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International Benchmarking in Higher Education: A Case Study for Engineering Education in Malaysia

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ABSTRACT

Engineering education is quickly expanding in Malaysia to meet the country's demand for engineers. The challenge arising from this phenomenon is quality assurance. This can be achieved if there is a sound accreditation system in place which is formally benchmarked against international standards to provide confidence among prospective employers and the wider public. Malaysia is currently a provisional member of the Washington Accord, an international agreement which recognizes the substantial equivalency of engineering degree programs. The engineering education community in Malaysia is currently engaged in intense efforts aimed towards full membership of the Washington Accord. The most significant requirement for this process is embarking upon a systematic shift towards a culture of continuous quality improvement in the engineering education system. It also involves a genuine shift in focus from the conventional prescriptive emphasis on inputs and processes towards an outcome-based education (OBE) system.

Keywords: Accreditation, engineering education, benchmarking, outcome-based education

INTRODUCTION

Engineering plays a major and central role in Malaysia's fast developing economy. It is the largest profession, and, consequently, engineering education is the biggest component in the nation's tertiary education sector. Being the biggest requires that it must done right, especially in the context of the unique conditions of the nation and region.

Young engineers will have to adapt to globalization, the rapid advancement of technology, intensive physical development, environmental degradation and its preservation,

capacity building, as well as ethical and civil obligations. It is thus an imperative that Malaysia's engineering education community puts in place an internationally benchmarked quality assurance system to ensure graduates are ready to enter the profession in the face of such daunting issues.

In this paper, the author will highlight the significance and implications of the Washington Accord agreement on the engineering education ommunity. The paper will also document experiences of some engineering faculties and the Engineering Accreditation Council (EAC) of Malaysia in meeting the requirements of the sponsors and mentors. In particular, efforts in introducing elements of Outcome-Based Education (OBE) as a key requirement for full membership of the Accord will be presented.

ENGINEERING EDUCATION IN MALAYSIA

Tertiary engineering education in Malaysia began in 1956 with the introduction of the Bachelor of Civil Engineering programme at the University of Malaya. Engineering programmes are now offered by 14 public and 9 private institutions of higher learning.

Within the last decade, the Malaysian government has taken a bold step with the setting up of four Technical University Colleges (TUCs). TUCs offer programmes with an applications and practice oriented curriculum along the lines of the successful and proven German fachhochschule system. This constitutes a major development in the Malaysian engineering profession, the impact of which will be that a large number of Malaysian engineering graduates produced in the future will be equipped with applications and practice oriented competencies. The TUC graduates are expected to be more practical, adaptive, agile and flexible to changes in the working environment and recognized as an important engineering team member within the profession.

The European Federation of National Engineering Associations (FEANI) recognizes two profiles of the professional engineer for the purpose of registration as a European Professional Engineer (EUR-ING).The first is the theoretical oriented engineer, and the second is the applications oriented engineer. Both categories of engineers, despite having some different competencies, are considered to have the same standing and importance in their role in industry. FEANI's publication, Competence of Professional Engineers/EUR-ING, explains at great length the attributes and roles of both.

France, Japan, and Korea have always adopted engineering curricula where practice constitutes a large and important part to compliment the theoretical component. The top engineering schools in France, while well-known for their strong theoretical foundation, prescribe extensive and well laid out structures to incorporate practice and applications elements in their curricula. The French accreditation agency for engineering programmes, Commission des Titres d Íngenieurs (CTI), has advanced to the extent of specifying that a minimum of 20 percent of teaching time to be in the form of industry contribution. Discussions with several accreditation agencies and universities in Europe, Korea and Japan generally point toward the direction of a desired engineer profile where both theory and practice are well-grounded.

Similarly, Malaysian employers require engineers with mainly two types of competency profiles. While the first and more widely preferred is a balanced profile combining both theoretical/research and applications/practice orientations, the second, i.e. the applications and practice oriented profile, still constitute a very significant component of the national demand for engineers. The government's decision to set up TUCs in previous years was a correct strategic move to meet this demand.

COMPETENCIES FOR MALAYSIAN ENGINEERS

In the rapidly changing world today, engineers are required to perform increasingly complex tasks. The competencies of future engineering graduates must be identified, assessed and reinforced as necessary. Consequently, it is inevitable that changes in engineering education are required to ensure these competencies remain relevant and are being achieved.

In response to industry needs and other stakeholder demands, engineering faculties have been motivated to redesign their programmes significantly. Engineering programmes have been encouraged to promote the ability to synthesize and relate courses to real world applications in order to facilitate a smooth transition from education to practice. The roles of non-technical competencies such as communications, ethics and knowledge of contemporary issues are being enhanced. The increasing emphasis on these outcome elements has also been demanded by national and international accreditation bodies for engineering programmes, including most recently by the Engineering Accreditation Council (EAC) in Malaysia.

In August 2005, EAC adopted a new Manual for the Accreditation of Engineering Programmes [1]. This new Manual shifted the basis for accreditation from inputs and processes, such as what is taught, to outcomes such as what has been learned or what competencies have been attained. The Manual specifies 13 programme outcomes and requires engineering programmes to assess and demonstrate student achievement for each one of them. Previous criteria on programme resources and technical content still remain, but it also emphasizes developing other professional skills such as teamwork, effective communication and socio-ethical considerations. Table 1 shows the list of engineer attributes that is expected of competent graduates.

The views of employers on graduate competencies [2] clearly point to an urgent need for engineering programmes to improve in all areas, particularly in several non-technical aspects of engineering education. Engineers must be educated to think broadly in fundamental and integrative ways about engineering. Apart from the application of mathematics and the sciences as core engineering subjects, engineering curricula must stress more on the humanistic, as apposed to scientific and mechanistic, aspects of problem solving or project implementation.

There is also agreement among employers and leading engineers that graduates lack effective communication skills, both oral and written. In preparing the student for a professional career, the importance of mastering these soft skills must be further emphasized.

