**

Unlike WACC based valuation models, cash flow to equity valuation directly values the equity by discounting the cash flows at the cost of equity. It can be calculated by the following formula,

Equity Cash Flow = Net Income - Increase in Equity + Other Comprehensive Income

Equity valuation model is used in financial institutions where financing and operating activities are inseparable from each other.

2.2.2 **Asset based approach in biotech valuation**

Asset based method, often called as cost approach, relies on the economic principle of substitution. This approach estimates the value of a business by estimating the cost of recreating the relevant business of similar economic utility (Certified Business Appraisals, LLC, 2012). The basis for valuation for asset approach is the financial statement, the balance sheet. Business

Resource Services (2007) mentions four assets based approaches for valuing a business; book value, adjusted book value, liquidation value and reproducible approach.

Book value represents the net worth of a business obtained from the difference of total assets and total liabilities. It represents only the liquid assets and ignores the illiquid and thus book value remains far from the fair market value. The difference between assets and liabilities is the intangible assets and goodwill. In balance sheets they appear as cost incurred to obtain them. If it is not mentioned in the financial statements it needs to be adjusted in the book value to obtain the value close to fair market value. This adjustment results in the more correct and applicable valuation approach, the adjusted book value.

Liquidation approach in business valuation does not consider the value of ongoing companies. Thus, this approach is not commonly used in biotech valuation. Reproducible approach focuses on the cost of reproducing the fixed assets of the business. Thus, in real business world value obtained from liquidation and reproducible approaches represent the lowest threshold of the business value that the prospective buyer can pay (Business Resource Services, 2007). Furthermore, in biotech companies, very little value is often left inside the company when staff has left the company.

The above mentioned asset based valuation approaches that rely on balance sheet as its sole financial statement poorly incorporate the intangible assets and goodwill in the valuation process. Despite this fact, stock market values the biotech firm based on these financial statements (Hand, 2001).

The productivity of biotech firms are the outcome of investment functions particularly the R&D expenditure in combination with bio-technical man power involved. Bio-scientists and bio-engineers produce intellectual capital from R&D expenditure and translate the property to monetary form via sales, profit and equity market value. Thus, stock market value biotech firm based on financial statements with more emphasis on R&D expenditure (Hand, 2001). Higher the R&D expenditure in early stage biotech companies, higher will be their market value. Hand (2001) concluded that higher elasticity is observed in biotech firm’s equity market values when there is higher R&D spending in early stage R&D pipeline. The value elasticity decreases with spending in matured firms.

2.2.3 **Market based approach in valuation**

Market based approach, also referred to as transactional method, relies on the comparison of the subject business to similar business that have actually been sold. Economic principle of competition is the foundation for this approach as it looks for the recently established market values of comparable business in order to value the subject business (Certified Business Appraisals, LLC, 2012). Flignor & Orozco (2006) consider this approach of valuation as the most appealing and reliable method as it provides direct value for the intangible assets. Ensuring comparability remains the key factor to successful performance of transactional method. This method has limited applicability for valuing the small businesses because of scarce accessibility and reliability of comparable transaction from similar guideline businesses. Thus, screening and adjustment of comparable factors is like finding needle in a haystack (Dukes, 2006).

Institute of Management Accountants (IMA) (2009) has classified this approach of business valuation in three subcategories viz, Sales of stock in same company, Sales of similar companies, and Guideline companies.

2.2.3.1 **Sales of stock in same company**

Sometimes a company may sale its stock at certain price which can be a basis for valuation of the same company. Though this simple approach sounds good, many flaws may occur while valuing a company on the basis of sold stocks. It is because; it may not reflect the fair market value due to certain restrictive agreements, time and economic environment, minority interest and controlling interests etc.

2.2.3.2 **Sales of similar private company**

Data of similar private company may be available but one cannot ensure with confidence that all the transactions are disclosed. If sufficient information on companies intrinsic value drivers such intangible assets, scope are available, then adjustment in baseline transaction can be made to enhance the rationality of valuation approach. Adjustment may range from complex statistical modeling that uses the multiples to experience based subjective adjustment (Flignor & Orozco, 2006).

2.2.3.3 **Guideline companies**

Publicly traded companies within same industry or similar related industry have similar risk factors and similar value drivers, and thus can provide better valuation measures through the use of multiples (Institute of Management Accountants (IMA), 2009).

2.2.3.4 **Use of multiples in market approach of valuation**

A well executed multiple analyses can be helpful in comparing the companies' performance with its competitors, testing the plausibility of cash flows forecast and companies potential to create value than other counterparts (Koller, Goedhart, & Wessels, 2004). Many analysts use price to earnings (P/E) ratio to calculate their multiple and establish the fair market value of the company. However, Koller, Goedhart, & Wessels (2004) insist that deriving multiples based on P/E ratio can have many flaws even though identical companies are compared. This is because the P/E ratio mixes both operating and non-operating items. Thus, a carefully designed multiple analysis can only give us valuable insight on company value.

Growth along with the return in invested capital drives the multiples and these multiple drivers can be better represented as enterprise value-to-EBITA multiple (forward looking estimates). The algebraic expression can be presented as below;

$$\frac{V}{\text{EBITA}} = \frac{(1-T)\left(1-\frac{g}{\text{ROIC}}\right)}{\text{WACC}-g}$$

Where;

V= value,

T= Taxes,

EBITA= Earnings Before deduction of Interest, Tax and Amortization,

g= Growth Rate

ROIC= Return on Invested Capital

WACC= Weight Adjusted Cost of Capital

Koller, Goedhart, & Wessels (2004) have suggested the guidelines for best practice in deriving multiples. These guidelines are illustrated in Figure 2.

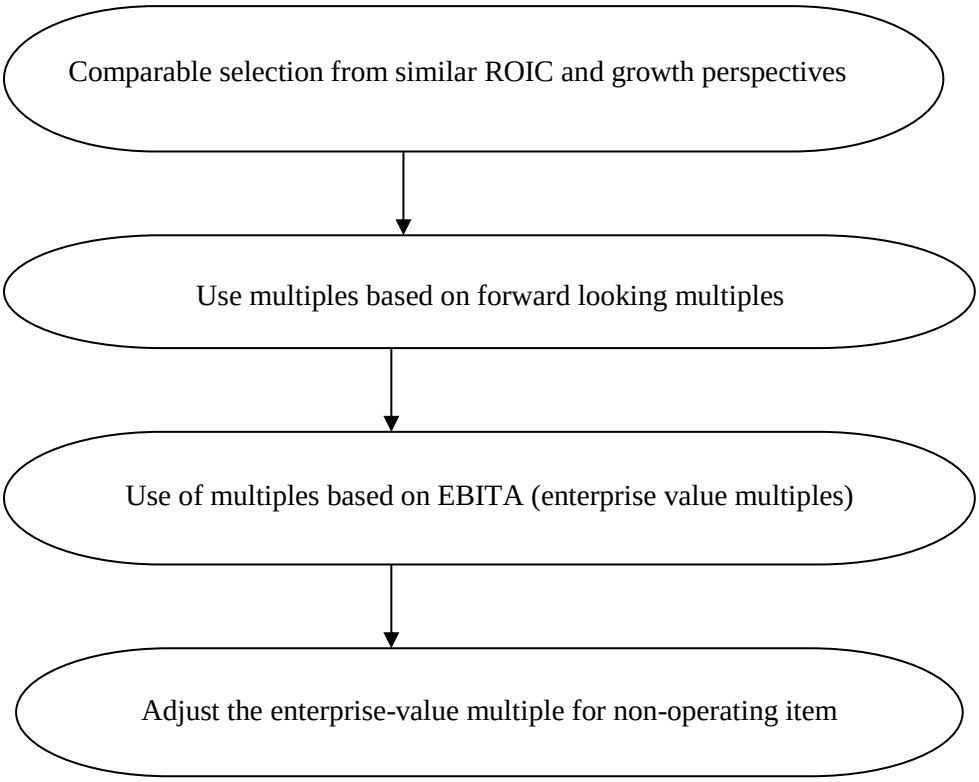

Figure 2: Steps for best applying multiples in market based valuation approach

2.2.4 Real options approaches

Traditional valuation methods are based on the assumption that projects meet their cash flow prediction, and managerial intervention has no or very limited role to play with any future risks. Managerial discretion and flexibility are not taken into account during the long life of a project (Trigeorgis, 1996).

"The basic inadequacy of the NPV approach and other DCF approaches to capital budgeting is that they ignore, or cannot properly capture, management's flexibility to adapt and revise later decisions (i.e., review its implicit operating strategy). The traditional NPV approach, in particular, makes implicit assumptions concerning an "expected scenario" of cash flows and presumes management's commitment to a certain "operating strategy"." (Trigeorgis, 1996).

Uncertainty underlying the future market development, regulatory frameworks, growth opportunities and value creation potential of IP assets in technology intensive companies are not addressed properly by traditional approaches of valuation. Discount rates and/or risk adjustments struggle insufficiently to manage the future uncertainty. Despite this fact, companies in biotech industries are often valued significantly high before they generate any sales even the company have highly negative NPV (Kellog & Charnes, 2000).

Real options valuation techniques are based on the assumption that not all the decisions of a company or a project occur at early stage of their life. It is essential to make some decisions in the later stage of company's life depending upon the techno-commercial environment. Thus, it takes into account the managerial flexibility. Managerial flexibility depends on the prudent act of the managers to maximize profit or minimize the loss and finally to increase the value of a company. Thus, Bogdan & Villiger (2010) have mentioned that real options consider flexibility as opposed to other traditional approaches, which have vaguely anticipated market conditions. It captures the market uncertainty and provides an opportunity for risk management to the managers through strategic thinking. The novelty of real options valuation lies in the conditioning of future decision as per the market condition rather than vague anticipation.

The managerial flexibility in real option valuation is offered by the following options viz., option to differ, option to switch, option to expand or contract, option to abandon or license, option to growth and option to stage investment.

According to Bogdan & Villiger (2010), these real options can be valued by four major methods; Formula based, Tree/Lattices, Simulations and Finite differences.

2.2.4.1 **Decision tree analysis**

Unaddressed uncertainty mounting on the cash flows based valuation approaches leads to the criticism on these traditional methods. Early stage biotech projects are full of expectation. According to Jagle (1999), technology intensive companies in USA have expectations' share up to 70% of total value of a company. Thus, making effective plan with high commitment of utilizing present resources to future action is essential for managerial decision that can meet the expectation. Today's decisions are directed by our future expectation and uncertainty paves the way of future decisions. Therefore, decisions should neither be made in isolation nor in terms of

sequence. Thus, for an effective long term plan, decisions are posed in terms of tree like fashion (Magee, 1964).

Decision Tree Analysis (DTA) tries to address the uncertainty of discounted cash flow and NPV based traditional analytical methods by allowing managerial flexibility in future events (Magee, 1964). This managerial flexibility is portrayed in a tree like fashion that resembles different paths for the life of the project. As a part of managerial flexibility, decisions are made at discrete points (nodes), and uncertainties are also resolved at these nodes.

DTA shows its efficiency over traditional approaches in its ability to incorporate managerial flexibility. However, more options at the nodes make the decision tree more complex. Trigeorgis (1996) called this complexity as bush tree analysis. Furthermore, use of constant discount rate throughout the DTA process even when uncertainty is reduced at nodes, is the major flaw of this valuation model.

2.2.5 Contingent claim analysis

The Contingent Claim Analysis (CCA) method was developed as an improvement over DTA where the constant interest rate is replaced by risk-adjusted interest rate. In CCA, real probabilities and risk-adjusted interest rate of DTA are transformed to risk adjusted probabilities and risk free interest rate which is independent of projects risk structure (Schulmerich, 2010). Flexibility, collection of options associated with investment opportunity, is also well captured by CCA than DTA (Trigeorgis, 1996).

2.3 Human resources and valuation in life science

A golden triangle composed of finance, management and intellectual property is considered as an essential component for a complete biotech life cycle. Each of these three components should complement each other for the sustainability of biotech companies. Every evolutionary stage of biotech life cycle needs different human resource, perhaps the renewal of board structure and also the functional human capital (Collingham, 2004).

The way by which intellectual capital lead to economic and market goals at enterprise level can be presented as follows in Figure 3.

