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THE DEVELOPMENT OF MANPOWER MODELING & OPTIMIZATION: A CASE STUDY ON ASIA LEADING ENERGY CONGLOMERATES

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ABSTRACT: The efficiency and operational excellence are the key factors in order for a manufacturing company to stay competitive. Optimization of manpower and forecasting manpower needs in modern conglomerates are an essential part of the future strategic planning and a very important different nature of business imperatives. As firm's business diversification has entered different business platform through firm supply chain operation increases more complexity for forecasting & planning manning level. The key driver analysis method was used in manpower modeling for five different nature types of business; sales based, volume based, trading based, project based, and back office based management. The distribution of manpower requirement in each specialty varied as different business context. This empirical study on manpower distribution and best fit modeling to predict the human resource planning in operation. Firstly, longitudinal study of manpower analysis was evolved to conduct the as-is manpower tiering; front process, core process, and support process for each business group. Later, all key financial & non-financial metrics were conducted for analysis. Finally, regression analysis was conducted to determine the development of manpower modeling or forecast model of demand/ supply in current energy context companies. Considering the market constraints & fluctuation with the governmental demand, policies, or advance in process technology impacted different demand & supply manning level for each of five business types. Finally, the study is to design a HR operating expenses (HROPEX) as the way to determine the resource headcount forecast for human resource planning regardless of employee competency constraint. The research findings showed significant relationship for each key specific metrics or model for each business group. Therefore, five manpower models were developed on each specialty for the strategic planning of human resource to serve the development of the industry.

KEYWORDS: Development, Manpower Modeling & Optimization: Asia, Energy Conglomerates

INTRODUCTION

The ability to forecast manpower requirements is crucial for an industry. On the demand side, companies rely on these forecasts to formulate their manpower planning strategies, while, on the supply side, they provide job seekers with a basis to assess the attractiveness of a given sector. Forecasts of supply and demand for manpower also make an important contribution to the governmental policy-making process by serving as pointers, to avoid redundant investments and achieve efficient and balanced growth for an industry. Meanwhile, forecasts based on an inaccurate market analysis can be a cause for imbalances such as undersupply or oversupply of labor. Static and unilateral analyses are the most common culprits for erroneous predictions of supply and demand for manpower. These approaches can yield particularly severely flawed

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forecasts with cutting-edge industries and emerging industries which, while entertaining complex relationships of interdependence with other industries and experiencing rapidly-growing manpower demand, are characterized by a longer period required developing needed human resources.

Assumptions about the future demand and the performance are essential for decision making for a given industry. For example, how much to produce; how much capacity and other resources to acquire; what products to develop; and how much financing will be needed by the business, etc. Sometimes decision makers tend to make the naive forecast, assuming that the future will be like the past or the past trend (Lyneis, 2000). Meanwhile, in other cases, efforts are made to estimate future demand and supply, using statistical techniques or mathematical models. However, the existing methodologies, due to their fundamental limitations, fall short of enabling dynamic structural analysis or identification of delayed feedback effects.

Actions undertaken based on inaccurate demand forecasts can occasionally produce results that are opposite to the intended ones. Underestimates of demand can lead to self-fulfilling prophecies as feedbacks, often through product or service availability, drive sales to equal the capacity provided to meet the forecast (Lyneis 1980). Also, decisions taken due to overestimates of demand can lead to over-capacity and financial difficulties. These instances are easily found from the electronic utility in the 1970s, the petroleum industry in the 1980s, and the personal computer industry in the late 1980s (Barnett 1988). In the meantime, agriculture is perennially affected by this type of imbalance with only the crops hit by the problem changing from year to year.

As a result of forecast inaccuracies and potential misuses in decisions many practitioners desire to shift managerial emphasis away from forecasting and towards understanding and policy design. Sterman (2001) contends that the purpose of modeling is not to anticipate and react to problems in the environment but to eliminate the problems by changing the underlying structure of the system.

HUMAN RESOURCE PLANNING IN ENERGY INDUSTRY

The energy industry has been ingenious at continuing to make things work, and has been critical in the continued growth in the industry on a global basis. The ever-changing dynamics of the industry have created an interesting and unique, which also challenge the company in which to do strategic business. Among the more notable of these dynamics has led human resource planning for companies of the tendency to spin off business units or ancillary divisions in efforts to concentrate resources on core products & markets. Another distinct trend has been the focus on multinational expansion, particularly in global arena, has become fertile ground for new subsidiaries. And, not surprisingly, talents and investment capital have also weighed heavily on the development of the energy industry.

Energy conglomerates have always required a fair amount of capital investment and talent to enable the business of wider and more competitive advantage through their own business supply chain. With the rate of technological change accelerating and business divestitures, more leading energy conglomerates moving to a foundry model, mostly the challenge will be to increase the

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return of investment capital by raising yields and lowering costs, while maintaining the flexibility to satisfy a variety, even a proliferation, of sophisticated new products demanded by consumers. Therefore, many organizations have professed to view human resources as valued assets as incubating talent pools to adapt the needs of market and technology innovation; and the investment in human resources as strategically imperative to corporate competitiveness (Harrell-Cook and Ferris, 1997).

THE HEADCOUNT PLANNING

The purpose of this headcount planning is to provide useful information for a variety of organizational purposed ranging from human resource planning to streamline manpower requirement in different types of business & affiliates within energy conglomerates. It is also the foundation of forecasting the need for human resources as well as the plans for such activities as training, transfer, or promotion. Frequently manpower analysis information is incorporated into a human resource information system. Moreover, some combination of existing job analysis & pay methods should be used to weight the advantages and disadvantages. HR operating expense systems are often keyed to job analysis and classification systems, without the information, it is impossible to determine reliably the structure of the relationships between jobs in an organization (Cascio, 1989).

Although headcount planning, it involves the ideas on: (1) to maximise the operator workload; (2) manage the extra hours; (3) manage sub-contracting; (4) manage the assignment of the operators from one workshop to another; (5) assign to a job the operator who has the best skill; (6) have a better view on the global capacity in operators required to perform a planning; (7) have a better view on the capacity per competence required to perform the planning; (8) have a better view on individual assignments; (9) manage continuous training (Grabot and Letouzey, 2000). Thus, management of manpower can be modelled by a reasonable and flexible thinking logic and go through the points as group expert's discussions. The impact to headcount modeling, which setting human resource objectives is art as much as it is science. It requires conscious forethought based on the kind of future the firm wants to create for itself.