DEMAND FOR ENGINEERS

One of the main indicators of a technologically developed nation is the ratio of engineers to the population of a country. Table 2 shows engineer-population ratios for Malaysia and several advanced countries [3].

Clearly Malaysia is trailing far behind, and hence there is a need to intensify production of engineers at a very significant rate in order to achieve a comparable index with the developed nations. It is reasonable to set an "advanced nation benchmark" at engineer/population ratio of 1:100. This means that the nation would need approximately 275,000 and 300,000 engineers in 5 and 10 years respectively (assuming population growth at 2% per annum).

TABLE 1

ATTRIBUTES EXPECTED IN GRADUATE ENGINEERS

1	Ability to acquire and apply knowledge of engineering fundamentals.
2	Having the competency in theoretical and research engineering.
3	Having competency in application and practice oriented engineering.
4	Ability to communicate effectively, not only with engineers but also with the community at large.
5	Having in-depth technical competence in a specific engineering discipline.
6	Ability to undertake problem identification, formulation and solution
7	Ability to utilize a systems approach to design and evaluate operational performance.
8	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member.
9	Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development.
10	Recognizing the need to undertake lifelong learning, and possessing/acquiring the capacity to do so
11	Ability to design and conduct experiments, as well as to analyze and interpret data
12	Having the knowledge of contemporary issues.
13	Having the basic entrepreneurial skills

TABLE 2

ENGINEER-POPULATION RATIOS

Country	Engineer-Population ratio
Malaysia	1:312
France	1:75
Germany	1:82
Canada	1:120
United Kingdom	1:141

ACCREDITATION & QUALITY ASSURANCE

In Malaysia, the accreditation of engineering programmes falls under the jurisdiction of the Engineering Accreditation Council (EAC). EAC was instituted by the Board of Engineers Malaysia (BEM), the statutory body which has the legal responsibility of registering engineers and regulating the engineering profession in the country. EAC derives its membership from the Institution of Engineers Malaysia, Malaysian Qualifications Agency, the Public Services Department of Malaysia, The Malaysian Council of Engineering Deans, and several members appointed by the President of BEM from among industry practitioners and academia.

EAC currently has a register of 309 engineering programmes in various disciplines being offered by 23 institutions of higher learning. This represents a very significant increase in number over the last decade. It is a direct result of Malaysia's strategy to become an international education hub for the region, as well as providing sufficient manpower for the nation's industrial and technological development.

The challenge arising from this phenomenon is quality assurance. Prospective employers, both national and international, must be assured of engineering graduates from Malaysian IHEs who are sufficiently prepared for the local and global job market. Quality assurance is thus essential to provide confidence among all stakeholders. This can be achieved if there is a sound accreditation system in place which ensures that accredited study programmes meet a preset minimum quality standard for their resources, processes and outcomes. It is also essential that the accreditation system be formally benchmarked against international standards by means of participation in appropriate international accords and agreements.

THE WASHINGTON ACCORD & INTERNATIONAL BENCHMARKING

In 2003, Malaysia was accorded provisional signatory status in the Washington Accord, alongside Germany, Singapore and Japan. The Accord is a multinational agreement on the mutual recognition of substantial equivalency between engineering degree programs accredited by the responsible bodies in each of the signatory countries. The agreement paves the way for mutual recognition of accredited programmes, establishing that graduates have met the academic requirements for entry to the practice of engineering in any signatory country. Admission to the Accord is, more importantly, an endorsement that the engineering education system of the member nation has demonstrated a strong, long-term commitment to quality assurance in producing engineers ready for global industry practice.

There are two categories of Washington Accord membership: provisional and full. Provisional membership requires that the accreditation system of the applicant nation is conceptually similar to those of the other signatories of the Washington Accord and has the potential capability to reach full signatory status. Full admission to the Accord is granted if an applicant country has proven that its accreditation system and criteria are of equivalent standard to those of the signatory nations.

Malaysia's admission into the Washington Accord as a provisional signatory was a significant development since it implied that Malaysia's accreditation system is conceptually similar to those of the full signatory members with respect to quality assurance of engineering education programmes. The Accord has subsequently appointed three countries as mentors, namely, Australia (acting as lead mentor), USA and Hong Kong. Currently the Malaysian accreditation system for engineering education is undergoing a major improvement programme with the assistance of its mentors through a series of observations, discussions and seminars.

The Washington Accord agreement covers only professional engineering undergraduate degrees. Engineering technology (covered by the Sydney Accord), engineering technician (covered by the Dublin Accord) and postgraduate-level programmes (Masters and PhD) are not covered by the Washington Accord.

International agreements which cover the domain of professional practice include the FEANI Register of European Engineers (EUR ING), the Engineers Mobility Forum (EMF) and the Asia Pacific Economic Cooperation (APEC) Engineer.

EUROPEAN DEVELOPMENTS

Engineering education in Europe witnessed remarkable developments since 2004. Current and past practice in the continent is characterized by non-uniformity regarding nomenclature, systems and procedures relating to engineering education and the profession itself. This has created great confusion in the mutual recognition of academic and professional qualifications.

Notwithstanding the prestige of some engineering titles at national levels, the lack of an accreditation system recognized on the European scale places the graduate in an objectively weak position when confronted with international recognition agreements in the context of a global job market. Remedying this serious weakness was the main motivating factor for the concerted efforts to ensure Europe-wide consistency in the accreditation of engineering programmes.

The European Network for the Accreditation of Engineering Education (ENAEE) was established in Brussels on February 8, 2006 by a consortium of 14 European accreditation bodies and other institutions in the field of engineering education. Among the key members are the European Society for Engineering Education (SEFI), the European Federation of National

Engineering Associations (FEANI), and the engineering accreditations bodies for Germany (ASIIN), UK (ECUK), and France (CTI).