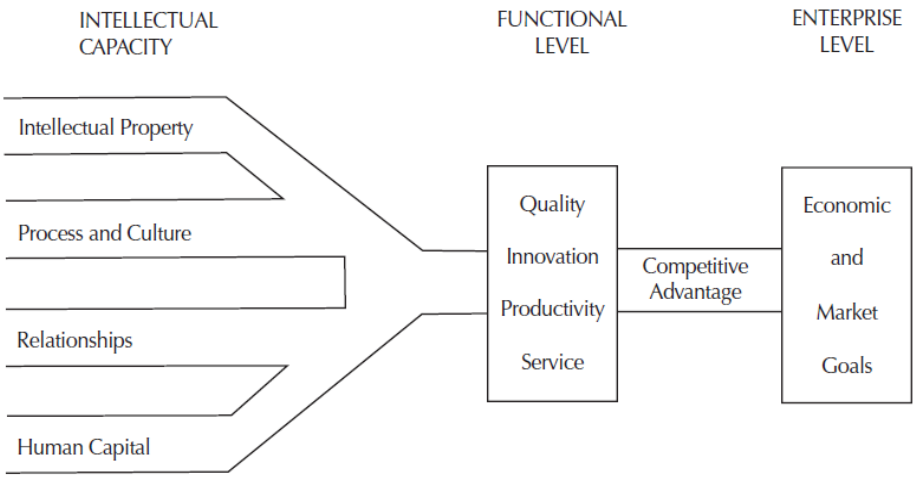

Figure 3: Relationship between intellectual capacity and market goals Source: (Fitz-enz, 2009)

As an essential component of the intellectual capital, human resource needs to be managed well. Being an elusive asset, measurement is not an easy task. To materialize the saying, "What gets measured gets managed," the human value in a company needs to be measured (Weatherly, 2003). With the advent of an era of innovation, the asset composition for a company has been changed. This change was reflected in terms of diminishing correlation between company's accounting/financial data and market performance. The increasing difference between society audit transactions and stock market performance also reflects the value of capital accumulated (Vărzaru & Stancu, 2007). Almost 80% of company's asset is human resources, intellectual properties and brand value; collectively known as intellectual capital. The intellectual capital is the key elements to create a holistic image of firm's hidden value. This dramatic shift of asset structure from its physical nature towards knowledge based abstract nature has created an issue of measurement of economic value of intangibles/intellectual capital including the human capital (OECD, 2006).

With the advent of human capital measurement issues, it was practiced to be included as assets in balance sheet. Reflecting the human capital in the balance sheets served for two different purposes, namely; supporting investors' decision and for internal decision-making process. This initial practice stimulated the emergence of two pioneer concepts of "Human Capital Theory" and "Human Relationship School". Two methods of human capital quantification; historical cost method and cost replacement method were also proposed. Since then cost of hidden

performance, cost of opportunity methodology, and behavioral cost in work have been proposed (Vărzaru & Stancu, 2007). In addition, human resource accounting, cost accounting paradigm, surplus distribution paradigm and performance potential paradigm are also some efforts in capitalizing human capital in valuation. However, models are silent about the freedom of managers as individuals and also ignore the uncontrollable nature of human asset. In other words, they ignore the social and personal aspects of human resources. The company can retain the human capital, but it does not own it (Vărzaru & Stancu, 2007). Therefore, human values/human capital can hardly be expressed in monetary terms as accounting parameters. However, they are the value adders which attempt to convert the subjectively projected hypothetical corporate value to real life value (Scholz, 2007).

Assigning a value to human capital has been a contentious issue in human resource economics. The Organization for Economic Co-operation and Development (OECD) council meeting at ministerial level has also mentioned that intellectual capital is essential for sustaining economic growth of a company but the value creation is an outcome of sum total of human resource reflected via managerial activities (OECD, 2006). Almost all present days CEOs emphasize human as the most critical assets for them in the era of the knowledge economy. Thus, Kaye (2012) argues that paradigmatic shift from goods oriented business models to knowledge based innovative and service oriented era of 21st century has challenged CEOs to materialize their rhetoric in language of accounting and finance. In an effort to convert rhetoric to practicality, various progresses in valuing human resources have been performed. Summary of these efforts is presented in Figure 4.

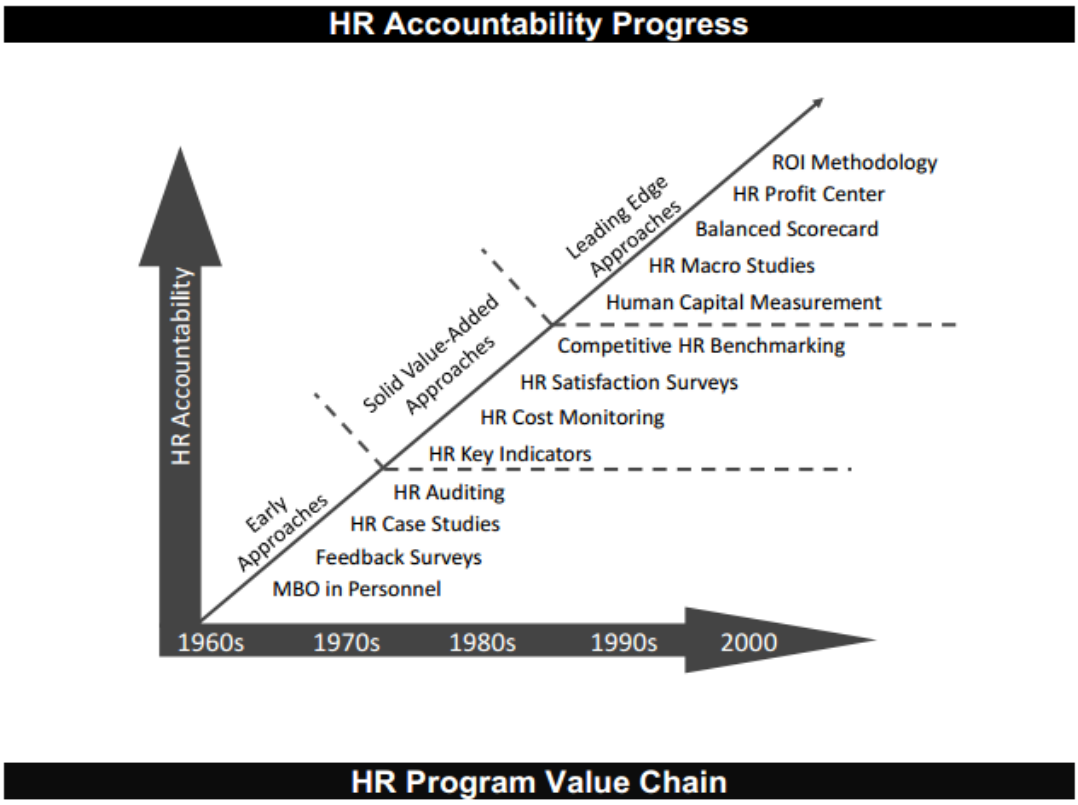

Figure 4: Progress pattern in human resource valuation Source: (Phillips, 2007)

3 HYPOTHESIS DEVELOPMENT

The biotech company valuation models developed so far have perhaps failed to incorporate perhaps the most important factor, human resource factor, which leads to a discrepancy in real market value and the results obtained by the use of existing formulae. Though various works in human resource economics have leveraged an effort to develop the human value measurement tools, their applicability is limited due to the subjectivity of the models that are based on complex measuring factors.

Value of a company is the outcome of total of tangible (physical assets) and intangible assets (intellectual capital).

Value (V_{bc}) = Tangible assets (T) + Intangible assets (I)

i.e., $V_{(bc)} = T_{(t)} + I_{(t)}$ ……. (1)

Where, bc = biotech company and t = total.

Intangible asset is an outcome of a complex interplay between relational capital or overall market, human capital (human resources, process and culture) and intellectual property (technology and traditional intellectual capitals such as patent, trademark, copy rights, license etc.). Traditionally, intangible assets were presented as sum of relational, intellectual and human capital as shown in equation 2.

Intangible assets (I) = (relational capital + human capital (including process and culture) + intellectual property (IP)) ...…….. (2)

This equation ignores the uncontrollable nature of human beings. A company can retain its human capital but does not own it. Therefore, the value of intangible assets of a company can be derived from accurate assessment of technology (product or service offered, license, copyright, patent etc), relational capital (customer preferences, suppliers, regulatory issues, brand value, competitors, emerging market trends etc) and the financial issues related to technology and relational capital.

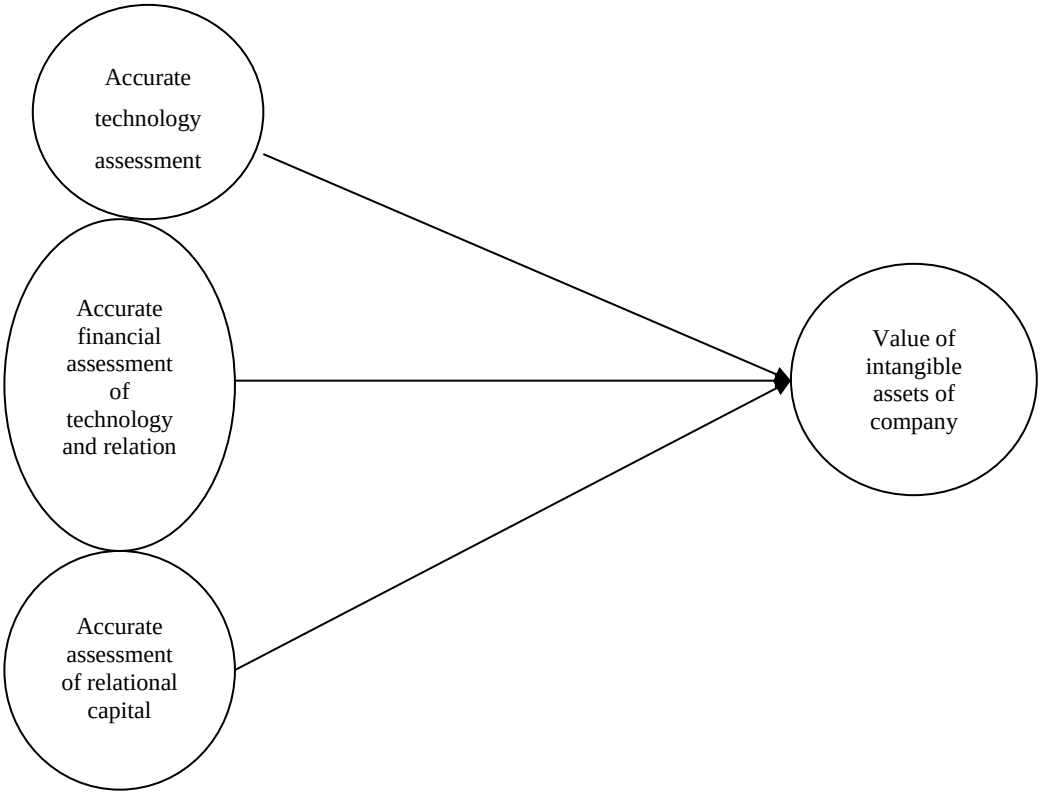

Figure 5: Components of intangible assets

Technology seldom sells by itself. It is not a solution but act as an enabler of human capacity and intelligence. On the other hand, translation of innovative technology to revenue requires efficient human resources. Thus, human are catalysts for technology and their offerings (Phillips, 2007). According to (Edvinsson & Malone, 1999), corporate value does not arise directly from any of its intellectual capital components (human capital, relational capital and intellectual property) but it is a complex interplay between these factors. No matter how strong are the two other factors, weakness of the third factor misdirects the mission and ruins the company value. Among these factors, the company owns the IP assets and relational/ environmental capital but human capital cannot be an asset. Human capital can be retained by the company but it cannot be owned. Human resources, especially those on upper echelons create the market through innovation, develop strategies with changing business environment, and finally translate those strategies to operational success (Bossidy & Charan, 2002). This operational success determines the firm's performance and finally the value of a company.

In this thesis, it is hypothesized that the intellectual capital translation efficiency of human resource of a company can be expressed in terms of human resource factor (hrf). The hrf can be a correction factor in an ideal value derived from the accurate assessment of relational, financial and technological capital. Thus, company valuation model can be diagrammatically expressed as in Figure 6.