IMPACT ON BUSINESS CYCLING

The cycling changed the way many companies do business. It has also changed how their customers do business. Many of the customers have undergone tremendous pressures in downsizing their structures. Thus, their expectations toward suppliers and partners in terms of equipment and process technology are higher. There is more of a need to limit risk, changes in commitment, and a stronger push to fix costs. This leads to the outsourcing of different functions which not just the equipment but some of the research expertise, process technology, everything that's eventually incorporated into the package that the company deliver. This could be a major driver behind the business model. To be competitive in the global business environment, organizations must build competence in their human resource as well as forming a demand/supply model, because such resources will be a vital determinant for survivability in a changing environment. During the downturn, companies are generally looked at acquisition possibilities.

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As of a strategic alliance - joining forces with some of their long-term customers. It may have strengthened both capabilities in terms of leading technology, as well as other competencies. Besides, there are always looking for new applications for the core technologies as well as new business strategies. As predicting the future manpower planning with variety external factors (eg. technology, outsourcing etc.) could be risky and changeable (Woods, 1999). Hence, the business cycling have impacted the rule of human resource planning to new insight of manpower allocation as sticking to the core technologies and recomposition the capability of workforce as of the business model requires focus and careful choices.

FORECAST MODEL OF DEMAND AND SUPPLY

For the forecast model of manpower requirement as well as job analyses have always been done for providing a deeper understanding of the behavioral requirements of jobs (Choudhury et al., 2002). This in turn creates a solid basis on which to make job-related personnel decisions. Generally, job analyses are often done for a specific purpose (e.g., training design, manpower allocation and support program) with consideration of the many other uses of the information.

THEORETICAL PERSPECTIVES

The goal of manpower planning is to make future demand and supply in the workforce coincide optimally. Manpower planning takes into account various environmental factors of an industry (Lederer, 1987). To achieve this goal, the planning must simultaneously consider demand and supply. For prediction of workforce demand, there are many models including regression analysis models and Delphi techniques which base the assessment on the future volume of work, size of sales or other economic indicators (Bechet et al., 1987; Milkovich et al., 1972; Gatewood et al., 1983).

For the appropriate size of manpower supply, there are optimization models which consider the business strategy of the organization, changes in the industry's environment and the resulting manpower management goals (Kahalas et al., 1974; Price, 1977; Welling, 1977). What is critically needed in manpower planning to be able to meet the future demand in a given industry is the capability to view the workforce needed and supplied from multiple perspectives and over the entire process, from inflow to stock and outflow.

Markov Analysis (MA) is a powerful analysis technique which, used in manpower planning, can help it successfully achieve its goal. Developed in the early 1960s, it has been in use ever since. Markov chains make it possible to predict the size of manpower.

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A Markov chain, in this case, corresponds to a succession of events, each of whose probability of occurrence is affected by an event immediately preceding it. Such a chain may be considered to have a memory, in other words, the memory of the last event, and this memory determines the probabilities of future events. More importantly yet, with a Markov chain, one can obtain longterm average probabilities or equilibrium probabilities. Published examples of applications of MA to manpower planning are chiefly from the army, government and public institutions (Kalamatianou et al., 1987; Stewman, 1978; Trivedi et al., 1987; Zanakis et al., 1980). Although the statistical validity of Markov chains has been consistently verified over 30 years, their level of adoption in corporate organization-related fields is rather low. This is mainly due to the fact that in MA, Markov transition proabibilities are assumed to be constant. Hence, the need to modify transition probabilities has been continuously pointed out, for instance by changing them into variable transition coefficients or controlled decision-making variables of some sort. Meanwhile, many prior studies on the prediction of manpower demand resort to the macroeconomic model used by the US Bureau of Labor Statistics (BLS). This method, consisting of estimating labor demand within a macroeconomic model that describes the overall economy, is popularly adopted in labor forecast-related reports and research papers. For more than 35 years, the Bureau of Labor Statistics has developed medium- to long-term (10 years ahead) projections of likely employment patterns in the U.S. economy. Since the early 1970s, projections have been prepared on a 2-year cycle. The projections cover the future size and composition of the labor force, aggregate economic growth, detailed estimates of industrial production, and industrial and occupational employment. The resulting data serve the many users who need information on likely patterns of economic growth and their effects on employment. The information on future employment opportunities by occupation, for example, is used by counselors, educators, and others helping young persons choose a career, and by officials who plan education and training programs (BSL, 1997)

The BLS itself publishes employment forecasts based on this macroeconomic model, per industry, occupation and state. Despite new data added over the past 35 years and changes in industry and occupational classification systems, BLS data have maintained the same basic analytical framework to this day. The BLS produces its forecasts based on labor productivity estimates and industry-occupation matrices which indicate the status of employment per occupation category within an industry.

However, to predict manpower supply and demand with accuracy using a macroeconomic model, one needs a vast array of data for each of the many variables used. To collect these data, one must first get hold of sufficiently broad-ranging time series data for each industry. For this reason, a method of this type proves to be unadaptable for emerging sectors undergoing fast-paced growth with only small amounts of statistical data on the industry as a whole and manpower available. With such industries, this technique will be forced to base the estimations on a handful of factors with numerous restrictions attached, and will thus fail to reflect dynamic interactions between different variables and delayed feed effects.

METHODOLOGY

In general, a company tends to be two basic trends in manpower planning research: (1) a normative approach which emphasized mathematical programming models; (2) a comprehensive planning process which uses methods like job analysis, work study, factor analysis, organization structure, performance appraisal etc. (Purkiss,1981). Nevertheless, human judgments for deciding the relationship between departments or groups are usually given by crisp values for establishing a structural model. In many cases, crisp values are an inadequate reflection of vagueness in the real world; the fact that human judgments with preferences are often unclear and hard toestimate by exact numerical values (Tau et al., 2001). In practice, to achieve effective and reasonable decision-making for solving complicated problems with multiple criteria, it is usually necessary to gather group knowledge and employ key business drivers as forecast method. Therefore, a suitable strategy would be to perform a methodological analysis of historical data generated during the historical capacity, seeking to find empirical relationships among the history of all key financial & non financial metrics, manpower status, etc. to create the manpower modeling as most direct and efficient way.