The objectives of ENAEE are to build confidence in accreditation systems for engineering degree programmes and to promote the implementation of sound accreditation practices in Europe. In order to achieve this objective, ENAEE will establish a European system for engineering accreditation based on a framework of standards developed by the EUR-ACE project sponsored by the European Commission. This framework is known as the EUR-ACE Framework Standards for the Accreditation of Engineering Programmes, and accredited programmes will carry the EUR-ACE label. It is envisaged that this label will be a European Label indicating quality engineering programmes.

These European efforts are also designed to achieve wider objectives as follows.

- Ensure engineering degree programmes maintain minimum defined educational standards based on educational outcomes.
- Improving the quality of engineering degree programmes.
- Facilitate trans-national recognition by means of the EUR-ACE Label.
- Facilitate mutual recognition agreements
- Facilitate recognition by competent authorities, in accordance with EU Directives.

The EUR-ACE Label and the EANEE were launched together in Brussels on March 31, 2006, and Malaysia, represented by a delegation led by the author, was honored to be the only non-European nation invited to attend the ceremony.

The formation of the ENAEE to implement the EUR-ACE Label can effectively be viewed as a European Accord for engineering accreditation. Governance of the ENAEE has a well-defined structure, allowing for a wider European participation which involves differing

education systems. There also appears to be an effort among the key European parties to understand and accommodate the aspirations of countries at varying stages of development throughout Europe in enhancing engineering education.

Some of the salient features of the ENAEE and the EUR-ACE Label project are:

- ENAEE declared objectives and the EUR-ACE Framework Standards are well-structured and transparent.
- The EUR-ACE Framework Standards cover both Bachelor (First Cycle) and Masters (Second Cycle) programmes (Washington Accord covers only the first cycle degree).
- The EUR-ACE Framework Standards allow for a dual engineer profile based on outcomes, which is in line with Malaysia's engineering education strategy.
- EUR-ACE/ENAEE has the official and financial support of the European Commission under the Directorate-General for Education and Culture.
- ENAEE is a bigger grouping (20 participating nations) when compared to the Washington Accord.

RECENT DEVELOPMENTS IN ASIA: THE LAUNCH OF NABEEA

The developments in Europe described above have sparked interest among several Asian countries to create a similar regional framework. EAC played a central role in deliberations with several engineering accreditation organizations in Asia, eventually reaching a consensus to form a network with four founding member countries - Japan, Korea, Malaysia and Singapore.

On August 6, 2007 in Penang, the Network of Accreditation Bodies for Engineering Education in Asia (NABEEA) was formally launched in a meeting hosted by EAC. A representative from Malaysia was elected as the Secretary and one from Japan as the Chairman.

The formation of NABEEA is an interesting proposition based on several premises:

1. There are many cultural similarities which are unique among Asian nations. This can be used as a catalyst for a more meaningful cooperation.

2. There is a wide disparity in the development of engineering education among Asian countries. This requires a unique approach which can accommodate as many nations as possible in the spirit of mutual cooperation.

3. A new regional accord can build on the invaluable experiences of the Washington Accord and ENAEE/EUR-ACE, and promote intra- and inter-regional networking and cooperation.

4. There are still some discrepancies between engineering education approaches taken by western nations and some major Asian countries.

The broad strategies that NABEEA will undertake may involve:

- Striking an inter-regional partnership with ENAEE which will mutually benefit Europe and Asia.
- Working closely with the Washington Accord in efforts towards continual quality improvement based on the outcomes approach.
- Widening the membership base to incorporate other Asian countries.

CONTINUAL QUALITY IMPROVEMENT (CQI) & THE OUTCOMES APPROACH

A Culture Shift towards Outcome-based Education

The engineering education community in Malaysia is currently engaged in intense efforts aimed toward full membership of the Washington Accord. The most significant requirement for this process is the need for a genuine shift from the conventional prescriptive-based system towards an outcome-based education (OBE) system. The outcomes approach for continuous

programme improvement is a significant element in the contents of the Accreditation Manual of the Engineering Accreditation Council (EAC).

Prior to this, educational elements based on objectives and outcomes for continuous programme improvement are mentioned in at least two regulatory documents - the accreditation guidelines of the then National Accreditation Board (precursor organization to the Malaysian Qualifications Agency) and the Code of Practice for Quality Assurance (Ministry of Higher Education Malaysia) [4]. However, the emphasis and the clarity of those elements in these documents are not as explicit as the requirements spelt out as Criteria 2 and 3 in the ABET [5] Criteria. As is now widely recognized and anticipated, the outcomes-approach is now featuring more prominently in engineering accreditation exercises in Malaysia as well as internationally.

Apart from meeting the above regulatory requirements, it is clear that by initiating and sustaining a genuine shift towards OBE, engineering programmes can anticipate real benefits and improvements that include:

- a more directed and coherent curriculum,
- graduates with attributes more relevant to industry stakeholders, and
- Continuous Quality Improvement (CQI) as an inevitable consequence.

An awareness of these significant benefits should provide a powerful motivating force for engineering faculties to be committed to the implementation of OBE. Thus, in meeting the Washington Accord requirements, the engineering education system will necessarily be driven toward continuously improving programme quality. This, regardless of the status of Washington Accord membership, is the more important consequence benefitting the engineering profession in Malaysia.

What is Outcome-based Education?

OBE focuses on outcomes in the preparation of graduates for professional practice. This requires documented evidence demonstrating that the graduates have achieved the required outcomes, rather than focusing on the process in achieving the outcomes even though this may also be important.

Programme outcomes are those outcomes that are expected to be attained upon graduation, while programme objectives are the longer term outcomes following graduation. Both programme outcomes and objectives are identified, tracked, assessed and evaluated for use in continually improving the quality of the programme. Outcomes at the level of individual courses are also important, and must be clarified, assessed, and contribute to programme level outcomes.