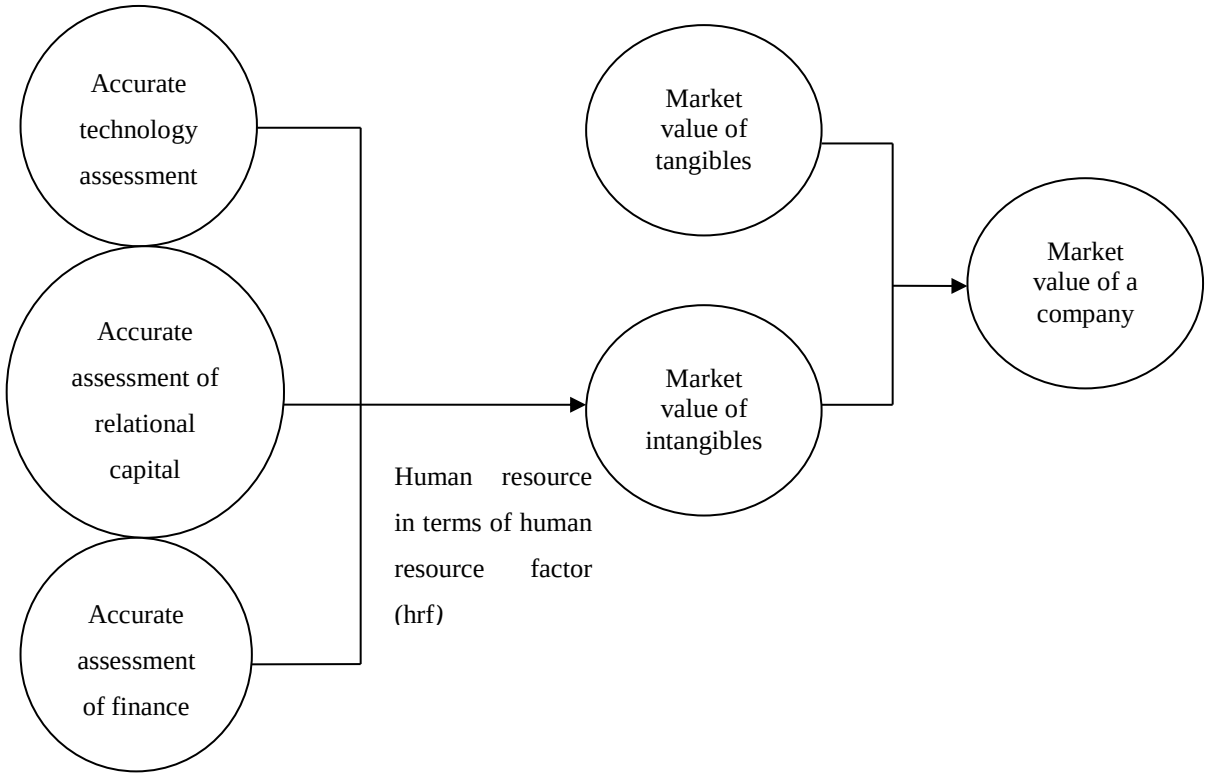

Figure 6: Diagrammatic representation showing relationship between various components of valuation with human resource factor

Mathematically, value of a biotech company as mentioned in equation (1) can be expressed as

$V_{(bc)} = T_{(t)} + I_{(t)}$

Or, $V_{(bc)} = \alpha T + \beta I$ .....(3)

Where, $V_{(bc)}$ = value of biotech company

β = hrf,

α = market function for tangible assets value,

T= value of tangible assets, and,

I = value of intangibles obtained from existing valuation models (for example, CCA model of valuation which consider intangible assets as an outcome of relational capital and intellectual property)

The market value of a company is a complex interplay between the tangible and intangible assets as shown in the Figure 7.

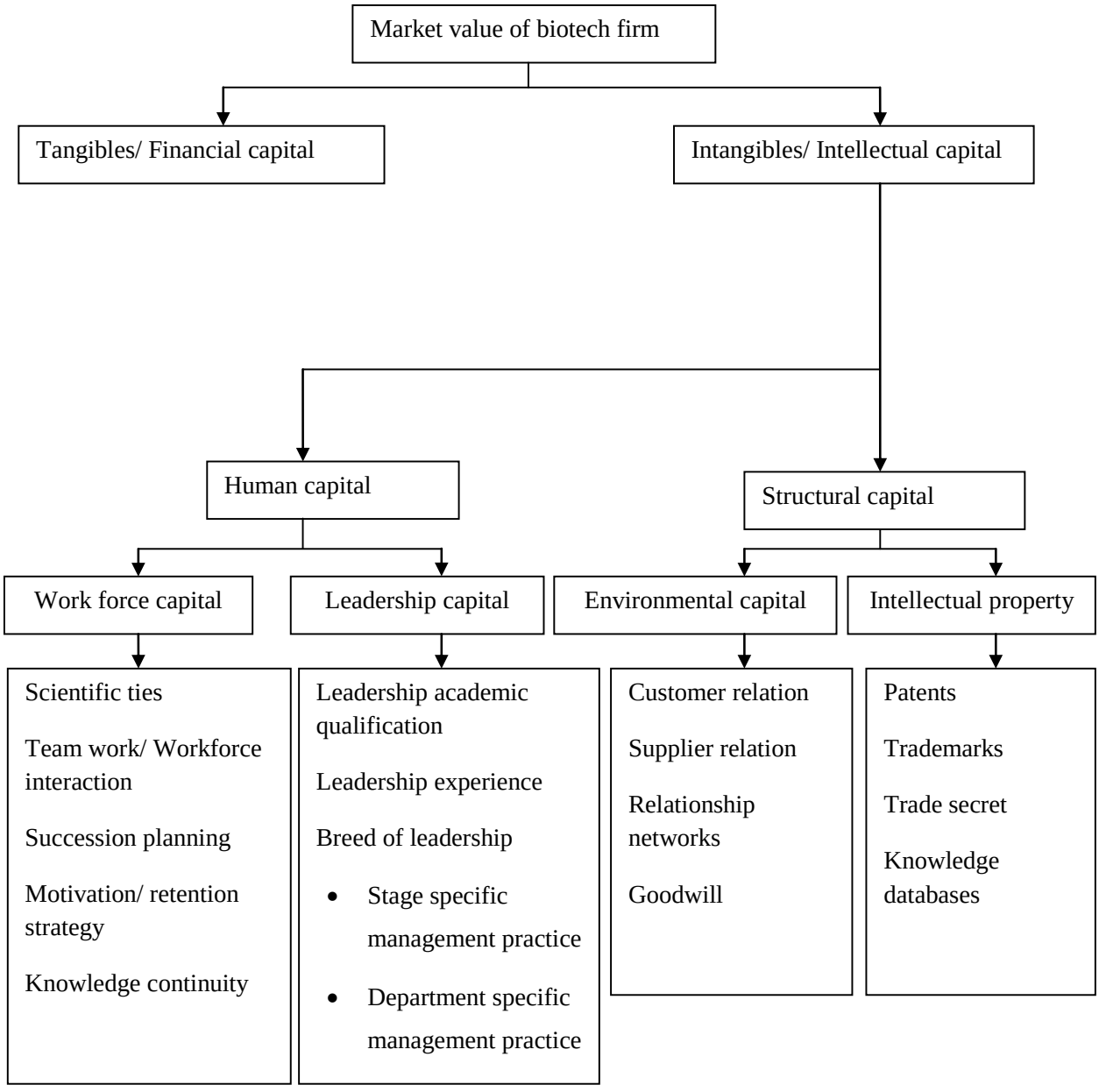

Figure 7: Diagrammatic representation of various components contributing to establishing the market value of human capital proportion of biotech firms

3.1 Human resource factor

The existing human capital of a firm is responsible for converting the market potential of firms' intangible assets to actual market value. Ideal human capital seldom exists in a business environment because of highly volatile and mobile nature of human capital. Thus, firm's intangible asset is rarely translated to market value in its full potential. In this thesis, it is proposed that translational capacity of human capital is expressed in terms of human resource factor (hrf) which is defined by firm-specific human resource indicators. The firm-specific human resource indicators for biotech companies proposed in this study include the following;

Leadership capital:

- CEO effect
- Breed of managers

Workforce capital:

- Ties with star scientists
- Knowledge continuity
- Succession planning
- HR interaction

3.1.1 Breed of managers

Knowledge and academic qualification in the field of science and management are essential for the successful management of the biotech company. Citing an example of Eli Lily and Company's success in scientific innovation, Powell (2013) argues that data drives the decision and direction; and scientists at the leadership position can drive innovation successfully. However, this may not be the universal case. In contrast to this argument, Smart (1998) emphasizes on the project development stage-specific human resources. He argues that the early stage biotechnology companies can be better managed by scientific leaders whereas the commercial stage company is better managed by experienced business managers. He further adds that many investors in the biotech industry fail by backing the technical people with great technological knowledge even in later stage of commercialization. Specific entrepreneurial ownership in a leading position highly enhances the human resource value of a company.

The managing director of Royal and Sun Alliance (RSA) Singapore, Laura Thomas, also analyze the attributes of Biotech CEOs and focuses on the three CEO phases of a biotech company similar to the stage-specific HR arguments of Smart (1998) (Thomas, 2009). She argues that there cannot be "one size fits all" CEOs in biotech firms. Fair degree of leadership specialization for specific development stages can only boost the firm value. According to Thomas, three different leadership qualities are essential for three different stages; 1) founder scientist with more scientific and technical staffs in early stage of a company (intensive R&D) stage, 2) second stage specially deals with later stage of clinical trials, market strategy development and IPO, therefore, CEOs with proven capabilities in marketing and fundraising through IPO are essential, 3) third stage specifically deals with production, commercial and stock market regulation where CEOs with prior experience in commercial pipelines and stock market regulation are essential for leading the biotech firm successfully.

In similar arguments to Laura Thomas and Smart, Andreas Foller points out that company's success is not solely determined by ideas and concept, but the management team plays a crucial role. He argues that European biotech firms remain un-stocked and have delayed consolidation as compared to that of United States. This bigger difference between these two is the management practice; development stage-specific management practice in US and the Europeans are lagging far behind in this matter (Föller, 2002). Figure 8 illustrates the change in human capital needs with growth phases of biotech companies.

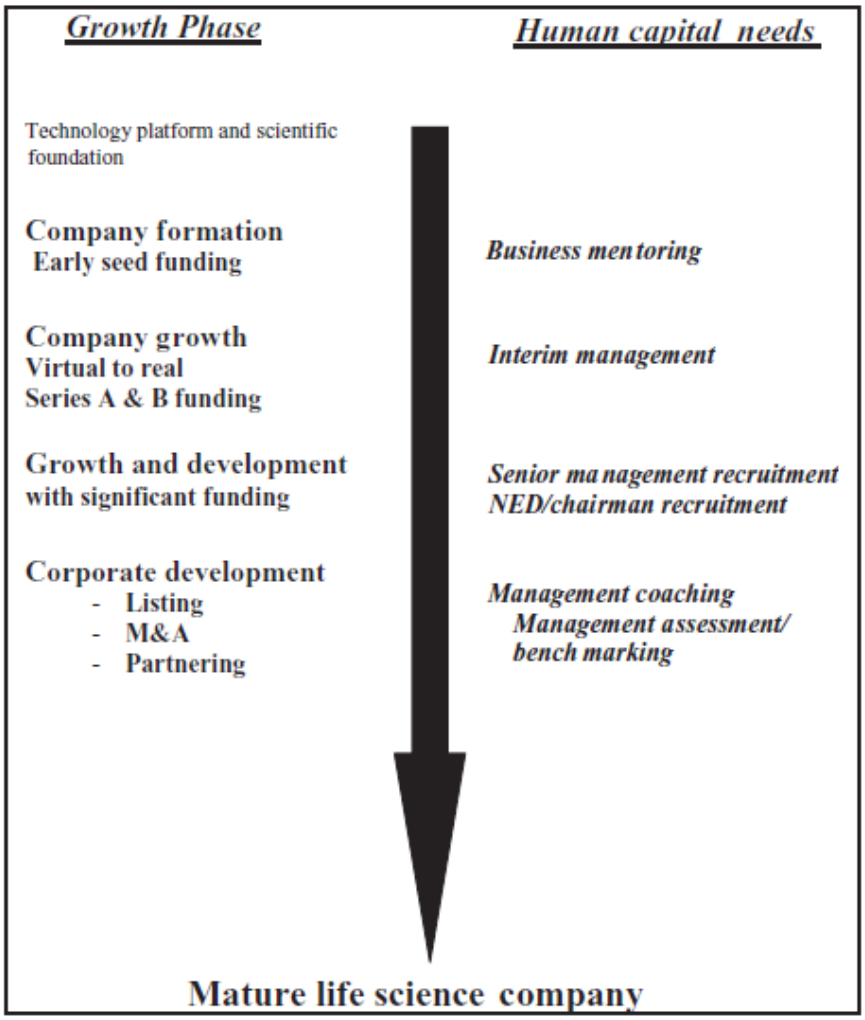

Figure 8: Human capitals need changing with growth phase in the biotechnology company Source: (Collingham, 2004)

3.1.2 Ties with star scientists

Firms having ties with star scientist have higher chances of R&D breakthrough for valuable commercial product and thus have a direct influence in firm's market value. In an effort to determine the effect of intellectual human capital on firms' market value, (Darby, Liu, & Zucker, 2009), found that market value of a firm with an article written by its star scientist increases by 7.3% as compared to its counterparts. However, there exists a concave relation between the ties

and the probability of innovation. Darby, Liu, & Zucker (2009) have expressed this concave relation via mathematical expression as;

$X = \text{ties}^{½}$.