DESIGNING A SIMULATION MODEL



Figure 1: Research Methodology

Step I: Tiering Concept of Manpower Modeling

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To understand current manpower deployment, we need to identify the key activities for the different departments under each Business Group (BG) and separate it based on different types of Strategic Implication





Figure 3: Manpower Tiering for 5 Business Group



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| | End-to-End Group | Sales-Oriented Group | Managing-Oriented Group | Analysis Period is 2004 – |
|---------|--|--|--|------------------------------------|
| BG | Gas Oil | Trading | | 2007 unless indicated otherwise |
| Revenue | Gas and Oil have a similar level of revenue generation per person at B146m and B171m respectively | Trading has exceptionally high revenue per person. In 2010, each person generates B6.6bn. | PR&HO's revenue per perso low but has been rising in the three years to B33m in 2010 thanks to income from strate investment | e past |
| Profit* | Gas' profit per person is relatively high at B25m in 2010. This efficiency level has been stable in the past 3 years Oil's profit per head is less exciting hovering around nil to B2m | high profit per person as | Profit per head from PR&HC jumped in 2008-9 and stayed at B23 in 2010 due to its very low cost structure and increase in investment income | d 🔲 🔲 |
| OPEX | Gas and Oil has similar OPEX per person at B3.1m and B3m respectively | Cost structure per person is highest in Trading. The ratio had declined due to a jump in personnel in 2009 and a decline in OPEX in 2010 | OPEX per head at PR&HO i the lowest across BGs at B2.8m in 2010. | S |
| Net PPE | Gas is the most capital intensive per person, and efficiency is growing. Net PPE GAGR is 22% at the mid of 2011, while its personnel grew 10.9% Cil's has a much lower net PPE per person which has been stable at B4rr through 2010. This is quite comparable to PR&HO | | Net PPE per person at PR&HO is quite comparable to Oil at B3m per person | 2007 |
| | p.a Net PPE/Head in 2010 was B49m | Note: Net | D 📕 Oil 🗌 Trad | • _ |
| | | NULE. INEL | FIGHT IS FIGHT DENDE TAX AND FUREX C | /dillo/LU0050 |

Step II: Review Key Business Valued Drivers

The development or manpower historical trend with the consideration of real business key valued drivers, as it is a competitiveness. A well manpower planning as well as a study on the key business valued driver modeling is quite useful for a operational efficiency. Therefore, the related effect factors on the forecast model are considered: (1) key financial metrics; (2) key non financial metrics.

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| Table 1: Analysis of Key No | on-Financial Drivers Across 5 BGs |
|-----------------------------|-----------------------------------|
|-----------------------------|-----------------------------------|

| Summary of <u>Key Non- Financial Drivers</u> Across 5 BG | | | | | | | |
|--|---|--|--|--|--|--|--|
| Sales Based | Sales volume by sectors & products No of customers by sector & product Sales volume per customers No of service days / customer No of NGV Stations No of gas separation projects No of pipeline construction projects | Gas Demand by Sector by product Capacity (Production Volume) of Gas Separation plants Size and Length of pipelines built No of gas separation plants / pipeline construction projects No of M/R Stations, Compressors No of cases (maintenance) | | | | | |
| Volume Based | Sales volume by sectors & products No of customers by sector & product Sales volume per customers No of service days / customer No of cases (order, maintenance) No of purchasing order by sectors & products | No of Service stations No of Retail shops in service stations Sales volume by sectors and by products Inventory Level & Turn No and capacity of Warehouse / Depots No of Inbound & Outbound transportation | | | | | |
| Trading Based | Trade volume by sectors & products Trade volume by tiers (e.g. Physical, Paper) No of shipments | No of customers by sectors & tiers No of deals / contracts Production volume from the Group | | | | | |
| Project Based | Sales Volume by Product Type (Petrochem & Refinery) No of customers & size of customers No of subsidiaries managed under BG | Size of subsidiaries /Type of Partnership No of Projects by type (Acquisition, New set up, Divest, increase Capacity) Size of Projects | | | | | |
| Support Based | No of businesses/subsidiaries that HO support No of new departments created within HO No of new products anticipated for release in each business that HO supports | No of products sold in each business Growth of business that HO supports | | | | | |

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| Summary of <u>Key F</u> | Summary of <u>Key Financial Drivers</u> Across 5 BG | | | | | | | |
|---|--|--|--|--|--|--|--|--|
| Sales Based (Oil)Volume Based (Gas)Trading Based (Trading)Project Based (Petrochemical)Support Based (Head Office) | EVA Revenue Variation of sales by BG Investment income [for P&R] Group sales [for HO] Operating Costs OPEX OPEX – HR costs (excluding HR costs) Assets Net PPE (Property, Plant, and Equipment) Net investment in other companies (Subsidiaries, Associate, Affiliate, JV, Others) Cash Flow | | | | | | | |

Table 3: Financial Drivers on HR OPEX

Statistical Test between HROPEX and Financial Drivers: Main Criteria for Selection

| | Oil | Trading | Gas | P&R | НО | Overall |
|--------------------------|--------|---------|--------|-----|--------|---------|
| EVA | | | | | | |
| EVA | 14.36% | | 20.80% | | 84.29% | 81.11% |
| Revenue | | | | | | |
| Revenue | 43.14% | 99.88% | 98.28% | | 98.20% | 98.50% |
| Revenue (Ext) | | | 99.05% | | | |
| Normalized Revenue (Ext) | | | 93.15% | | | |
| Costs | | | | | | |
| COGs | 42.62% | 99.90% | 98.10% | | 98.26% | 98.82% |
| SG&A | 10.48% | | 97.61% | | 95.63% | 94.02% |
| SG&A - HROPEX | | | | | | 92.56% |
| OPEX | 42.41% | | 98.34% | | 98.38% | 98.81% |
| OPEX - HROPEX | 42.34% | 99.88% | 98.32% | | 99.74% | 98.80% |
| HR Opex (4 BGs) | | | | | 99.20% | |
| HR Opex (5 BGs) | | | | | 99.74% | |
| Assets | | | | | | |
| Total Assets | 38.91% | 98.99% | 97.90% | | 93.85% | 93.30% |
| Current Assets | 25.33% | 98.99% | 99.31% | | | 91.55% |
| Non-Current Assets | 98.80% | | | | | 92.17% |
| Fixed Asset | 97.04% | | | | | |
| Profit | | | | | | |
| EBITDA | | | | | 91.67% | 90.43% |