OBE has been described as 'an educational process which is based on trying to achieve certain specified outcomes in terms of individual student learning. Thus, having decided what are the key things students should understand and be able to do or the qualities they should develop, both structures and curricula are designed to achieve those capabilities or qualities. Educational structures and curriculum are regarded as means not ends. If they do not do the job, they are rethought.

An important and integral component of the OBE approach is Continuous Quality Improvement (CQI). Feedback from all stakeholders and the necessary follow-up actions must be implemented at all stages to complete the quality improvement loop. This spans from the time of curriculum design until the execution and implementation of the programme.

Some of the immediate effects and advantages of an outcome-based approach are:

- Universities are always alert and concerned about the quality of the graduates produced;
- More systematic, innovative and flexible teaching methods, for example, project based learning within an integrated learning environment, will be encouraged, and;
- Student's increased exposure to professional practice through industrial training, site visits and industry-linked projects or assignments.

Driving a Culture Change in Engineering Faculties

The Ministry of Higher Education Malaysia, EAC, and the Engineering Faculty of Universiti Kebangsaan Malaysia (UKM), have embarked on an intensive project aimed at driving the required culture change towards OBE in Malaysian engineering faculties. The project was based on the sharing of the UKM experience in the implementation of OBE practices, and was implemented in an 18 month period throughout 2005 until May 2006.

The desired culture change in the universities was initially driven by and centered on a conscious effort in changing the existing curriculum in line with OBE. This strategy has been found to be effective for the case of UKM.

The first main objective was for all engineering faculties in Malaysia to design and adopt an outcome-based curriculum and implement it in the academic session of 2006. This exercise will create the necessary initial awareness, understanding and motivation for faculty and staff to continuously improve the programme by focusing on outcomes.

Workshops on OBE awareness, setting objectives & outcomes, and the implementation of OBE in curriculum design were offered to participants from among management in all engineering faculties. It was expected that the participants will immediately conduct similar workshops on selected groups in their own faculties. These groups will then form the core team

to spearhead OBE curriculum design and delivery. The workshop modules are continually revised and improved and are currently appropriate for wider implementation covering panel evaluators and EAC members.

Conferences on engineering education, led by UTM and the Malaysian Council of Engineering Deans, have been held annually since 2004. All engineering faculties in Malaysia were requested to present and share their experiences in their efforts to implement outcome-based educational policies and practices.

CONCLUSION

A sound accreditation system ensures that a minimum standard is maintained in the delivery of engineering programmes. Benchmarking of Malaysia's accreditation system against appropriate international standards will go a long way in assuring quality graduates who are able to compete in the global job market and in enhancing the nation's effort to be an education hub for the region.

Malaysia is currently a signatory of the Washington Accord. In meeting the requirements for Accord and other quality assurance frameworks, universities as well as the engineering education fraternity must prepare themselves for a major change towards a culture of continuous improvement in educational practices. This entails changing from a system which focuses on facilities, resources and processes toward one which focuses on outcomes of courses and programmes. This culture change will inevitably contribute significantly towards strengthening quality assurance where engineering programmes in Malaysia can be relied upon to produce competent engineers.

Finally, Malaysia's experience as a central player in the recent formation of NABEEA has the potential to be utilized for the possible formation of a similar network among OIC countries.

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Financial Analysis of Global Pharmaceutical Companies for 2006 and 2007

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ABSTRACT

A survey was conducted to assess the financial performance and management efficiency of twenty-one representative pharmaceutical companies based in the United States, Europe and Asia for 2006 and 2007. The parameters that are measured in this study are profitability, ability to pay current liabilities, ability to sell inventory and collect receivables, ability to pay long-term debt, and stock valuations. Many western companies' rate of return exceeded 10% on total assets and 15% on common stockholders' equity, while the Asian companies did not do as well as their US and European counterparts in term of rate of returns. The reason for this may be attributed to the difference in social systems and price control implemented by the some governments. The rates of return for innovative companies are slightly higher than generic companies with a few exceptions. Biotechnology companies return very high rates compared to the other companies in this survey. Successful businesses operate with current ratios between 1.2 and 1.5 and keep the acid-test ratio at about 1.0. The debt ratio for most companies in the U.S ranges from 0.6 to 0.7. Many of the pharmaceutical companies in this survey have lower debt ratio than the norm. The average days' sales in receivables for these companies are 67; the average accounts receivable turnover is 6.0; and the average inventory turnover is 2.7. The price/earning ratio of the western companies' stocks ranges from 14 to 44 in 2006 and 10 to 40 in 2007. This ratio is higher for companies in emerging economies. The price/book ratio of the studied companies ranges from 1 to 9 in 2006 and 2 to 9 in 2007. Investors usually believe that stocks become more expensive with higher price/earning ratios, and that the stocks with lower price to book ratios are more attractive. However, stock prices are often influenced by many other factors such as the prospect of future earnings and investor psychology. Data show that high P/E stocks got more expensive from 2006 to 2007. Therefore, it is not always easy to analyze stock as an investment in the short term.

Key Words

Financial analysis, pharmaceutical companies, profitability and management efficiency.

INTRODUCTION

Despite facing challenges in competitive market environment and higher development and marketing cost, pharmaceutical companies around the world have made 2006 and 2007 successful years, with many of them achieving a double digit gains in profits. A survey was conducted to assess the financial performance and management efficiency of twenty-one representative pharmaceutical companies based in the United States, Europe and Asia. These companies are categorized into four groups: research based innovative companies, generic companies, biotechnology companies, and pharmaceuticals in a bigger conglomerate. The parameters that are measured in this study are profitability, ability to pay current liabilities, ability to sell inventory and collect receivables, ability to pay long-term debt, and stock valuations. The reason behind profitability is also briefly discussed. The companies that are researched by this study are shown in Figure 1 along with their sales, the countries where they are based in and their business models. It was not the author's intention to rule out other companies but to keep the table reasonably concise. In order to evaluate the measures mentioned above, data were abstracted from the 2006 and 2007 consolidated financial statements of these companies[1]. Financial analysis is performed by calculating a series of ratios[2] as discussed in the following.