Where, "X" represents the probability of innovation and "ties" represents the number of scientific staffs (intellectual human capital) of a biotech company.

This equation reflects the decreasing effect of firms' intellectual human capital on technological innovation with increase in star scientist ties. Darby, Liu, & Zucker (2009), explain this phenomenon as diminishing marginal product. The innovation has a direct positive relation with the value of a company.

Joint collaboration between firm scientists and star university scientists improves the firm technological performance provided that they have joint research collaboration for innovative technological breakthrough (Colen, Belderbos, Leten, & Kelchtermans, 2014); (Zucker & Darby, 1995). However, Colen, Belderbos, Leten, & Kelchtermans (2014), have also suggested that it is a real managerial challenge to convert the innovative challenge to its full potential. This collaboration also has the competitive implications. Zucker & Darby (1995), have found that collaborative research publication between firm scientists and academic stars is a key determinant about where and when the firm started with that technological innovation. Through their descriptive research about the virtuous cycle of productivity in bioscience, they have found that for every 9 joint article publications, there will be 3 product in development pipeline, 1 in market and more than 1500 employees employed.

Collaboration of firm scientists with star scientists enhance the knowledge transfer which in turn stimulate technological innovation. Greater the stimulation towards technological innovation greater will be a patent application applied by the firm. In addition to this, core scientists/star scientists working in the biotech firm laboratory also increase the firms absorptive capacity (Furukawaa & Gotob, 2006; Sedita & Shichijo, 2008). In photocatalyst sector, higher R&D productivity, higher absorption and greater experience has been observed when firm scientist have collaborative research with star consulting scientist and consulting scientist. Furthermore, impact on R&D productivity (expressed in terms of number of patents/ patent applications) is double when the collaboration is with star consulting scientist in comparison to consulting

scientist (Sedita & Shichijo, 2008). From IPO perspective, the probability that non-public firms go public increases with their science base, i.e., the quality of a science base of the firm determines its probability of going public. This probability in turn depends on the tie with star academic scientists (Darby & Zucker, 2002).

3.1.3 Knowledge continuity

Knowledge depreciation prevention

Exponential growth of the commercial field of biotechnology has made the technological capital under immense competitive pressure. This competitive environment has made the R&D investment riskier. Like all knowledge capital, technological knowledge capital can be gained or accumulated as well as depreciated. Knowledge capital in the technology sector is gained from two major activities; "learning by doing" and "learning by searching". Here, Grubler & Nemet (2012) refer "learning by doing" activities like production and market deployment and "learning by searching" activities as firms R&D activities. They also argue that knowledge gained from experience is more susceptible to depreciation than scientific knowledge obtained from systematically organized experiment, peer review and dissemination.

Further, knowledge capital is not traded in secondhand market, thus Hall, (2007), argues that depreciation has a serious effect in rate of return on R&D expenses and finally to the market value of the firm. Knowledge depreciation rate varies from as high as 95% in the service industry to an average depreciation of 20-40% and knowledge depreciation of biotech and pharma varies from 15-20% (Hall, 2007). In a similar study, Grubler & Nemet, (2012) pointed out that high staff turnover and rapid technological obsolescence are the major events that leverage the knowledge depreciation rate. Thus, they suggest for stable gradually rising trajectory of R&D is essential rather than the boom and bust cycles for constant recharge of knowledge in order to combat depreciation. Policy support is also essential to mitigate the high staff turnover rate. In addition, training, workshop, conference and internship, public disclosure through scientific papers and patent application are also essential for preventing the technological knowledge depreciation.

Motivation and incentives

According to agency theory, firms' employees act in the interest of its shareholders. To maximize the interest of shareholders, firm can adapt various mechanisms. Among these mechanisms, incentive schemes that reward the executives financially are the most prominent ones. Furthermore, shareholders do not have complete information about the firm and the executive courses of actions are not completely observable to the shareholders. In such situation, providing best incentive package to the executives in order to take desired course of action that favors shareholders interest is the only solution. These incentive schemes are based on the belief that firms profit are the function of managerial efforts (Coles, McWilliams, & Sen, 2001). Among these incentive options right to purchase the share of the firm is gaining importance. As the executive ownership increases in a firm, the executive actions are directed towards maximizing the firms' value. This results in a closer alignment between the outside shareholders and the firm executives (Smith, 2008).

While examining the manufacturing firms' executive compensation structure, Mehran, (1995) found that incentive compensation is a good motivator for the firm leadership to increase firm value. His research also found that the form of compensation rather than the level of compensation have higher degree of motivation. Highly R&D intensive, highly volatile and highly competitive firms exercise stock option as one of the most effective strategies for highly valuable employee retention. Lin (2009), in his study about stock options and their design in Taiwanese firm has discovered that larger and profitable firms that have high market to book ratio grant stock options to valuable employees. Furthermore, the study showed negative relation between R&D intensity and volatility with the retirement. Designing low valued stock options for retiring employees deters retirement and thus enhances the retention. Pasternack & Rosenberg (2002), while studying "the impact of stock option incentives on investment and firm value", have found that it has the significant impact on firm value. They emphasized that stock options incentives are used as executive remunerations to align the interest of managers with those of shareholders.

Michael Francisco in his article "Rising compensation for Biotech R&D officers" present the annual direct compensation packages from Bio world executive compensation report 2013 (Francisco, 2013). The annual compensation packages for biopharmaceutical executives were as

follows; long term incentives (41.1%), attractive salary (43.85%), payment bonus (12.76%) and other types of incentives nearly 1% (Francisco, 2013). These figures also emphasise the importance of long-term incentives such as stock options and equity-based option to align the executive interests with that of shareholders in order to maximize the firm market value.

During the comparative study on Private Equity (PE) firms and public companies, Leslie & Oyer, (2008) have documented that PE firms use stronger incentives for their top executives, and have higher operational profitability and higher efficiency. Quantitative assessment from comparison showed that EBITDA/Total asset of PE-owned firm was one-seventh higher than the comparable public firm. This is because PE firms increase the value of a company by increasing the management through incentives, improved governance and greater disciplines (Leslie & Oyer, 2008).

3.1.4 Succession planning

Sustained excellence in CEO succession with seamless transition usually results in better performance of biotech firms. Succession planning is an important tool of the overall process of corporate governance, but many corporate giants lack in action on succession planning within their firm despite their interest. A survey conducted by Korn/Ferry Institute over corporate leaders revealed that nearly 98% of the corporate leaders consider succession planning as an important tool in corporate governance but only 35% have such plans (Korn Ferry Institute, 2010). Succession planning is not in the priority of many companies because of poor dynamics between CEOs and board of directors, lack of well-defined responsibilities or unavailability of CEO ready talent within the company. But, more importantly the personality, power, ego and mortality that lies at the heart of succession planning (Cascio, 2011).

Succession planning usually focuses on the internal candidate. Sometimes, when the board feels that a change is essential than continuity or when things are not going well, the board of directors seeks for the outside successor. Findings by Falato & Kadyrzhanova, (2012) showed that the outsider CEOs have better performance by 4% excess return. Addressing this issue, Khurana & Nohria, (2000) mentioned that the process of CEO turnover is a dual process of succession and precession which cannot be viewed independently. Furthermore, these events can be natural or forced process. The firm performances differ according to the nature of the event. Forces

turnover followed by outside succession increases the firm performance by 4.4% whereas, natural turnover followed by outsider succession results in declining the performance by up to 5.8%. However, forced succession followed by insider and natural turnover followed by insider has insignificant change in firm performance (Khurana & Nohria, 2000).

Improvement in firm performance after outsider succession is temporary. The outsiders think that they are not bound by social contract with employees. So, they make some bolder short term change and may avoid key peoples, are good at cost-cutting and divestment. These activities may lead to dry up the opportunities and is the way towards disruption of the firm (Steingraber, 2011). However, recruiting the outsider may lead to loss of senior executive that means the loss of knowledge (Cascio, 2011). Greater cost in acquiring firm-specific knowledge, greater settlement time for the outsider, lower the incentives to perform for the insiders as the path to promotion is hindered (Naveen, 2006). Thus, the outsider successor may benefit the firm operation but a subsequent loss of senior executives may outweigh any gains that come from hiring the outside successor. Firm with greater complexity in operational activities should groom internal candidate for the succession in order to avoid the high cost of knowledge transfer and expertise to the outsider (Naveen, 2006). Furthermore, Volery, Doclo, Munton, & Sheaand (2007) have mentioned that high-risk ventures have more career risk, and it is difficult to find the appropriate human resources. Thus, home grown CEOs with a seamless transition has been proved to be fruitful in the biotech giant Amgen (Gordon & Philip, 2009).

In an effort to find a solution about this pressing question of succession, Steingraber (2011) with Kelley, School of Business examined the leadership of 500 Standard and Poor's Financial Services LLC (S&P) firms[2]. They measured the performance in 7 different metrics which cover productivity, growth and margin. They found that 36 non-financial S&P firms which cover 25 different sectors were continuously leading the list with average productivity of 13%. They have also claimed that no outsider CEOs surpass this number for 20 years in these non-financial S&P 500 companies. Thus, they attribute this success to the home-grown leadership (Steingraber, 2011). This finding was also supported by the evidence from McDonalds and Apple CEOs

[2] S&P is a USA based financial company well known for its financial services. It regularly publishes the financial research and analysis of stocks and bonds of 502 US companies and lists these companies as per their value (more valuable companies are given more indices).

insider succession where the share price has increased steadily after their announcement that they are working on insider succession planning (Adams, 2012).

3.1.5 Human resource interaction effect

Human resources operate as in different departments as separate organic units. Thus, practice of team work, interdepartmental communication and knowledge exchange is essential for enhancing the value of human resources. Deep level diversity, surface level diversity, face to face meetings also has a significant impact on firm performance (York, McCarthy, & Arnold, 2009).

Furthermore, the inseparable tie between freedom to work and financial accountability of human resources in Biotechnology Company encourages the practice of organic life within the company. The small, redundant units have a freedom to operate to meet their targets while ensuring the survival of the company as a whole increases the probability of innovation. This finally leads to higher market value of a company (Li & Halal, 2002).

Interaction of various parameters such as technology, firm's age, diversity in employee and management, functional heterogeneity etc. resulted in 7% variation in market performance as a result of productivity and sales growth (Amason, Shrader, & Tompson, 2006).

3.1.6 CEO effect

Decision making and strategic actions determine the move that finally paves the way towards the achievement of the overall goal of the company (Matvieiets, 2012)**.** The CEO is considered to be the final individual to make decisions and take strategic actions and thus drives the company towards specific goals. Thus, quality of CEOs affects the strategic actions, financial performance and finally the value of a company. Higher qualities CEOs have proper knowledge of industry value chain and profitability. Thus, they choose better projects, implement them effectively, maintain a balance between debt and equity, and finally lower the cost of capital of the company. These actions of quality managers convey the intrinsic value of the firm to the market that results in better IPO performance and also higher valuation of a company (Rakhmayil & Yuce, 2013). Mackey (2008) adopted a new methodological approach to determine the impact of CEOs on firm performance and found that CEOs have the substantial impact (about 30%) on firm

performance. Further, he found that CEO effect was found to be more influential than industry effect and corporate effect.

Qualification

According to Matvieiets (2012), CEOs education is among the list of drivers that leads the company and the shareholder towards the better wealth. While studying the effect of education and experience of senior executives on firm performance, Rakhmayil & Yuce (2008) found that not only the MBA degree of executives but also the university form which they are graduated affect the firm valuation while adjusting the firm age and industry effect as constant.

MBA degree holders seem to follow short term goals, stability-oriented and have better financial performance while the technical executives are found to have higher stock return by about 4.69% but the performance is rather volatile. Furthermore, citing the findings from Kaplan (2007), Cimerova (2012) has mentioned that interpersonal skills (soft) skills are overvalued while hiring the senior executives but the executive skills (hard skills) which are the outcome of qualification and experience matter in company success (Cimerova, 2012)

Experience

In a cross section study of expansion stage companies, Hutzschenreuter & Horstkotte (2013) found that international experience and experience of teamwork positively moderate the cultural differences and firm performance which finally lead to improved firm performance. CEOs' diverse experience reflects diversity of CEOs' skills and capability to bear and manage risks. In words of Ryan & Wang (2012), this attribute is known as the general human capital. This general human capital improves the firms that are experiencing revenue shock and poor stock performance. Thus, diverse experience of CEOs is helpful in increasing firm value and firm performance of those firms that has performed poorly and need the strategic directional change. They attribute this positive change in firm performance by diverse experienced CEOs is by changing the firm policies (Ryan & Wang, 2012). Economics and MBA degree holder CEOs are more growth oriented and have less volatile firm performance. Leadership with higher technical education has more volatile firm performance.