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Table 4: Financial Drivers on HR Number

| HR No. | Oil | Trading | Gas | P&R | HO* | Overall | R-Square |
|----------------------|--------|---------|--------|--------|--------|---------|----------|
| EVA | | | | | | | - |
| EVA | 92.04% | 24.90% | 34.52% | | 5.03% | 83.19% | |
| EVA-Ex HROPEX | 93.49% | 14.53% | 43.16% | | 4.43% | 83.22% | |
| Revenue | | | | | | * | |
| Revenue | 40.69% | 66.16% | 93.25% | | 1.06% | 75.87% | |
| Costs | | | | | | | |
| COGS | 41.34% | 65.95% | 94.81% | | 1.62% | 73.89% | |
| SG&A | 96.02% | 24.18% | 80.86% | | 0.20% | 81.29% | |
| OPEX | 41.91% | 66.16% | 94.21% | | 1.54% | 74.08% | |
| OPEX-Ex HROPEX | 41.95% | 66.16% | 94.55% | | 1.54% | 74.09% | |
| Assets | | | | | | | |
| Total Assets | 10.74% | 53.38% | 95.69% | | 0.03% | 75.73% | |
| Fixed Assets | 7.09% | 5.33% | 78.80% | | 0.10% | 57.50% | |
| Strategic Investment | | | | 97.87% | 10.20% | 57.26% | |
| Non-Current Assets | 16.50% | 37.49% | 92.15% | 95.17% | 93.44% | 22.21% | |
| Profit | | | | | | | |
| EBITDA | 62.55% | 42.72% | 87.04% | | 1.53% | 89.94% | |
| Cash Flows | | | | | | | |
| Operating Cash Flow | 1.89% | 78.03% | 70.17% | | 7.09% | 24.55% | |

Statistical Test between HR No. and Financial Drivers: Main Criteria for Selection.

| Gas | Gas Demand | 94.04% |
|-----|-------------------|--------|
| | Gas Product Sales | 90.53% |
| | | |
| | | |

| Oil | PPE & Assets Under Construction | 98.97% |
|---------|--|--------|
| | Oil Product Sold 05 -07 | 91.03% |
| | Oil Product Sold & Supporting Business | 99% |
| | | |
| P&R | Investment in Affilliates | 99.80% |
| | Cumalative Total Investment | 96.05% |
| | Cumalative Internall Investment & JV | 99.83% |
| | | |
| Trading | Trading Volume (M Barrel) | 97.92% |
| | Trading Volume (M litre) | 98.67% |
| | Trading Less Risk Volume | 98.79% |
| | Ln (Trading Volume - M Barrel) | 98.87% |
| | Ln (Trading Volume - M litre) | 99.41% |
| | Ln (Trading less Risk Volume) | 99.49% |
| | | |
| P&R | Revenue of Affilliates | 90.51% |
| | Non Current Assets of Affiliate | 99.58% |
| | Fixed Assets of Affiliates | 99.47% |

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Step III: Manpower Prediction Modeling

Figure 5: Manpower Prediction Modeling

| $\hat{Y} = \sum_{i=1}^{n} w_i \times Y_i$ | | | | | | | |
|---|--|--|--|--|--|--|--|
| where | $m{Y}_i = m{c}_i + m{m}_i 	imes m{X}_i$ | | | | | | |
| | $X_i = $ Selected Key Driver, i | | | | | | |
| | $m_i, c_i = $ Regression Coefficients of Selected KeyDriver, i | | | | | | |
| | $c_i = \text{Coefficient of Selected KeyDriver, i}$ | | | | | | |
| | n = Number of Selected Key Drivers | | | | | | |
| | $\boldsymbol{w}_{i} = \left[\frac{1/SE_{i}}{\sum_{i} 1/SE_{i}}\right]$ | | | | | | |
| | SE = Standard Error of Regression of Key Driver, i | | | | | | |

<u>Step 1:</u> Selected key drivers (Xi) in the BG's (or Overall 5 BGs) that are expected to have a significant impact on manpower level.

<u>Step 2:</u> Calculate the estimated of manpower level (Yi) for each of selected key drivers based on the corresponding prediction model.

<u>Step 3:</u> Calculate the weightage (Wi) for each the estimated of manpower level (Yi) based on corresponding standard error of regression (SEi).

<u>Step 4:</u> Obtain the weightage average manpower level using the provided equation.

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Table 6: Manpower Modeling for 5 Business Group

| | $0.010(0.001704020 \oplus 0)$ D 0.070740010 |
|-----------------------|---|
| Overall HROPEX | 0.618 (0.001784632 *Conso Revenue+ 2797.42018) + |
| | 0.382 (0.005217288 *Conso Non-Curr Assets+ 2596.49469) |
| | |
| Oil HROPEX | 0.295 (0.043692048 *Non-Curr Assets+ 949.1910358) + 0.705 |
| | (0.229637687 *PPE + 0.122401116* Assets Under Construction - |
| | 343.5930031) |
| | 545.5750051) |
| C. UDODEV | $0.267 (0.00(1252)12*E_{-1}) = 0.626$ |
| Gas HROPEX | 0.267 (0.006125213*Ext Revenue+ 7.586673224) + 0.626 |
| | (0.007502648*Non-Curr Assets+ 219.5386157) + 0.137 |
| | (1.010712656*Gas Volume - 1831.142764) |
| | |
| Trading HROPEX | 0.615 (0.000127725 *Revenue+ 39.3983105) + 0.196 (0.365301804 |
| C | *Trading less Risk Vol.+ 20.2640899) + 0.189 (0.365301804 |
| | *Trading Vol.+ 22.2838434) |
| | Trucing (01.1 22.2000101) |
| P&R | 0.597 (0.000649285 *Inv In Affiliates - 6.6959813) + 0.403 |
| I & K | |
| | (0.00035891 *Non-Curr Assets of Affiliates - 61.38097) |
| | |
| HO HROPEX | 0.316 (0.000776304 * Conso Revenue + 658.3489705) + 0.209 |
| | (0.002210064 *Conso Non-Curr Assets + 598.8481474)+ 0.476 |
| | (0.741311225 *HR OPEX:4BGs - 922.8673789) |
| | |

Table 7: Suggest Key Driver for Oil

Basing on the statistical results and forward testing, the following are recommended key drivers for Oil

| Key Driver | Unit | Data Source | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|---|------------------------|--------------------------|--------------------|---|---|---|
| Avg Non Current Asset | M Baht | Accounting Department | 2005 - 2007 | R^2 = 98.33% Adjusted R^2 = 96.65% | 0.043692048 X + 949.1910358 | 19.10129954 |
| PPE (X1) Asset Under Construction (X2) | M Baht M Baht | Accounting Department | 2004 - 2007 | R^2 = 99.77% Adjusted R^2 = 99.31% | + 0.229637687 X1 + 0.122401116 X2 - 343.5930031 | 7.993409147 |

Weight for Recommended Drivers

| Oil | SE | 1/SE | S 1/SE | Weight |
|---|-------------|-------------|------------|--------|
| Avg Non Current Asset | 19.10129954 | 0.052352459 | | 29.5% |
| PPE (X1) Asset Under Construction (X2) | 7.993409147 | 0.125103067 | 0.17745553 | 70.5% |