PROFITABILITY

There are four ratios that are commonly used to measured profitability of a business, (i) rate of return on sales, (ii) rate of return on total assets, (iii) rate of return on common stockholders' equity and (iv) earnings per share of common stock. The formula to calculate these ratios are shown in the following:

$$Rate\ of\ return\ on\ sale = \frac{Net\ income}{Sales} \quad ,$$

shows the percentage of each sales dollar earned as net income.

$$Rate\ of\ return\ on\ total\ assets = \frac{Net\ income + Interest\ expense}{Average\ total\ assets} ,$$

measures how profitably a company uses its assets.

$$Rate\ of\ return\ on\ common\ stockholders'\ equity = \frac{Net\ income - Preferred\ dividents}{Average\ common\ stockholders'\ equity}$$

gauges how much income is earned with the money invested by the common shareholders.

$$Earnings\ per\ share\ of\ common\ stock = \frac{Net\ income - \Pr eferred\ dividents}{Number\ of\ shares\ of\ common\ stock\ ous\tan ding} ,$$

gives the amount of net income earned per share of the company's common stock outstanding.

These ratios for the twenty-one pharmaceutical companies are calculated and shown in Figure 2(a-c). The data suggest that there is little correlation between profitability and the size of the companies. Pfizer who has the top selling prescription drug Lipitor® has the highest rate of return on sales for 2006, but the 2007 return is lower due to the loss of patent protection of several key products. Barr and Eisai's returns on sales drop from 2006 to 2007 because of

business acquisitions, while Novartis's return on sales increases in 2007 primarily due to divesture of business. Astra Zeneca and Glaxo SmithKline score the highest in rate of return on total assets in 2006 and 2007, and Glaxo SmithKline has the highest mark in rate of return on common stockholders' equity for both 2006 and 2007. In general, a rate of return on total assets of 10% and rate of return on common stockholders' equity of 15% are considered strong for most companies. Most of the companies in this study exceeded these return numbers. Therefore, one may conclude that the pharmaceutical industry is a profitable business. It is noted that the Asian companies did not do as well as their US and European counterparts in term of rate of returns. The reason for this may be attributed to the difference in social systems (e.g. benefit cost and taxes) and price control implemented by the some governments who want to assure the availability of inexpensive medicine to the relatively poor population. As these Asian companies strive to explore oversea markets, especially in the US and Europe, their rates of return is expected to improve in the future.

The data also suggest that the rates of return for innovative companies are slightly higher than generic companies with a few exceptions. For example, the returns for Bristol-Myers Squibb and Abbott appear on the low side. Bristol-Myers Squibb is struggling with patent expiration of many of its key products. Barr Laboratories has an exceptionally high rate of return compared to their generic peers. This may be attributed to their successful business strategies. Barr engages in many patent challenge suits that entitle them to six months exclusivity of sales if the court ruling is in their favor. They also try to develop technically difficult products that add value to their portfolio.

Biotechnology companies Amgen and Genentech return very high rates compared to the other companies in this survey. They represent a business that can be very profitable from the

new types of medicine developed from cutting edge biotechnology. Biotech products typically enjoy high profit margin. The have relatively lower marketing cost and no generic competition in the USA. This helps the biotech companies to sustain long-term market monopoly of these products. However, the future profitability are likely be affected by the generic entry in biotech market. Recently, the US congress has introduced bills to allow the generic approval for biotech products.

Bayer and Procter & Gamble pharmaceuticals are within bigger chemicals and consumer good parents, respectively. Therefore, their rates of returns are better measures for the parent companies than the pharmaceutical division. Nevertheless, these return numbers are not as impressive as pure pharmaceutical companies due to diversification of the businesses.

ABILITY TO PAY CURRENT LIABILITIES

Current ratio and acid-test ratio are commonly used by accountants to measure the ability of a company to pay current liabilities. The formulas to calculate these two ratios are shown in the following equations.

$$Current\ ratio = \frac{Current\ assets}{Current\ liabilities},$$

measures ability to pay current liabilities with current assets.

$$Acid-test\ ratio = \frac{Cash + Short-term\ investments + Current\ receivables}{Current\ liabilities},$$

shows ability to pay all current liabilities if they come due immediately.

The current ratio and acid-test ratio ratios for the twenty-one pharmaceutical companies are shown in Figure 3(a, b). Most successful businesses operate with current ratios between 1.2 and 1.5. A strong current ratio is 1.5. Most companies usually keep the acid-test ratio at 1.0. As we can see in the figures, companies such as Pfizer, Roche, Wyeth, Eisai, Barr, Genentech and Eli Lilly have very strong financial positions. Barr and Eisai, for example, use the excessive current asset to make an acquisition to expand the business. The acid-test ratio for Johnson & Johnson, Abbott, Ranbaxy, Procter & Gamble, Sanofi Aventis and Bayer is relatively low, and adjustments should be made to bring the figure to a normal range.

ABILITY TO PAY LONG-TERM DEBT

Debt ratio is commonly used to indicate percentage of assets financed with debt. The formula to calculate debt ratio is shown as follows.

$$Debt\ ratio = \frac{Total\ liabilities}{Total\ assets}$$

The debt ratio for the twenty-one pharmaceutical companies is shown in Figure 4. The debt ratio for most companies in the U.S ranges from 0.6 to 0.7. Many of the pharmaceutical companies in this survey have lower debt ratio than the norm. They can afford more bank loans to finance their operations.