3.2 Introduction of the model

Human capital creates economic value of a business firm through the application of set of skills, intelligence and know-how. As mentioned in section 3.1, breed of managers, star scientists,

knowledge continuity, succession planning, HR interaction, and CEO effect are the most important indicators of human capital in a biotech company. In this thesis, these indicators are used to define the human capital. The following model is introduced to define the human capital in terms of hrf (β).

$\beta = X_1 V_1 + X_2 V_2 + X_3 V_3 + X_4 V_4 + X_5 V_5 + X_6 V_6$

Where, X_1.....X_6 represent the constant for the variables V_1……V_6

V_1= Breed of managers

V_2= Ties with star scientists

V_3= Knowledge continuity

V_4= Succession planning

V_5= Human resource interaction effect

V_6= CEO effect

4 METHODOLOGY

4.1 Content analysis of valuation models

Literature review for different practice in valuation models was performed to identify the various issues, trends, best practices and shortcoming of existing valuation models. Content analysis of income based, asset based, market based and real options approaches was performed. Content analysis revealed that the human resource factor was found to be lacking in these models which made these models incomplete.

4.2 Identification of indicators for human value factor

Biotechnology industry specific human resource indicators were identified which are presented in two specific headings

- ✓ **Leadership based indicators**
  - CEO Effect (CEO Qualification and Experience)
  - Breed of Managers (Stage Specific Managers)
- ✓ **Work force based indicators**
  - Scientific ties
  - Human resource interaction effect
  - Succession planning (human resource source and succession)
  - Knowledge continuity (knowledge prevention strategy, knowledge continuity and motivation/ retention strategy)

4.3 Assigning weight to each human resource indicators

Each indicator is given a specific weight measured in terms of percentage. The weight assigned is partially based on already established numbers as specified by previous researches and partially as hypothesis based on literature available. Mackey, (2008) has mentioned that nearly 30% variance in firm performance is atributed to CEOs and this effect is considered to be more important that industry effect. Similarly, interaction of various human resource related factors such as functional heterogeneity, management diversity, personal communication and interaction, technological changes etc explain 7% variance in firm performance as explained by profitability and market performance (Amason, Shrader, & Tompson, 2006). Darby & Zucker, (2002) have mentioned that star scientist can have 7% impact on variance in firm market value

through the publication of an article. Percentage variation in stock market performance of well established companies like Hewlett Packard (HP) and Bank of America was largely attributed to succession planning (Steingraber, 2011). This forms the basis of assigning weight to effect of succession planning on human capital.

Preventing knowledge depreciation and retention of key employees are the two major aspects of knowledge continuity. Since knowledge is major capital for technology intensive industries like biotech industries, firm value depreciates along with the depreciation in knowledge. Application of strategies for preventing knowledge depreciation prevents the depreciation of firm value (Hall, 2007). This forms for the basis of assigning weight for knowledge continuity.

Breed of managers is biotech firm specific indicator newly introduced in this study. Though, no numerical data are available, previous research by Föller, (2002), Smart, (1998) and Thomas, (2009) forms the basis of assumption that breed of managers have 15% effect on human capital of biotech firms. Table 1 summarizes the source of literature that supported the weight assigned to each human resource factor indicator.

Table 1: Assigned weight for different human resource indicators

S. No.	Indicators	Weight Assigned	References
1	CEO Effect	30%	(Mackey, 2008)
2	Star Scientists	7%	(Darby & Zucker, 2002)
3	Motivation And Retention	13%	(Leslie & Oyer, 2008)
4	Succession Planning	13%	(Steingraber, 2011)
5	Knowledge depreciation and Prevention	15%	(Hall, 2007)
6	Human resource interaction effect	7%	(Amason, Shrader, & Tompson, 2006)
7	Breed of Managers	15%	(Smart (1998); Thomas, (2009))

4.4 Development of scorecard model measuring human resource factor

A linear scorecard model for measuring the human capital in terms of human resource factor is introduced in this thesis as follows;

$$\beta = 15\%\ V_1 + 7\%\ V_2 + 28\%\ V_3 + 13\%\ V_4 + 7\% V_5 + 30\%\ V_6$$

At the same time can be argued that this model is relevant as a component for valuing the actual market value of a biotech company.

4.5 Questionnaire

Three different types of questions were included in a set of questionnaire. It consists of the following:

- Yes/No questions,
- Opinion questions (answers are expressed in Likert Scale[3]) and,
- Open format questions (information that cannot be obtained through Yes/No questions and Likert scale is presented through open format questions.

The questionnaire developed for the purpose of collecting data is given in APPENDIX I

4.6 Data collection via questionnaire-based interview

Information regarding the human resource of a company is often regarded as confidential. So, the response rate would have been insignificant if it had been performed via mail questionnaires to thousands of respondents. Furthermore, technical nature of some indicators introduced in this model is new to the respondents. So, appropriate and precise answer could only be an imagination. Therefore, a 40-50 minute long interview based on the set of questionnaire was performed with Senior Executives (especially CEOs) of five Norwegian Biotechnology Companies located in Hamar and Oslo. Selection of companies was done in order to cover the representative of different stages (early stage biotech companies and commercial stage biotech companies), different field (plant breeding industry, blue, green and red biotechnology companies) of biotechnology industry.

[3] Likert Scale is a rating scale used for scaling responses in various types of survey research.

4.7 Data analysis and interpretation

Answers obtained from questionnaire-based interview were used to compute the efficiency of a company in each of the indicators that determine the overall human resource factor. For that purpose, certain assumptions were made.

- Yes/No questions: For each yes/no question; 1 or 100% is assigned to “Yes” answer and for” No” answer 0 or 0% was assigned.
- Opinion questions: Opinion questions were expressed in 1-5 likert scale. The score in likert scale was converted into corresponding quartiles. 1=0; 2=25%; 3=50%; 4=75% and 5=100%.
- Open format questions: Answers obtained from open format questions were used to derive the conclusion to certain attribute or parameter. For example, education of CEOs was expressed in different levels. Higher level of education was given higher value and lower level is given lower value as other answers in Likert scale. In another example, CEOs graduating from top 100 universities (according to times higher education ranking) is given 100% score and no score for others.

4.8 Presentation of findings

The findings from the interviews were presented in tabular form. Furthermore, sensitivity analysis was performed to see the impact of indicators on human resource factor.

4.9 Sources of errors

Use of novel and technical terms might be misunderstood by the respondents and there could be the probability of obtaining incorrect information. To avoid the probability of such error indirect questions were used to derive the inference for such parameters (for example, breed of managers, succession planning).

5 RESULT AND DISCUSSION

This section presents the findings from questionnaire based interviews. Human resource practice and status of human resource indicators, as proposed in the model are discussed. Human resource capacity of companies under study is calculated from the indicator values and presented in terms of human resource factor (hrf).

5.1 Breed of managers

Biotech industry straddles on two distinct and independent disciplines viz., science and commerce. This nature of biotech industry places unique demand on executive characteristics. The management of biotech industry needs to reconcile research primacy with urgency in market profitability. Imitation of managerial styles from other corporations does not work. Although many managers are sufficiently intuitive enough for leading biotech industries, formal/academic learning can simplify this daunting task. Thus, breed of managers with mastery in science and commerce will leverage the firm competitiveness.

During this study, all the five companies were found to be practicing the stage-specific management. The management practice in terms of breed of managers has the following effect on hrf. Findings on effect of breed of managers on human capital are summarized in Table 2.

Table 2: Effect of breed of managers on hrf

S. No.	Company	Indicator value	Percentage contribution to hrf
1	A	100	15
2	B	100	15
3	C	100	15
4	D	100	15
5	E	100	15

Among the five companies interviewed, four of them are in commercial stage and are managed by managers with commercial background where one company was in early stage of its clinical trial managed by scientist. All commercial stage companies have their products in the market and also have their products in product development pipelines. Company C has highest number of

products in market (>15) followed by B (10-15), C (6-10), E (<5). Company C has more than fifteen products in its product development pipeline while all other have 1 to 5 products in their pipelines. In addition, the commercial stage companies have well-organized departments to conduct their specific activities of R&D, marketing (national and international), finance etc. Company D is in early stage of operation and still has a long way to present itself with specific departments. Furthermore, two companies, A and E were established with the R&D outputs from their parent organization. They entered directly into commercial phase with well experienced managers and continuing the own R&D activities.

This, practice of management is in line with stage-specific management practice put forth by (Föller, 2002); (Thomas, 2009); (Smart, 1998) and (Parker, 2001). In early stage companies, founders, especially the scientists, are in the management team because of lower need of management sophistication, greater focus on successful R&D process and getting intellectual property of broad scope and value. However, with an increase in complexity of the organization firm need the managerial sophistication and thus managers lead the commercial stage well.

Supporting this idea of stage-specific management, Föller, (2002) further stressed that European biotech sector falls behind US biotech sector as the founder CEOs are considered potential to lead the operational stage of a company also, which is far away from the reality. In contrast to his argument, this pilot scale study finds the practice of stage specific management in Norwegian biotech sector.

For better market performance, these companies should practice a detailed stage-specific management practice in each stages of their product lifecycle, where, stage specific management resembles the breed of managers in a company. For this practice, managerial succession with stage of product in the pipeline is an essential activity. Figure 9 presents the diagrammatic illustration of managerial changes necessary with age of Biotechnology Company.

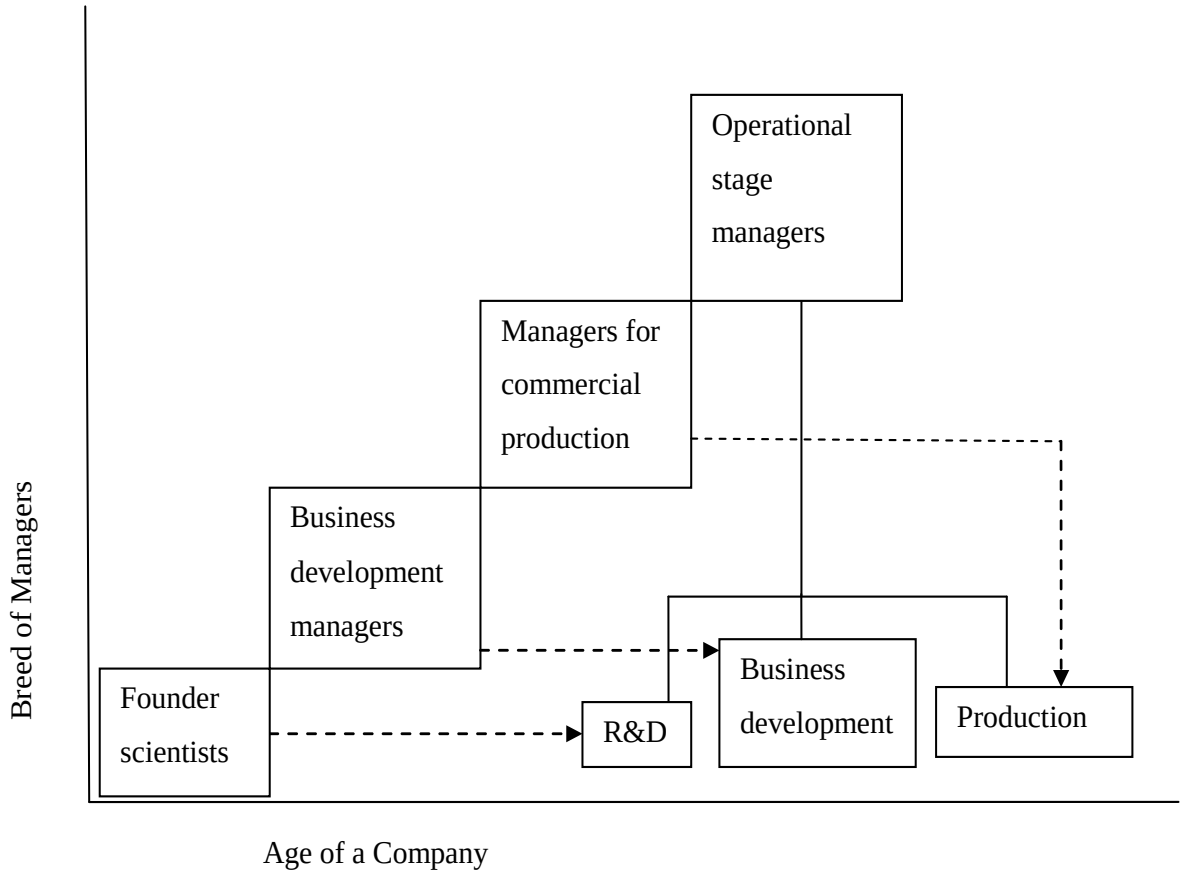

Figure 9: Necessary managerial changes with age and development stage of Biotech Company

5.2 Ties with star scientists

As mentioned earlier in section 3.1.2, quality of scientists and scientific ties, frequency of research publication, research collaboration, and presence of scientists in board or as venture capitalists have significant impact on firm performance and finally the firm value in research-intensive industry such as biotechnology. These parameters were used to evaluate the star scientist indicator in order to determine its effect on hrf value.