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Table 8: Suggest Key Driver for Gas

Basing on the statistical results and forward testing, the following are recommended key drivers for Gas.

| Key Driver | Unit | Data Source | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|-----------------------------|--------|--------------------------|--------------------|---|-----------------------------|---|
| Revenue (External) | M Baht | Accounting Department | 2003 - 2007 | R^2 = 99.05% Adjusted R^2 = 98.73% | 0.006125213 X + 7.586673224 | 28.74073922 |
| Avg Non Current Asset | M Baht | Accounting Department | 2004 - 2007 | R^2 = 99.82% Adjusted R^2 = 99.74% | 0.008152416 X + 219.5386157 | 12.25252143 |
| Gas Volume | mmscfd | Annual Report | 2003 - 2007 | R^2 = 94.04% Adjusted R^2 = 92.06% | 1.010712656 X - 1831.142764 | 71.80463085 |

Weight for Recommended Drivers

| Gas | SE | 1/SE | S 1/SE | Weight |
|-----------------------|----------|----------|----------|--------|
| Revenue (External) | 28.74074 | 0.034794 | | 26.7% |
| Avg Non Current Asset | 12.25252 | 0.081616 | 0.130336 | 62.6% |
| Gas Volume | 71.80463 | 0.013927 | | 10.7% |

Table 9: Suggest Key Driver for Trading

Basing on the statistical results and forward testing, the following are recommended key drivers for Trading.

| Unit | Data Source | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|----------|----------------------------------|--|--|---|---|
| M Baht | Accounting Department | 2005 – 2007 | R^2 = 99.88% Adjusted R^2 = 99.75% | 0.000127725 X + 39.3983105 | 1.012272991 |
| kboe/d | PTT Analyst Meeting Report | 2005 – 2007 | R^2 = 98.70% Adjusted R^2 = 97.40% | 0.14176387 X + 22.2838434 | 3.295266726 |
| M Barrel | Trading BG | 2005 – 2007 | R^2 = 98.79% Adjusted R^2 = 97.59% | 0.365301804 X + 20.2640899 | 3.172678808 |
| | M Baht kboe/d | SourceM BahtAccounting Departmentkboe/dPTT Analyst Meeting Report | SourceDataM BahtAccounting Department2005 – 2007kboe/dPTT Analyst Meeting Report2005 – 2007 | SourceDatawith HR OPEX + CONTRACTM BahtAccounting Department2005 - 2007R^2 = 99.88% Adjusted R^2 = 99.75%kboe/dPTT Analyst Meeting Report2005 - 2007R^2 = 98.70% Adjusted R^2 = 97.40%M BarrelTrading BG2005 - 2007R^2 = 98.79% | SourceDatawith HR OPEX + CONTRACTOperationM BahtAccounting Department2005 - 2007R^2 = 99.88% Adjusted R^2 = 99.75%0.000127725 X + 39.3983105 |

Weight for Recommended Drivers

| Trading | SE | 1/SE | S 1/SE | Weight |
|---------------------------|------------|----------|----------|--------|
| Revenue (M Baht) | 1.01227299 | 0.987876 | | 61.5% |
| Trading Volume (M Barrel) | 3.17267881 | 0.315191 | 1.606532 | 19.6% |
| Trading Volume (kboe/d) | 3.29526673 | 0.303466 | | 18.9% |

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Table 10: Suggest Key Driver for P&R

Basing on the statistical results and forward testing, the following are recommended key drivers for Trading.

| Key Driver | Unit | Data Source | Historical Data | Linear Relationship with Salary + Bonus + Contract Expenses | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|--|--------|------------------|--------------------|---|---------------------------|---|
| Avg Investment in Affiliates | M Baht | Annual Report | 2003 - 2007 | R^2 = 99.80% Adjusted R^2 = 99.73% | 0.000649285 X - 6.6959813 | 0.879738607 |
| Avg Non Current Asset of Affiliates | M Baht | Annual Report | 2004 - 2007 | R^2 = 99.58% Adjusted R^2 = 99.37% | 0.00035891 X – 61.38097 | 1.302240582 |

Weight for Recommended Drivers

| P&R | SE | 1/SE | S 1/SE | Weight |
|-------------------------------------|----------|----------|------------|--------|
| Avg Investment in Affiliates | 0.879739 | 1.136701 | 1.90460779 | 59.7% |
| Avg Non Current Asset of Affiliates | 1.302241 | 0.767907 | 1.90400779 | 40.3% |

Table 11: Suggest Key Driver for Head Office

Basing on the statistical results and forward testing, the following are recommended key drivers for Head Office

| Key Driver | Unit | Data Source | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|--|--------|--------------------------|--------------------|---|-----------------------------|---|
| Corporate Revenue Consolidated | M Baht | Annual Report | 2003 - 2007 | R^2 = 98.20% Adjusted R^2 = 97.59% | 0.000776304 X + 658.3489705 | 49.84620377 |
| Avg Corporate Non Current Asset Consolidated | M Baht | Annual Report | 2004 - 2007 | R^2 = 95.51% Adjusted R^2 = 93.26% | 0.002210064 X + 598.8481474 | 75.38398987 |
| HR OPEX (4 BGs) | M Baht | Accounting Department | 2003 - 2007 | R^2 = 99.20% Adjusted R^2 = 98.94% | 0.741311225 X - 922.8673789 | 33.09475827 |

Weight for Recommended Drivers

| HO Support | SE | 1/SE | S 1/SE | Weight |
|------------------------------------|----------|------------|------------|--------|
| Revenue Consolidated | 49.84620 | 0.02006171 | | 31.6% |
| Avg Non Current Asset Consolidated | 75.38399 | 0.01326542 | 0.06354339 | 20.9% |
| HR OPEX (4 BGs) | 33.09476 | 0.03021627 | | 47.6% |

DISCUSSIONS AND SUGGESTION

As can be noted from the simulation results, the current manpower supply and demand behavior in the Asia leading energy conglomerate reveals different business context composed of different key business valued drivers for prediction of manning level. Company historical data played a

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crucial role to determine the baseline for future forecast unless major business change was taking in place.

However, an analysis by HR operating expense or HR budget can perform better prediction model for each business due to different nature of business context and different people competency requirement. HR operating expense is therefore more practical & flexible way to manage headcount for corporate level. The current research findings also recommend to giant conglomerates that have several business groups, which each business is different in nature, one size fit all model therefore might not be a practical way to determine and to explain the accurate manning level requirement. Different models & right fit key business valued drivers can perform a better method to determine the number of staff's requirement.