ABILITY TO SELL INVENTORY AND COLLECT RECEIVABLES

The ability to sell inventory and collect receivables is critical for businesses. Companies generally seek to sell their inventory and collect cash from customers as quickly as possible. The lower the receivable balance, the better the cash flow. There are three ratios that measure the ability to do these as shown in the following.

$$Inventory\ turnover = \frac{Cost\ of\ good\ sold}{Average\ inventory},$$

calculates the number of times a company sells its average level of inventory during a year.

$$Accounts\ \ receivable\ \ turnover\ = \frac{Credit\ \ sales}{Average\ \ accounts\ \ receivable},$$

measures ability to collect cash from credit customers.

$$Days'\ sales\ \ in\ \ receivable\ \ s = \frac{Average\ \ net\ \ accounts\ \ receivable}{One\ \ day's\ \ sales},$$

shows how many days it takes to collect the average level of receivables.

Inventory turnover, accounts receivable turnover, and days' sales in receivables for the twenty-one pharmaceutical companies are shown in Figure 5(a-c). The average inventory turnover is 2.7 for the companies included in this study. Procter & Gamble, Xinhua, Abbott, Merck, and Johnson & Johnson have higher inventory turnover than the average, while the figures for Pfizer, Eli Lilly, Amgen, and Genentech are on the low side. A precaution should be taken to make direct comparison of inventory figures because companies may use different methods to report their inventory.

The average accounts receivable turnover for these companies is 6.0. Merck, Amgen, Eli Lilly and Procter & Gamble have higher accounts receivable turnover than the average, while the figures for Eisai, Teva, Glaxo SmithKline and Ranbaxy are below the average. The high

inventory and accounts receivable turnover for Procter & Gamble may be due to the fact that most of its products are consumer goods instead of pharmaceuticals.

The average days' sales in receivables for these companies are 67. The rank order of days' sales in receivables is the same as accounts receivable turnover.

STOCK AS AN INVESTMENT

Investors often analyze stock valuation using price/earning ratio and the ratio of market price to book value. The formulas to calculate price/earning ratio and book value are shown in the following.

$$Price/earning\ ratio = \frac{Market\ price\ per\ share\ of\ common\ stock}{Earnings\ per\ share}$$

indicates the market price of $1 of earning. The higher this ratio is, the more expensive the stock becomes.

$$Book\ value\ per\ share\ of\ common\ stock = \frac{Total\ stockholders'equity - Preferred\ equity}{Number\ of\ shares\ of\ common\ stock\ outstanding}$$

indicates the recorded accounting amount for each share of common stock outstanding. Some investors believe that the lower the ratio of price to book value, the more attractive the stock.

The price/earning ratio and the price to book ratio for the twenty-one pharmaceutical companies are shown in Table 1 and Table 2. Among the western companies, Abbott and Barr's stocks have the highest price/earning ratio while Pfizer, Bayer and Novartis's stocks have the lowest price/earning ratio for 2006 and 2007, respectively. Teva, Ranbaxy and Xinhua's stocks

are more expensive than the others in terms of price/earning ratio, possibly because the local stock markets are running at higher multiples than the western markets. The price/book ratio is the highest for Glaxo SmithKline, Merck and lowest for Xinhua and Sanofi Aventis for 2006 and 2007, respectively.

Stock prices are often influenced by many other factors such as the prospect of future earnings and investor psychology. The data in Figure 6 show that the high P/E stocks got more expensive from 2006 to 2007, which disagrees with the common wisdom. Figure 7 shows that the price/book ratio seems to have a better correlation to stock price change (a downward sloping curve) in the same period although the correlation is week. Therefore, it is not always easy to analyze stock as an investment in the short term without insider information. Investment banks can provide more accurate estimations of stock prices.

ACKNOWLEDGEMENTS

The authors would like to thank Ms. Jing Ruan, CPA for the translation of Chinese financial statements, Mr. Linze Zhang for the explanation of the difference between the operation of Asian and Western pharmaceutical companies, colleagues at Barr Laboratories for the helpful discussion on pharmaceutical business, and Ms. Erin FitzPatrick for proof reading the manuscript.

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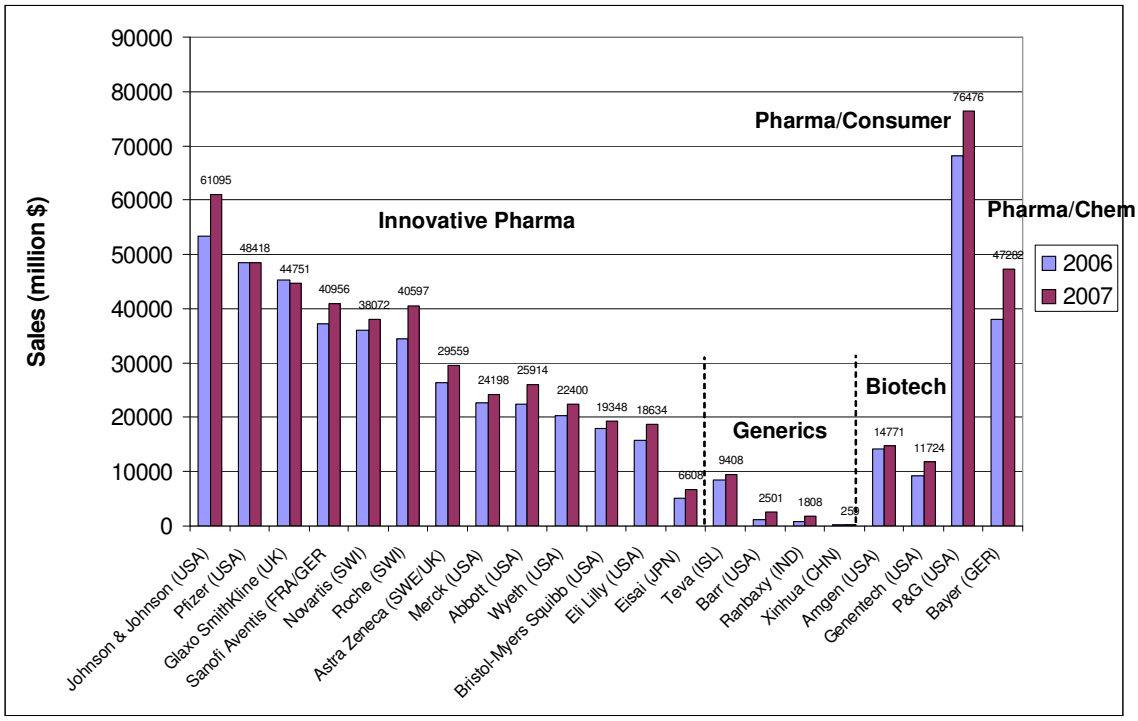
FIGURES AND TABLES