The study on star scientist effect of five biotech companies shows that Company B has the highest star scientist effect to human resource factor followed by Company E, and Company C has the lowest. This effect of each company and corresponding effect on hrf can be presented as below in Table 3.

Table 3: Star scientist effect on hrf

S. No.	Company	Indicator value	Percentage contribution to hrf
1	A	62.0	4.3
2	B	83.8	5.9
3	C	50.0	3.5
4	D	66.7	4.7
5	E	70.8	5.0

Among the five companies studied, only Company B has scientific staffs of more than ten which indicates that the firm has more intensive R&D activities than other comparable firms under study. Regarding the publication of scientific findings, CEO of Company C revealed that their scientists are not allowed to publish their findings in scientific journals. This practice was not found in other companies under study. Restriction to publish the finding by the scientific may retard the pace of innovation in this exponentially growing field of biotechnology. Company B has more than 20 scientific publications followed by Company E. Greater the number of articles published by firm scientists, greater will be the probability of innovation and hence the market value of the firm. Finding by Zucker & Darby, (1995) also support this relation, which states that articles are the indicators of firm knowledge capacity which determine success. Furthermore, their finding suggests that a single article publication by firm star scientist increases the firm's market value by 7.3%.

Quality of scientist also affects the firm innovative performance. Presence of star consulting scientist can contribute the scientific community through authorship and the industry via patenting thus leveraging R&D productivity. Similarly, consulting scientist can speak the firm language (Sedita & Shichijo, 2008). Among the company studied, company A has relatively lower base on scientific staff quality as compared to others, which are well equipped with star consulting scientists.

Sometimes, R&D activities are entangled with complex strategic decision-making process. In such cases, human capital of directors plays a significant role. Presence of board members with scientific background can provide valuable input that leverages the strategic decision making process (Kalyta, 2013). Citing the findings by Kalyta (2013); Abdoli, Panahi, & Rahimiyan

(2013) have mentioned that significant impact of board's human capital was observed in US public firms. The appointment of director scientists in the firm resulted in increase in 1% of stock price in 3 days period and abnormal return of 2.5% in a year after the event. This finding clearly signifies the importance of board's scientific human capital in firms' value. In this study, company C, D and E, either have scientists in their management board or venture capitalist-scientists as investor. Thus, their R&D activities can be enhanced through valuable inputs from scientists in board as well as by venture capitalist-scientists. Company B, which has better score on star scientist effect has farmers as investors and board members. It can further improve its human capital by inviting scientists in its board or scientists as investors. Similar activity by company A can also uplift its scientific human capital, which ultimately leads to better market performance.

5.3 Knowledge continuity

Knowledge capital is an indispensible component of organizations competitive advantage and hence the driver of firm value. Thus, it should be managed effectively and transferred continually to the successor in order to prevent decay and deprecation. In addition to that, continuous generation of knowledge is essential to mitigate the depreciation problem (Husman, 2001). Decay occurring through the loss of expertise can be minimized through effective knowledge management, employee motivation and retention techniques. Similarly, knowledge generation is equally important as knowledge depreciation prevention for continuity of knowledge. Learning by searching approach (example, R&D activities) of knowledge generation is common in biotech industry. In addition, learning by doing approach (training, workshop, internship, single loop learning, double loop learning, vertical integration of academia, public disclosure through patent, patent application/plant breeder's rights, adapting talent development pool) is also important for generating knowledge.

Executives from all five company interviewed considered knowledge continuity as the most important factor for biotech firm's competitive advantage. They also emphasized the importance of knowledge continuity as a competitive advantage for firms in exponentially growing biotech sector. However, the implementation of this consideration was found to be limited. Company B has better practice for knowledge continuity with about 70% whereas Company D has the poorer

practice accounting 50% of its full potential. The summary of results for knowledge continuity can be presented as follows in Table 4.

Table 4: Company wise effect of knowledge continuity on hrf

S. No.	Company	Indicator value	Percentage contribution to hrf
1	A	56.25	15.75
2	B	69.89	19.57
3	C	57.81	16.19
4	D	50.00	14.00
5	E	62.50	17.50

5.3.1 Knowledge depreciation prevention

Interview with the biotech companies under study revealed that all companies consider knowledge continuity as important factor for a company to be in line with exponential growth of biotech sector but they lack specific knowledge management strategy. All companies use documentation and non-disclosure agreement as a tool for preventing knowledge depreciation. However, codification and human resource retention strategies were also adapted by Company B.

Uncertainty of research output, individual accessibility of research output, long R&D and unpredictability of market performance of products makes the biotech R&D unique. Thus, retention of key human resources is most essential factor, which has been overlooked by companies under study with an exception of Company B. Thus, all companies should have HR retention strategy in order to maximize their human capital.

All companies have either continuous and stable, or linear R&D expenditure pattern which is essential for preventing the knowledge depreciation. Early stage company, Company D, and younger companies in commercial stage (Company A and E) have 100% absorptive capacity in terms of R&D investment. Company B and C which are matured companies in commercial stage have their absorptive capacity of 10 and 15%, respectively.

Biotech companies can use documentation, codification, NDA, HR retention strategy, article publication in journals, filing patent and patent application as tools to prevent knowledge

depreciation. In addition, regular internship program, workshop and training to the employees; and vertical integration of academia can leverage the effort preventing depreciation of knowledge.

5.3.2 Motivation

Challenging work environment was considered as an important motivating tool by Company B, C and E, whereas, Company A focuses on long term incentives as a primary motivating factor in addition to working environment, and Company C considers competent salary as a best motivating factor for their employees. It is obvious for Norway based Biotech Company to consider challenging work environment as a motivating tool because higher social security in Norway may inspire the employee for career development and higher achievement. Similar situations might not exist in other developing economies. In such situation, executive management should focus on other form of incentives. Furthermore, other form of incentives should also be taken into consideration during the internationalization of company because different environment demands different forms of motivation. This practice has been observed in Company A which focus on equity based long-term incentives in addition to competent salary and challenging work environment.

Motivating factor differs from employee to employee. Traditionalists (born 1925-1945) prefer respect, self-identity and hierarchy. Job security, reward of hard work and stable work environment is preferred by Baby Boomers (born during post world war II, 1946-1964). Generation X (generation after baby boomers, 1965-1981) seeks higher salary, greater challenge and immediate feedback, where as skill development and new opportunity creation is the priority for generation Y (Mcallister & Vandlen, 2010). Genencor International and Genetech are considered to be role model biotech giants in their motivating and human resource retention practices because they have 8% turn over rate while the industry average is 20%. Genencor International focus on seminar, peer recognition, continuous educationa and professional development whereas Genentech practizes promotion, internal transfer and after tax check provision. In addition, Genentech has gLife program which provides the knowledge about different types of incentive pattern (Mcallister & Vandlen, 2010). Thus, these examples can

provide a valuable reference for biotech companies under study to adapt better strategy to prevent decay of knowledge.

5.3.3 Knowledge generation

All companies in this study are adopting learning by searching approach for knowledge generation. However, poor practice of learning by doing approach was observed in companies under study. Learning by doing approach of knowledge generation is essential for every company to enhance their competitive advantage. Techniques such as training, workshop, single loop learning, double loop learning, vertical integration of academia, public disclosure through patent, patent application/plant breeder's rights, adapting talent development pool are some examples of learning by doing approach. Adopting learning by searching approach along with learning by doing approach can meet the goals of knowledge continuity and hence the human capital.

5.4 Succession planning

Leadership transition determines the degree of stability of a firm. The transition encounters more operational complexity as the firm size increases and greater will be the succession cost (Weber, 1947). There occur more cost of while transferring firm specific knowledge to outsider. More error can occur in selecting human capital from outside and lost opportunity during outside recruitment and greater settlement time for outside successor result in higher succession cost. Thus, careful succession planning is essential for stability in firm performance. Succession planning also enhance the retention of top leadership human capital and can be the better motivation for other staffs as well (Bulter & Roche-Tarry, 2002).

Though none of the companies under study have a formal succession planning, they have indirectly implemented it through transition support during recruitment, coordination during point of inflection of product life cycle, talent development pool etc. The result shows that Company B has better succession planning with an overall score of 68.75% and poor succession planning of Company C with score of 34.38%. However, all of the company executives are reluctant about the CEO succession plan and none of them have identified their successors.

Table 5: Company wise effect of succession planning on hrf

S. No.	Company	Indicator value	Percentage contribution to hrf
1	A	40.63	5.28
2	B	68.75	8.94
3	C	53.13	6.91
4	D	56.25	7.31
5	E	34.38	4.47

Power issue, ego factor, personality contrast and more importantly feeling of self-dismissal lie behind succession planning which is a major obstacle in this process (Ogden & Wood, 2008). This was found to be true among most of the company studied. Non of the companies under study have their formal succession plan. Their employees do not have knowledge about talent development pool. Furthermore, CEO from Company E retariated; "there are a tones of CV coming daily to our company. So there is no need of preparation for successor in each department". In addition, CEO added; "we are still in growth phase and existing manpower is sufficient to handle every circumstances". In this way, the executive from Company E showed reluctance to succession planning. The case is quite different with Company B which was following a performance scorecard to evaluate the potential candidates for succession.

Inside succession was observed in company D and E whereas other three have outside succession. For those companies having outside succession, it is necessary for them to establish the talent development pool in order to find the viable candidate for succession within the company. Internal succession provides motivation for senior staffs as it increases the possibility of promotion and also leverage the effort in key employee retention. Furthermore, practice of internal succession reduces the transition cost and expenditure on human resource becomes more fruitful through the expertise of experienced and well trained internal candidates.

With an exception of Company E, all companies under study have strong board transition support to their incomming CEOs. Strong coordination between department also exists in these companies during point of inflection in product life cycle and leadership transition. Only Company B has a practice of talent development pool in form of trainee employee and only Company D has the succession expert in board.

Role of board becomes crucial in this issue. Citing an example of Ralston Purina CEO succession, (Naveen, 2006) has mentioned that the outgoing CEO William Stiritz was awarded an option equivalent of $16 million for finding his successor. Every company should learn the importance of succession planning from this outstanding example.

Therefore, well-defined talent development pool, regular consultation from succession expert, strong transition support for incoming CEOs, proper coordination between departments during the point of inflection in product life cycle and leadership transition will definitely leverage the effort toward smooth transition during leadership succession. Both, the executives and the board should be actively involved with shared responsibility in the process of succession planning. As a consequence, succession planning will boosts the human capital of any organization which leads to enhanced market performance and firm value.

5.5 HR interaction effect

Translating bioscience research outputs to global marketable products requires a complex interplay of knowledge in the field of science, management and law. This is only possible for a cross-disciplinary team via teamwork, effective communication, collaborative culture, and active board management interaction. Change in anyone discipline will have an impact on firm performance. Thus, effective interaction of the diverse workforce is essential for higher productivity.

Table 6: Effect of HR interaction on hrf

S. No.	Company	Indicator value	Percentage contribution to hrf
1	A	77.50	5.43
2	B	75.00	5.25
3	C	60.00	4.20
4	D	65.00	4.55
5	E	87.50	6.13

In this study, parameters such as team work, board management interaction, interdepartmental communication, collaborative R&D culture and work force diversity were used to measure the human resource interaction status of the companies under study. The questionnaire-based study

showed that the companies under study have good interaction effect. Company E has highest HR interaction effect scoring 87.5% followed by Company A (77.5%) and Company B (75) while Company C has the lowest HR interaction effect with 60%.

All companies under study have good internal communication, strong board management interaction, and collaborative culture in R&D. Effective interdepartmental communication and strong board management interaction can withstand possible technology and market turbulence which in turn has positive impact on product quality (Menon, Jaworsky, & Kohli, 1997). This has been supported by findings from Yates, (2006) which states that effective communication helps companies to cherish market premium by 19.4% higher than their counterparts. Furthermore, organizational stability as a result of effective internal communication is also a competitive advvantage for those firms.