CONCLUSION

Forecasting supply and demand of manpower is an indispensable step for an industry, providing companies with a basis for manpower planning. Meanwhile, forecasts of supply and demand for manpower have thus far been often seriously flawed. They were either based on superficial data and lacked a comprehensive examination of the structural characteristics of the market & business context, or were the results of the assessment of the present state within an industry, disregarding dynamic changes that may occur over time. These problems inevitably led to frequent overestimations or underestimations of both supply and demand. Most approaches can yield particularly severely erroneous forecasts with cutting-edge industries and emerging industries.

In the present paper, we analyzed the manpower modeling in the energy industry from a dynamic perspective, and proposed solutions to correct it. This study, although it has the merit of concretely explaining key valued drivers to determine for practical solutions to the manpower problem, has nevertheless several limitations. For example, manpower supply and demand is an issue which requires an even consideration of both quantitative and qualitative aspects, and the qualitative aspect cannot be simply discussed in terms of general workload levels. For greater analytical accuracy, future research must consider more detailed supply and demand behaviors per each type of business sector & people competency requirement. Furthermore, while we tried to base our model as much as possible on actual data, referring to prior research on the subject, we used either a base value. Hence, to an extent, we have sacrificed the accuracy of parameters, a fundamental principle in the key business valued driver method, for the sake of understanding the general supply/demand behavior and its structural pattern. As a consequence, the resulting measurements leave something to be desired in terms of accuracy.

The role of energy company are to the delivery higher operation efficiency & excellence, while the outcome in those of competitive environment must align the manpower landscape and planning with a right sizing of staff. Therefore, the human resources of a company those are mostly to supply the core competencies which will be the source of sustained competitive advantage. In such industry, well-planned manpower demand and supply can smoothen the business operation; the acceptance of headcount forecast model might be well helpful toward changeable market situation. Published by European Centre for Research Training and Development UK (www.eajournals.org)

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APPENDIX



All (5 BGs) | Key Drivers and Manpower Statistical Analysis

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|--|--------|--------------------|--|-----------------------------|--|
| EVA | M Baht | 2006 - 2010 | R^2 = 81.11% Adjusted R^2 = 74.82% | 0.033106645 X + 2865.867895 | 370.1150443 |
| Revenue (Consolidated) | M Baht | 2006 - 2010 | R^2 = 98.50% Adjusted R^2 = 98.00% | 0.001784632 X + 2797.42018 | 104.4104862 |
| Asset (Consolidated) | M Baht | 2006 - 2010 | R^2 = 93.30% Adjusted R^2 = 91.07% | 0.003203463 X + 2510.78338 | 220.4045942 |
| Current Asset (Consolidated) | M Baht | 2006 - 2010 | R^2 = 91.55% Adjusted R^2 = 88.73% | 0.0100661 X + 2270.80296 | 247.6053279 |
| Non Current Asset (Consolidated) | M Baht | 2006 - 2010 | R^2 = 95.93% Adjusted R^2 = 93.89% | 0.005217288 X + 2596.49469 | 169.0229569 |
| Fixed Asset (Consolidated) | M Baht | 2006 - 2010 | R^2 = 69.09%% Adjusted R^2 = 58.78% | 0.006683936 X + 2812.122641 | 473.5293071 |
| COGS (Consolidated) | M Baht | 2006 - 2010 | R^2 = 98.82% Adjusted R^2 = 98.42% | 0.001955718 X + 2847.47077 | 92.68330802 |
| SG&A (Consolidated) | M Baht | 2006 - 2010 | R^2 = 94.02% Adjusted R^2 = 92.03% | 0.104149744 X + 2126.671935 | 208.2381385 |

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| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|--------------------------------|--------|--------------------|--|----------------------------|--|
| SG&A less HR (Consolidated) | M Baht | 2006 - 2010 | R^2 = 92.56% Adjusted R^2 = 90.08% | 0.115299502 X + 2391.45409 | 232.347667 |
| OPEX (Consolidated) | M Baht | 2006 - 2010 | R^2 = 98.81% Adjusted R^2 = 98.41% | 0.001921252 X + 2832.81167 | 92.95789858 |
| OPEX less HR (Consolidated) | M Baht | 2006 - 2010 | R^2 = 98.80% Adjusted R^2 = 98.41% | 0.001924901 X + 2838.30337 | 93.13683586 |
| EBITDA (Consolidated) | M Baht | 2006 - 2010 | R^2 = 90.43% Adjusted R^2 = 87.24% | 0.018599995 X + 2471.29212 | 263.5054868 |
| Revenue (PTT Only) | M Baht | 2006 - 2010 | R^2 = 95.08% Adjusted R^2 = 93.43% | 0.001858202 X + 2768.94608 | 189.0025759 |

Oil | Key Drivers and Manpower Statistical Analysis

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|----------------------|--------|--------------------|--|------------------------------|---|
| EVA | M Baht | 2006 - 2010 | R^2 = 14.36% Adjusted R^2 = -28.46% | - 0.012866144 X + 1768.50332 | 109.4332366 |
| Revenue | M Baht | 2006 - 2010 | R^2 = 43.14% Adjusted R^2 = 14.71% | 0.000631627 X + 1610.61286 | 89.17161334 |
| Asset | M Baht | 2006 - 2010 | R^2 = 38.91% Adjusted R^2 = 8.37% | 0.005015423 X + 1476.347737 | 92.42556273 |
| Current Asset | M Baht | 2006 - 2010 | R^2 = 25.33% Adjusted R^2 = -12.00% | 0.005168767 X + 1571.171616 | 102.1814508 |
| Non Current Asset | M Baht | 2006 - 2010 | R^2 = 79.97% Adjusted R^2 = 69.96% | 0.027992482 X + 1248.64319 | 52.92146742 |
| Non Current Asset | M Baht | 2006 - 2010 | R^2 = 98.33% Adjusted R^2 = 96.65% | 0.04392048 X + 825.970426 | 19.10129954 |
| Fixed Asset | M Baht | 2006 – 2010 | R^2 = 94.21% Adjusted R^2 = 91.48% | 0.099239759 X + 797.471645 | 28.18772996 |
| Fixed Asset | M Baht | 2006 – 2010 | R^2 = 97.04% Adjusted R^2 = 94.08% | 0.11449676 X + 629.009162 | 25.3981539 |