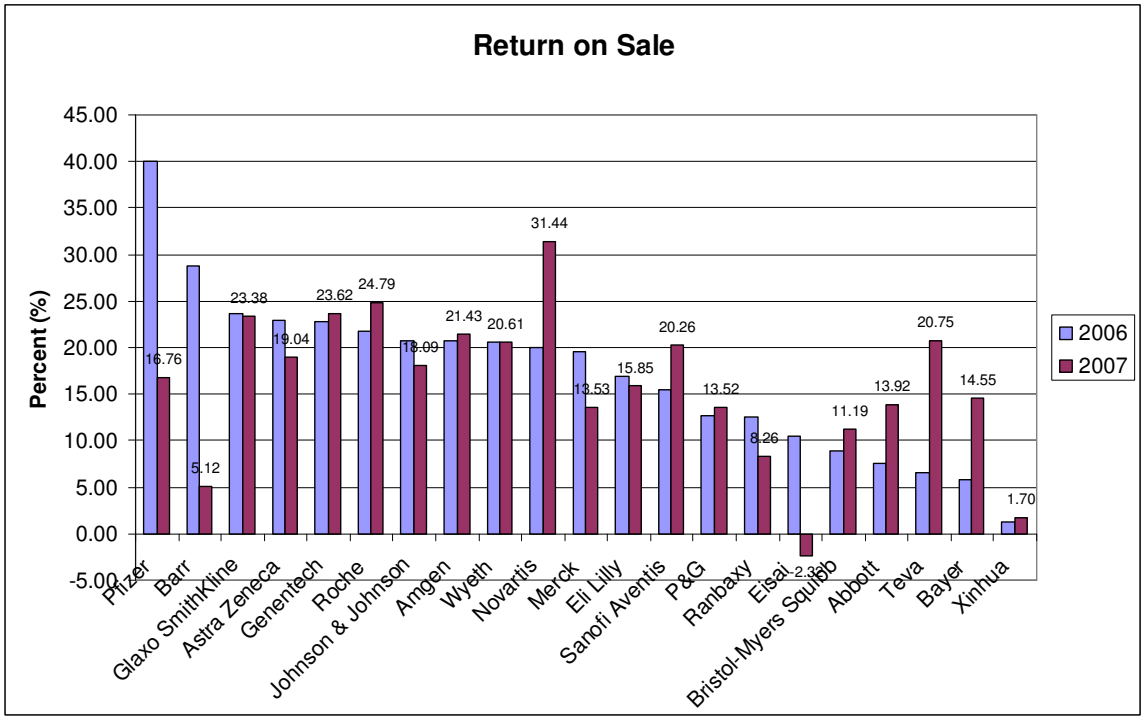
Figure 1: Pharmaceutical Companies Reviewed in This Study



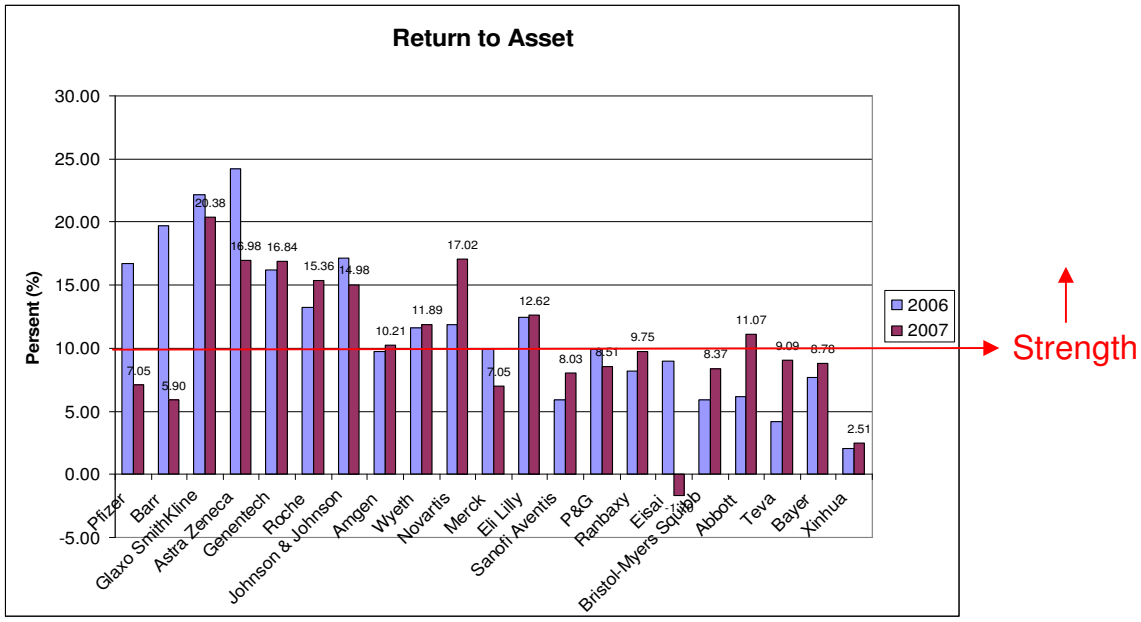
Note: Novartis has a $7B generic business (Sandoz)