Executives of all companies with an exception of Company D believe on teamwork, participation and consensus. Leadership believes in entrepreneurship, innovation and risk taking with an exception of company C where the leadership is neutral to this attribute. Companies under study are neutral to hierarchical company structure except company D. Greater the hierarchical structure with in a company less efficient will be the communication lower will be the interconnectedness and greater will be the departmental conflict. This results in lower product quality and ultimately leads to lower market value of the firm (Menon, Jaworsky, & Kohli, 1997).

Workforce diversity enhances creativity, higher innovativeness and greater success in marketing (Gupta, 2013). Further detailed study by York, McCarthy, & Arnold, (2009) has identified two levels of diversity viz., surface level diversity and deep level diversity. They refer surface level diversity to demographic and functional differences and deep level diversity to differences in personality, values and attitude. By performing naturally occurring experiment on workforce diversity focused on bioscience enterprises, they found that surface level diversity enhances has positive impact on creativity and innovativeness, whereas deep level diversity tend to increase conflict. In this study very good surface level diversity was observed in Company A, good level of diversity in Company B and C, and fair in Company D and E. Poor deep level diversity was observed in Company E, good in A, B and C whereas Company D has very good deep level diversity.

Human resource interaction can be made effective in interdisciplinary firms like biotech firms by the practice of less hierarchical organizational structure with organic culture and team work where management is characterized by entrepreneurial, innovative and risk taking. In addition, active board-management interaction and effective interdepartmental communication will lead to economically positive impact of human resource in firm performance. Finally, maximizing the surface level diversity with minimum deep level diversity within the workforce will enhances the strength of intra-firm human capital.

5.6 CEO effect

CEOs perceive the organizational challenges and opportunities based on their mental orientations also known as "Conception of Control" in terms of Fligstein (Fligstein, 1987). This mental orientation or cognitive behavior is an outcome of CEO education and experience. This is often considered as the measure of quality of managers. Individuals with higher quality provide higher human capital to the firm which helps in better performance and thus, higher quality CEOs are the source of competitive advantage to the firm (Hitt, Bierman, Shimizu, & Kochhar, 2001). Furthermore, conversion of firm potential to actual market value is often determined by translational efficiency of total management team, especially the CEOs. This translational efficiency is often considered as an outcome of qualification and experience.

Based on various parameters related to education and experience the CEO effect was determined. Highest CEO effect was observed in company B and lowest in Company D.

Table 7: CEO effect on hrf

S. No.	Company	Indicator value	Percentage contribution to hrf
1	A	70.00	21.00
2	B	77.50	23.25
3	C	60.00	18.00
4	D	47.50	14.25
5	E	67.50	20.25

For determining the quality of CEO; experience, education, level of education, type of education, and the university from which CEO is graduated were considered as the parameters. Early stage company, Company D has scientist as manager with doctorate degree in life science where as other companies in commercial phases were under the leadership of managers with masters degree in management related subject. There has been observed a special trend in CEOs educational background over time. Fligstein (1987), in his study of top leadership found that CEOs with manufacturing and operation background were dominant before 1930s. Period between 1930-1950 was dominated by CEOs with sales and marketing background and then finance in 1970s. In 1980s it has been observed the dominance of CEOs with operations and technical background (Wernerfelt, 1984), followed by MBA degree holders CEOs with the advent of 21st century (Rakhmayil & Yuce, 2013). Figure 10 describes the trends of MBA holders in managerial position and the firm performance measured interms of Tobin'sQ[4]. The current trends in biotehnology shows that CEOs in biotechnology firms have degree in science along with MBA degree or some kind of executive education (Shimasaki, 2009). Scientific educational background is considered to be important particularly in pharma, medical device and biotech industry because it helps the CEOs to evaluate the technology critically. Critical assessment of the technology may help to identify and evaluate the threats and opportunity of the technology (Castanias & Helfat, 2001); (Cooper, Gimeno, & Woo, 1994). More competent evaluation of proposals was observed with CEOs having scientific educational background than CEOs without scientific educational background (Hitt, Bierman, Shimizu, & Kochhar, 2001). With common scientific appraoch the CEO and directors in board can easily accept and welcome the ideas which lead to productive collaboration between board and management team. This productive collaboration lead to better firm performance, seamless IPO transition and lower the underpricing during IPO (Finkelstein, Hambrick, & Cannella, 2009). However, the present trends in CEO educational background was observed poor in the company studied.

[4] Tobin'Q is defined as; Tobin's Q = (Market value of equity – book value of equity + total assets)/Total assets)

Time line of average Tobin's Q1 for companies that have (do not have) MBAs in their managerial teams.

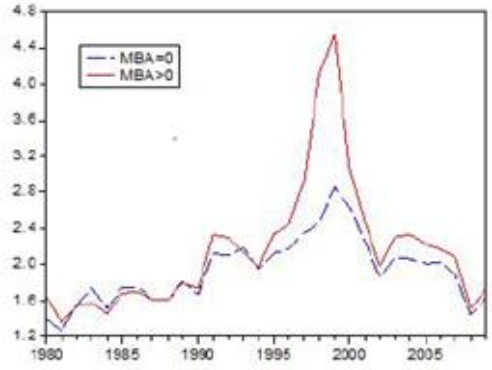

Figure 10: Tobin's Q for companies over 30 year period with MBAs and without MBAs in management team. Source: (Rakhmayil & Yuce, 2013)

The quality of education obtained by CEOs also depends on ranking of the university from which the degree is obtained which in turn determine the firm performance. (Bhagat, Bolton, & Subramanian, 2010); (Rakhmayil & Yuce, 2013). In our study CEO from Company A, was found to have university degree from "Top 100 Universities" based on Times Ranking of University 2014 (Times Higher Education, 2014). Thus, Company A will have an advantage of having CEOs with better educational background and thus better performance.

Hierarchy of skills is developed in upper echelons due to education and experiences. These skills may be industry specific, which can apply across industry or firm specific which helps in thorough understanding of the particular type of firm's dynamics such as operations, culture and values, opportunity and vulnerabilities, social-cultural environment etc. (Castanias & Helfat, 2001). Thus, experience of CEOs is considered as the most valuable human capital in biotech firms. Experience in public company boards is helpful for biotech company CEOs during their IPO performance. Similarly, start up experience and industry specific experience is significantly important in industry with exponential growth and knowledge intensive industry such as biotechnology industry. Industry specific experience of CEOs helps in prudent investment decision and also in competitive positioning of firm in that industry. Furthermore, international experience of total management team and diverse experience of board members reduces the cultural distance internationally and positively moderate the firm performance (Hutzschenreuter

& Horstkotte, 2013). The CEOs and total management team of company studied have high experience in managerial position, good international experience of total management team which thus adds positive value to CEO effect and finally to the human capital of firm. Poor start up success experience was observed in CEOs of company C and D and no biotech company experience was observed in CEO of Company C.

In summary, highly qualified CEOs having scientific education along with managerial qualification from highly reputed universities; well experienced CEOs with international experience, startup success experience, and biotech company experience; and management board with diverged experience can provide better leadership for a biotech company.

5.7 Summary of data modeling the human resource factor

IP assets and relational capital collectively reflect the market potential of a biotech company. As proposed in the hypothesis, the translation of firm's market potential to actual market value is determined by the human resources of a company. In this thesis, the translational efficiency of human resource is expressed in terms of human resource factor. Six human resource indicators viz. breed of managers, star scientists, knowledge continuity, succession planning, HR interaction, and CEO effect determine the human resource factor. The relation between human resource factor and its indicators can be expressed by using the formula proposed above in Chapter 3 and Chapter 4.

$\beta = X_1 V_1 + X_2 V_2 + \ldots\ldots\ldots + X_6 V_6,$

Or,

$\beta = 15\% V_1 + 7\% V_2 + 28\% V_3 + 13\% V_4 + 7\% V_5 + 30\% V_6$

Where, 'β' is the measure of human resource factor (hrf).

A pilot scale study on human resource factor of five Norwegian biotech companies revealed the results as shown in Table 8. Result indicates that Company B has highest hrf value of 77.87% followed by Company E, A and C, whereas, Company D has lowest hrf value of 59.78%. Thus, Company B has better human resource to translate its market potential to real market values than other companies studied.

Table 8: Human resource factor of companies under study

S. No.	Company	Human Resource Factor (in percentage)
1	A	66.80
2	B	77.87
3	C	63.79
4	D	59.78
5	E	68.30

Finally, the model developed in this thesis can be widely used for the assessment of intra-firm human capital of biotech companies in terms of hrf. Accurate assessment of intra-firm human capital will provide information regarding the firm's capacity to exploit its structural capital (IP assets and relational capital) and convert it into real market value. Thus, it adds simplicity and accuracy to existing life science valuation models.

5.8 Limitations and criticism to the proposed model

Limitations occur during the course of study, and are not under the control of researcher. Sometimes limitation affects the result and hence false conclusions are drawn. Although very few researches have been performed and much remains to be accomplished in life science valuation models, this study provides some preliminary insight on incorporating the human capital in biotech company valuations. However, this study is not without limitations. Some of the criticisms of the study focused on the model are discussed below.

5.8.1 Indicators of human capital

The six indicators of human capital that determine the human resource factor of the valuation model are proposed theoretically based on the available literatures. It cannot be fully assured that these indicators represent all aspects of internal human capital of biotech firms. Large scale survey on individual components of biotech firm's human capital should be conducted in order to verify their significance. Large scale survey is beyond the scope of this master's thesis project.

5.8.2 Linear and constrained model

Simple and linear model was proposed to determine the translational efficiency of human capital. Thus, human resource factor (hrf) varies linearly according to variation in its various indicators (breed of managers, star scientists, knowledge continuity, succession planning, HR interaction, and CEO effect). The linear relation may not always exist in reality. For example, interaction between the individual components of hrf can have synergistic effect or antagonistic effect on hrf. This possibility of inter-linkage between individual parameters has been ignored in the model proposed in this study. A more complex and exponential model defining the inter linkage between these individual components could be an improved solution. However, exponential modeling that requires the expertise on econometrics is beyond the scope of this study.

Specific weight is assigned to all six indicators of hrf. Assignment of weight is based on available literatures from similar subjects. The possible variation of assigned weight of each indicator is not explained properly. Furthermore, breed of managers is a new indicator proposed in this study and assigning weight to this indicator is a supposition which may not hold true. Thus, the task of assigning weight to each indicator should be performed by obtaining statistically significant data.

5.8.3 Data and statistical significance

Human capital, being a source of competitive advantage, is often considered confidential. Retrieving confidential data via mailed questionnaire is irrelevant because of high probability of very low response rates. Thus, a questionnaire-based interview was performed with executives of five biotech companies to obtain the relevant data. Descriptive analysis of human capital was performed. Statistical validation of the model with real life data however remained unsolved due the limitation in data set. It would have been possible for professional service providers or research institutes to conduct myriad of interviews to obtain large data sets which could prove the statistical significance of the proposed model. However, this practice is irrelevant for master's thesis due to limitations in time and scope.

5.8.4 Sensitivity analysis

Sensitivity analysis studies the uncertainty in output that results from the uncertainty associated with input parameters in a mathematical system, equation or model (Saltelli, et al., 2008). Assumptions made on input parameters are subject to change. Small change in these parameters may result in change in output. This can have impact in the conclusion drawn from the models. Thus, sensitivity analysis is a simpler technique for impact assessment of input parameter to the output in mathematical system.

In this study, sensitivity analysis of Company A was carried out to demonstrate how the uncertainty associated with input parameters (breed of managers, star scientists, knowledge continuity, succession planning, HR interaction and CEO effect) impact on the output (human resource factor). Here, each parameter was changed by 20% in both direction while keeping all other variables constant and its impact on hrf was observed. The following Figure 11 illustrates the impact assessment through sensitivity analysis.