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|---|------------------|--------------------|--|---|---|
| PPE (X1) Asset Under Construction (X2) | M Baht M Baht | 2006 - 2010 | R^2 = 99.77% Adjusted R^2 = 99.31% | + 0.229637687 X1 + 0.122401116 X2 - 343.5930031 | 7.993409147 |
| COGS | M Baht | 2006 - 2010 | R^2 = 42.62% Adjusted R^2 = 13.92% | 0.000628781 X + 1616.98658 | 89.57882638 |
| SG&A | M Baht | 2006 - 2010 | R^2 = 10.48% Adjusted R^2 = -34.27% | 0.03418978 X + 1577.334422 | 111.8821657 |
| OPEX | M Baht | 2006 - 2010 | R^2 = 42.41% Adjusted R^2 = 13.62% | 0.000622966 X + 1614.45248 | 89.73722124 |
| OPEX less HR | M Baht | 2006 - 2010 | R^2 = 42.34% Adjusted R^2 = 13.51% | 0.000622826 X + 1615.63115 | 89.79313562 |
| Oil Product Sold (X1) | M Unit | 2006 - 2010 | R^2 = 91.03% Adjusted R^2 = 82.05%% | -0.215460627 X + 6151.209029 | 44.22363376 |
| Oil Product Sold (X1) Supporting Business (X2) | M Unit M Baht | 2006 - 2010 | R^2 = 99% Adjusted R^2 = 99% | -0.030269817 X1 +0.51475448 X2 +2131.27161 | 0.103173726 |

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|-----------------------------------|--------|--------------------|--|-----------------------------|---|
| EVA | M Baht | 2006 - 2010 | R^2 = 20.80% Adjusted R^2 = -18.80% | 0.054742387 X – 182.2864376 | 259.8604818 |
| Revenue (External) | M Baht | 2006 - 2010 | R^2 = 99.05% Adjusted R^2 = 98.73% | 0.006125213 X + 7.586673224 | 28.74073922 |
| Revenue | M Baht | 2006 - 2010 | R^2 = 98.28% Adjusted R^2 = 97.71% | 0.005704114 X – 36.748234 | 38.57005162 |
| Normalized Revenue External | M Baht | 2006 - 2010 | R^2 = 93.15% Adjusted R^2 = 90.87% | 0.014073535 X – 1916.3716 | 77.01145954 |
| Asset | M Baht | 2006 - 2010 | R^2 = 97.90% Adjusted R^2 = 97.20% | 0.005626462 X + 276.85352 | 42.65428703 |
| Current Asset | M Baht | 2006 - 2010 | R^2 = 99.31% Adjusted R^2 = 99.08% | 0.022313621 X + 427.3327317 | 24.43473651 |
| Non Current Asset | M Baht | 2006 - 2010 | R^2 = 99.82% Adjusted R^2 = 99.74% | 0.008152416 X + 219.5386157 | 12.25252143 |
| Fixed Asset | M Baht | 2006 - 2010 | R^2 = 77.36% Adjusted R^2 = 69.82% | 0.012485004 X + 432.17445 | 139.9864946 |

Gas | Key Drivers and Manpower Statistical Analysis

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|----------------------|--------|--------------------|--|---------------------------|---|
| COGS | M Baht | 2006 - 2010 | R^2 = 98.10% Adjusted R^2 = 97.47% | 0.006933904 X - 20.614289 | 40.561039 |
| SG&A | M Baht | 2006 - 2010 | R^2 = 97.61% Adjusted R^2 = 96.81% | 0.193046257X + 440.535225 | 45.48475807 |
| OPEX | M Baht | 2006 - 2010 | R^2 = 98.34% Adjusted R^2 = 97.79% | 0.006710969 X - 7.6619901 | 37.92215006 |
| OPEX less HR | M Baht | 2006 - 2010 | R^2 = 98.32% Adjusted R^2 = 97.76% | 0.006755534 X - 7.5798068 | 38.17834916 |
| Gas Demand | mmscfd | 2006 - 2010 | R^2 = 94.04% Adjusted R^2 = 92.06% | 1.010712656 X – 1831.1428 | 71.80463085 |
| Gas Product Sales | M Tons | 2006 - 2010 | R^2 = 90.53% Adjusted R^2 = 87.37% | 433.9053258 X - 275.13345 | 90.5664545 |

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| Trading | Key Drivers | and Manpower | Statistical Analysis |
|---------|-------------|--------------|-----------------------------|
|---------|-------------|--------------|-----------------------------|

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|------------------|--------|--------------------|--|----------------------------|---|
| EVA | M Baht | 2006 - 2010 | R^2 = 72.64% Adjusted R^2 = 58.96% | 0.06645661 X - 104.82984 | 25.12343489 |
| Revenue | M Baht | 2006 - 2010 | R^2 = 94.44% Adjusted R^2 = 91.65% | 0.000182.909 X + 3.5188147 | 11.32845401 |
| Asset | M Baht | 2006 - 2010 | R^2 = 81.65% Adjusted R^2 = 72.47% | 0.000918365 X +43.8242349 | 20.57579563 |
| Current Asset | M Baht | 2006 - 2010 | R^2 = 81.68% Adjusted R^2 = 72.51% | 0.00091831 X + 43.8377406 | 20.5598184 |
| COGS | M Baht | 2006 - 2010 | R^2 = 94.31% Adjusted R^2 = 91.46%% | 0.000183045 X + 4.03304374 | 11.4559759 |
| SG&A | M Baht | 2006 - 2010 | R^2 = 13.16% Adjusted R^2 = -30.26% | 0.017900021 X + 29.2978695 | 44.7566759 |
| OPEX | M Baht | 2006 - 2010 | R^2 = 94.45% Adjusted R^2 = 91.67% | 0.000183046 X + 3.33013303 | 11.31934355 |
| OPEX less HR | M Baht | 2006 - 2010 | R^2 = 94.44% Adjusted R^2 = 91.67% | 0.000183077 X + 3.33176226 | 11.32141588 |

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|-------------------------------------|------------------|--------------------|--|-----------------------------|---|
| Trading Volume | M Barrel | 2006 - 2010 | R^2 = 88.91% Adjusted R^2 = 83.37% | 0.41343119 X – 17.787267 | 15.99159205 |
| Trading Volume | M Liters | 2006 - 2010 | R^2 = 85.53% Adjusted R^2 = 78.30% | 0.003920052 X - 39.67345733 | 18.26802327 |
| Trading less Risk Volume | M Barrel | 2006 - 2010 | R^2 = 91.15% Adjusted R^2 = 86.72% | 0.553689405 X - 32.844586 | 14.28849694 |
| Ln (Trading Volume | M Liters | 2006 - 2010 | R^2 = 91.70% Adjusted R^2 = 87.55% | 146.2028785 X – 1428.5652 | 13.83618434 |
| Ln (Trading less Risk Volume) | Ln (M Barrel) | 2006 - 2010 | R^2 = 96.66% Adjusted R^2 = 94.99% | 133.6810798 X – 628.45286 | 8.780241967 |
| Revenue | M Baht | 2006 – 2010 | R^2 = 99.88% Adjusted R^2 = 99.75% | 0.000127725 X + 39.3983105 | 1.012272991 |
| Asset | M Baht | 2006 – 2010 | R^2 = 98.99% Adjusted R^2 = 97.97% | 0.00055869 X + 75.9071385 | 2.90854577 |
| Current Asset | M Baht | 2006 – 2010 | R^2 = 98.99% Adjusted R^2 = 97.97% | 0.00055873 X + 75.9057694 | 2.90773489 |