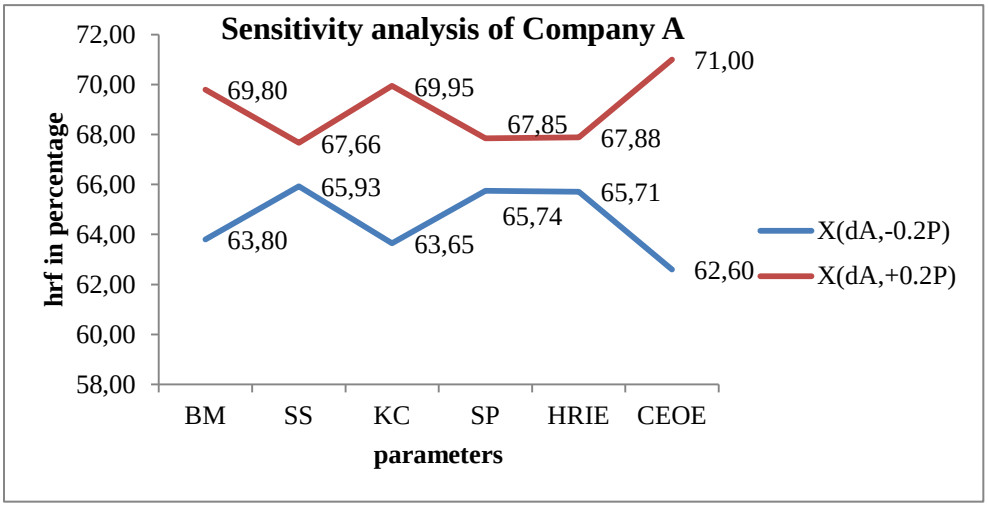

Figure 11: Sensitivity analysis for company A

The sensitivity analysis graph shows that with the change in one input parameter by 20%, while other parameters remaining constant, hrf changes accordingly. However the change observed is not uniform. This variable change indicates that the input parameters have different impact on hrf. As observed in Figure 11, CEO effect has more impact followed by knowledge continuity where as star scientist effect has the least impact on hrf followed by succession planning.

6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Valuation in life science has a long history from measure of lab footage to present day valuation based on return on investment. Review of literatures revealed that human capital was most important component that determines the firm value. However, it has been found to be either missing or improperly incorporated in valuation models. This study properly introduces the role of human capital in life science valuation practice through the introduction of human resource factor (hrf). The human resource factor, which determines the translational efficiency of firms market potential to actual market value, is an outcome of human capital related parameters viz., breed of managers, star scientists, knowledge continuity, succession planning, human resource interaction and finally the CEO effect.

All six human capital related parameters for companies under this study were estimated through the analysis of results obtained from questionnaire-based interviews. All companies follow the stage specific management and thus the corresponding value of the parameter, breed of managers, was found to be 100% to all companies under study. Average star scientist effect for five companies under study was 66.56% where, company B has the highest star scientist effect of 83.8% and company D has the lowest, 50%. Similarly, the questionnaire based survey showed that the knowledge continuity practice was found to be highest for company B followed by E, C, A and D accounting 69.89%, 62.50%, 57.81%, 56.25% and 50% respectively. Almost all companies under study were reluctant to succession planning. The study also revealed that average succession planning for five companies was 50.62%. Company B has better succession planning (68.75%) as compared to other companies under study while Company E has the weakest succession planning (34.38%). Human resource interaction effect for all five companies was better than all the indicators of human resource factor with an average of 73.01% with highest value for company E (87.50%) and lowest for company C (60%). All companies under study have well qualified and experienced CEOs. Examining the different aspect of CEOs revealed the average CEO effect of 64.5% with lower value for company D (47.5%) and highest for company B (77.5. It was also found that Company B has better star scientist effect,

knowledge continuity practice, succession planning and CEO effect as compared to other companies under study. Similarly, company E has the best human resource interaction among the five companies under study.

Human resource factor was computed by inserting the parameters value on proposed equation. This revealed that company B has highest hrf value of 77.87% followed by Company E (68.30%), company A (66.80%), company C (63.79%) while company D has lowest hrf value (59.78%). The hrf value indicates that company B has highest translational efficiency as compared to other companies and thus it can efficiently translate its market potential to market value. Furthermore, sensitivity analysis for Company A reveals that the proposed model is more sensitive to CEO effect and least to succession planning.

Finally and most importantly, the data supports that successful estimation of intra firm human capital by the proposed model can be advantageous in determining the translational efficiency of the human resource within the firm. And, efficient translation of market potential to market value results in higher market value of firm.

6.2 Recommendations

1) A theoretical approach in assigning weight to different indicators of hrf was adopted in this study. A statistical approach containing a much larger and significant data set is beyond the scope of the study due to the limited time period for master's thesis, and confidential nature of data sets used in measuring human capital. Therefore, a statistical approach containing a much larger and significant data set could be used to define the hrf factor.

2) Vast array of literature is available for each parameter in industries other than biotech industry. Therefore, detail study of each parameter could be helpful in developing a human resource scorecard in biotechnology industry. Scorecard developed in this manner could be used in measuring the translational efficiency of the biotech firms.

3) This study is based on a pilot scale study including only five biotech companies representing mostly the blue green biotech sector. Detailed and large-scale study on individual field of biotech (blue, green, white, red) could contribute in developing specific human resource factor for each sector of biotechnology. Estimation of human

capital in terms of human resource factor could determine the translation efficiency. By having the knowledge of human capital; negotiation related to merger and acquisition, investment decisions, licensing, fundraising activities etc., will become relatively simpler.

4) Introducing the best practice of each parameter; breed of managers, star consulting scientists, knowledge continuity practices, succession planning, best HR interaction and higher quality CEOs; could enhance the human capital of biotech firms and finally the firms' market value.

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APPENDIX

List of Questionnaires

A. Breed of Managers:

Please answer the next questions with a score 1-5 where 5 is the best

1. How many products are in the market?

1	2	3	4	5
0	1-5	6-10	10-15	>15

2. How many Products are in product development pipeline?

1	2	3	4	5
0	1-5	6-10	10-15	>15

3. Academic qualification of CEO (choose among the following options)

Science	MBA	Finance	Law	Accounting	Marketing	Other/specify

4. Academic qualification of Past CEO during start up phase (if any)

Science	MBA	Finance	Law	Accounting	Marketing	Other/specify

5. How many numbers of Divisions/ Department are there in your company? (Please name them).

6. Please mention the academic qualification of managers leading each department/ Division.

7. Do you follow the Stage Specific Management[5]?

[5] *Stage Specific Management:*

Early Stage innovation better managed by Scientists

Later stage of clinical trials (or later stage of field trials in blue green biotech) and regulatory approvals market development and IPO by Marketing Managers

Commercial stage production and market regulation by managers

0	1
No	Yes

8. If you do not have stage specific management practice which alternative strategy you think would better fit in biotechnology industry?

B. Star Scientists

9. How many Scientific Staffs are involved in research and development?

☐

10. Are the R & D staffs allowed to publish their research in Journal Publications?

0	1
No	Yes

11. How often they publish their research articles in renowned international journal publications?

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Very Frequently

12. Is there a collaboration of firm scientists with academic stars (Academic scientists/Professors in University)?

0	1
No	Yes

Please answer the questions with score 1-5 where 5 is the best

13. The number of articles co-authored by firm scientists with academic stars

1	2	3	4	5
1-5	6-10	11-15	16-20	>20

14. Is there a presence of Scientists in Board of Directors/ venture capitalist?

0	1
No	Yes

15. What types of Scientific Staffs are involved in your firm?

Firm Employee Scientist/ Employee researcher	Star Scientists/ Academic Scientist	Consulting Scientist	Star Consulting Scientist

C. Knowledge depreciation prevention strategy/knowledge continuity

Please answer the questions with score 1-5 where 5 is the best

16. How important is knowledge continuity for Company ____ to be in line with exponential growth of Biotech sector?

1	2	3	4	5
Unimportant	Of little importance	Moderately important	Important	Very important

17. How often the company uses the following techniques for knowledge continuity for a company to be updated with the exponential growth of biotech sectors?

S. No.	Knowledge generating techniques	Always	Very Often	Sometimes	Rarely	Never
1	Public disclosure through article					
2	Public disclosure through patent and patent application					
3	Internship					
4	Interaction with academia (vertical					

	integration of academia)					
5	Seminar/training workshop/ conference					
6	Lower loop learning/ lower level learning					
7	Double Loop Learning/ Higher level learning					
8	Talent Development Pool					

18. How often you use the following parameters for preventing the knowledge depreciation?

S. No.	Knowledge Depreciation Prevention Strategy	Always	Very Often	Sometimes	Rarely	Never
1	Documentation					
2	Codification					
3	NDA agreement					
4	Human capital retention					

19. What is the key human resource retention strategies/Motivation Techniques adopted mostly?

S. No.	Motivation techniques	Always	Very Often	Sometimes	Rarely	Never
1	Long term incentives/ stock options/ equity option					

2	Attractive salary					
3	Bonus payment					
4	Other type of incentives/ (specify)					

20. What is the R& D expenditure pattern adopted in your company?

S. No.	Expenditure pattern	Always	Very Often	Sometimes	Rarely	Never
1	Continuous and stable					
2	Linear					
3	Exponential					
4	Funding with boom and boost cycle depending on the nature of research					

21. The absorptive capacity of a firm (% of total revenue used for R and D . if the company do not generate revenue, the r and D intensity or the absorptive capacity is considered to be 100%)

_____

D. Succession Planning

22. How long have you been in the Office as a CEO? (In Years)

23. How long did the former CEO serve the company before you were recruited? (In Years)

Please answer the following questions with score 0 or 1 for No or Yes respectively

24. Have you served in any other position in this present company before being selected as a CEO?

0	1

No	Yes

25. As a CEO, do you have a written document detailing the Skills required for next successors in each department of your company?

0	1
No	Yes

26. Do your employees know about the formal talent development Pool?

0	1
No	Yes

27. In each department, do you have viable candidate for succession?

0	1
No	Yes

28. Does the Board has succession expert / research consultant to advice for succession?

0	1
No	Yes

The following items are measured in 5 points Likert scale, Please answer the following questions with a score 1-5, where 5 is the best.

29. When you were recruited as a CEO, are you provided with on board/transition support?

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Very Frequently

30. How you grade the coordination that exist in your company during the point of inflection in product life cycle and leadership transition

1	2	3	4	5
Very weak	Weak	Satisfactory	Strong	Very Strong

31. How would you rate the overall succession planning of your company?

1	2	3	4	5

Poor	Fair	Good	Very Good	Excellent

E. Human resource interaction effect

The following items are measured in 5 points Likert scale, Please answer the questions with score 1-5 where 5 is the best

32. The culture within Biotech Company _____ is characterized by team work participation and consensus

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

33. The culture within Biotech Company _____is very controlled and structure place formal procedure generally govern what people do

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

34. The leadership exemplify entrepreneurship, innovation, or risk taking

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

35. Surface level diversity* observed in your firm

1	2	3	4	5
Poor	Fair	Good	Very Good	Excellent

* ***Surface level diversity****: Observed difference among the team members on demographic basis; for example; age, race, gender, national culture and ethnicity, as well as differences along disciplinary or functional background.*

36. Deep Level Diversity* observed in your Firm

1	2	3	4	5
Poor	Fair	Good	Very Good	Excellent

Deep Level Diversity: *Observed difference among the team members on personalities, values and attitude*

37. Collaborative cultures in R & D

1	2	3	4	5
Poor	Fair	Good	Very Good	Excellent

38. Company preference to interdepartmental communication via face to face meeting

1	2	3	4	5
Poor	Fair	Good	Very Good	Excellent

39. Company preference to interdepartmental communication via electronic means

1	2	3	4	5
Poor	Fair	Good	Very Good	Excellent

40. How would you explain Board-Management interaction within your company

1	2	3	4	5
Poor	Fair	Good	Very Good	Excellent

41. Company is a member of some scientific research cluster

0	1

No	Yes

F. CEO Effect

Conversion of firm potential to actual market value is often determined by translational efficiency of total management team, especially the CEOs. This translation efficiency is often considered as an outcome of qualification and experience.

Please choose one of the following

42. CEO of Company _____ has the following academic qualification

MBA Degree	Economic Degree*	Technical Education	Others (Specify)

* Degree in Economics/Finance/Accounting/Marketing etc

43. Level of Academic qualification attained by the CEO

PhD	Masters	Bachelors	Other (Specify)

44. What is the name of the academic institute from which the CEO is graduated?

Please answer the next questions with a score 1-5 where 5 is the best

45. Past Experience as a CEO

1	2	3	4	5
No	Low	Average	High	Very high

46. Present CEO experience in any managerial position before

1	2	3	4	5
No	Low	Average	High	Very high

47. Past experience of present CEO as manager/ CEO in the field of biotechnology

1	2	3	4	5
No	Low	Average	High	Very high

48. Past experience of CEO as CEO and Board of Directors

1	2	3	4	5
No	Low	Average	High	Very high

49. International experience of total management team (TMT)/ CEO by being born abroad, studied abroad or Worked Broad

1	2	3	4	5
No	Low	Average	High	Very high

50. Past start up success experience of CEO

1	2	3	4	5
No	Low	Average	High	Very high

51. Diversity of experience in board of directors

1	2	3	4	5
No	Low	Average	High	Very high

THANK YOU