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| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|-------------------------------------|------------------|--------------------|--|-----------------------------|---|
| COGS | M Baht | 2006 – 2010 | R^2 = 99.90% Adjusted R^2 = 99.80% | 0.265188647 X + 32.9585614 | 0.91452758 |
| OPEX less HR | M Baht | 2006 - 2010 | R^2 = 99.88% Adjusted R^2 = 99.75% | 0.000127862 X + 39.2543533 | 1.014340301 |
| Trading Volume | kboe/d | 2006 – 2010 | R^2 = 98.70% Adjusted R^2 = 97.40% | 0.14176387 X + 22.2838434 | 3.29526673 |
| Trading Volume | M Barrel | 2006 – 2010 | R^2 = 97.92% Adjusted R^2 = 95.84% | 0.265188647 X + 32.9585614 | 4.165901513 |
| Trading Volume | M Liters | 2006 - 2010 | R^2 = 98.67% Adjusted R^2 = 97.34% | 0.002439461 X + 22.4075046 | 3.330809119 |
| Trading less Risk Volume | M Barrel | 2006 – 2010 | R^2 = 98.79% Adjusted R^2 = 97.59% | 0.365301804 X + 20.2640899 | 3.172678808 |
| Ln (Trading Volume) | Ln (M Barrel) | 2006 – 2010 | R^2 = 98.87% Adjusted R^2 = 97.74% | 86.88821327 X - 381.6746503 | 3.066185273 |
| Ln (Trading Volume) | Ln (M Liters) | 2006 - 2010 | R^2 = 99.41% Adjusted R^2 = 98.82% | 223.8409901 X - 908.6076177 | 2.22004564 |
| Ln (Trading less Risk Volume) | Ln (M Barrel) | 2006 – 2010 | R^2 = 99.49% Adjusted R^2 = 98.98% | 228.6592084 X - 435.5581982 | 2.062926668 |

P&R | Key Drivers and Manpower Statistical Analysis

| Key Driver | Unit | Historical Data | Linear Relationship with Salary + Bonus + Contract Expenses | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|---|--------|-----------------|---|--|---|
| Investment in Affiliates | M Baht | 2005 - 2010 | R^2 = 99.80% Adjusted R^2 = 99.73% | 0.000649285 X – 6.6959813 | 0.879738607 |
| Cumulative Total Investment | M Baht | 2005 - 2010 | R^2 = 96.05% Adjusted R^2 = 94.74% | 0.000486794 X + 24.5741092 | 3.901018949 |
| Cumulative Internal Investment (X1) Cumulative JV Investment (X2) | M Baht | 2005 - 2010 | R^2 = 99.91% Adjusted R^2 = 99.83% | 0.005184459 X1 + 0.000341604 X2 + 25.915862 | 0.703592681 |
| Revenue of Affiliates | M Baht | 2005 - 2010 | R^2 = 90.51% Adjusted R^2 = 85.76% | 0.000062986 X – 12.60863576 | 6.209756529 |
| Non Current Asset of Affiliates | M Baht | 2005 - 2010 | R^2 = 99.58% Adjusted R^2 = 99.37% | 0.00035891 X – 61.38097 | 1.302240582 |
| Fixed Asset of Affiliates | M Baht | 2005 - 2010 | R^2 = 99.47% Adjusted R^2 = 99.21% | 0.000412833 X – 67.74359617 | 1.46561201 |

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HO Support | Key Drivers and Manpower Statistical Analysis

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|-------------------------|--------|--------------------|--|-----------------------------|---|
| EVA (5BGs) | M Baht | 2005 - 2010 | R^2 = 84.29% Adjusted R^2 = 79.06% | 0.01470334 X + 673.1967573 | 147.0424778 |
| Revenue Consolidated | M Baht | 2005 - 2010 | R^2 = 98.20% Adjusted R^2 = 97.59% | 0.000776304 X + 658.3489705 | 49.84620377 |
| Asset Consolidated | M Baht | 2005 - 2010 | R^2 = 95.18% Adjusted R^2 = 92.77% | 0.001581873 X + 500.909411 | 78.06010379 |
| Non Current Asset | M Baht | 2005 - 2010 | R^2 = 95.51% Adjusted R^2 = 93.26% | 0.002210064 X + 598.8481474 | 75.38398987 |
| Fixed Asset | M Baht | 2005 - 2010 | R^2 = 83.82% Adjusted R^2 = 75.73% | 0.003415032 X + 597.3370642 | 143.0570286 |
| COGS Consolidated | M Baht | 2005 - 2010 | R^2 = 98.26% Adjusted R^2 = 97.82% | 0.00085008 X + 680.667695 | 47.4705963 |
| SG&A Consolidated | M Baht | 2005 - 2010 | R^2 = 95.63% Adjusted R^2 = 94.17% | 0.045760196 X + 356.187378 | 77.5754091 |
| OPEX Consolidated | M Baht | 2005 - 2010 | R^2 = 98.38% Adjusted R^2 = 97.86% | 0.00083526 X + 674.158089 | 47.0277998 |

| Key Driver | Unit | Historical Data | Linear Relationship with HR OPEX + CONTRACT | Regression Line (M Baht) | Standard Error of Regression (M Baht) |
|------------------------|--------|--------------------|--|-----------------------------|---|
| HR OPEX (5 BGs) | M Baht | 2005 - 2010 | R^2 = 99.74% Adjusted R^2 = 99.65% | 0.435092667 X - 558.956426 | 18.96013345 |
| HR OPEX (4 BGs) | M Baht | 2005 - 2010 | R^2 = 99.20% Adjusted R^2 = 98.94% | 0.741311225 X – 922.8673789 | 33.09475827 |
| EBITDA Consolidated | M Baht | 2005 - 2010 | R^2 = 91.67% Adjusted R^2 = 88.89% | 0.008158663 X + 509.0876234 | 107.1084431 |