Figure 2: Profitability of Representative Pharmaceutical Companies

(a)



(b)


Return to Asset
Persent (%)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
7.05
5.90
20.38
16.98
16.84
15.36
14.98
10.21
11.89
17.02
7.05
12.62
8.03
8.51
9.75
-1.19
8.37
11.07
9.09
8.78
2.51
Pfizer
Barr
Glaxo SmithKline
Astra Zeneca
Genentech
Roche
Johnson & Johnson
Amgen
Wyeth
Novartis
Merck
Eli Lilly
Sanofi Aventis
P&G
Ranbaxy
Eisai
Bristol-Myers Squibb
Abbott
Teva
Bayer
Xinhua
2006
2007
Strength

(c)

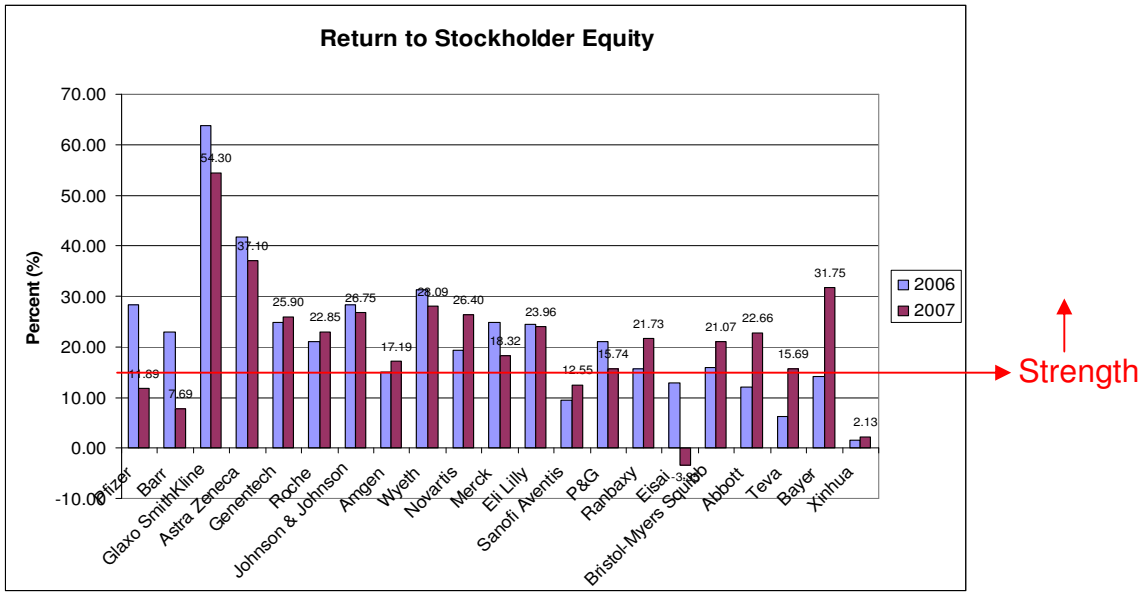
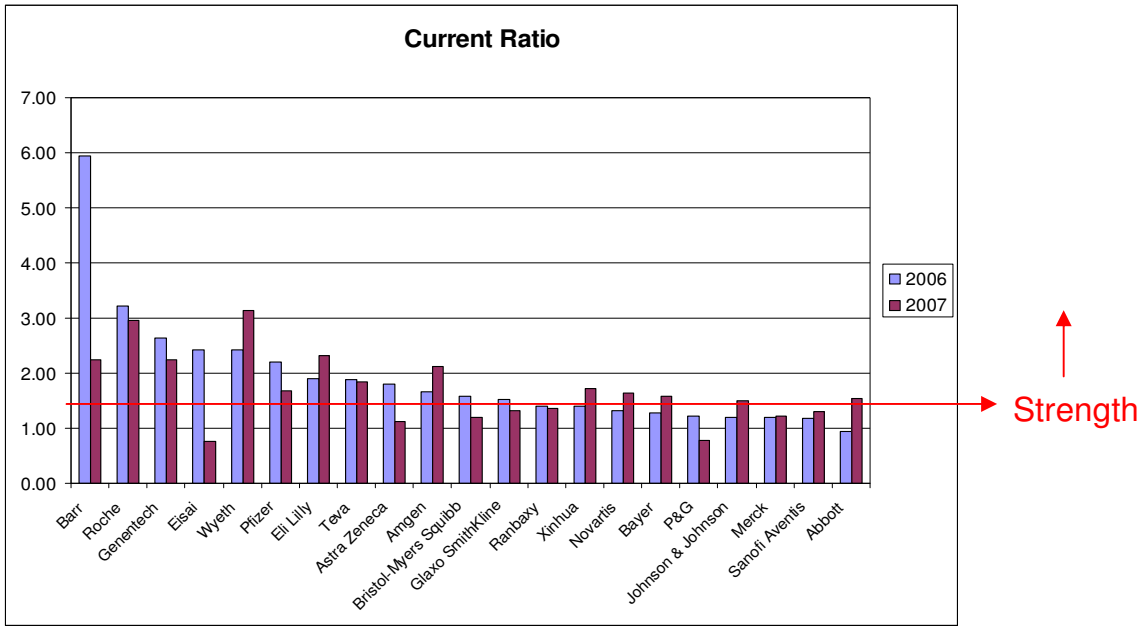

Return to Stockholder Equity
Percent (%)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
2006
2007
Strength
Pfizer
Barr
Glaxo SmithKline
Astra Zeneca
Genentech
Roche
Johnson & Johnson
Amgen
Wyeth
Novartis
Merck
Eli Lilly
Sanofi Aventis
P&G
Ranbaxy
Eisai
Bristol-Myers Squibb
Abbott
Teva
Bayer
Xinhua

Figure 3: Current Ratio and Acid-Test Ratio Ratios of Representative Pharmaceutical Companies

(a)



(b)

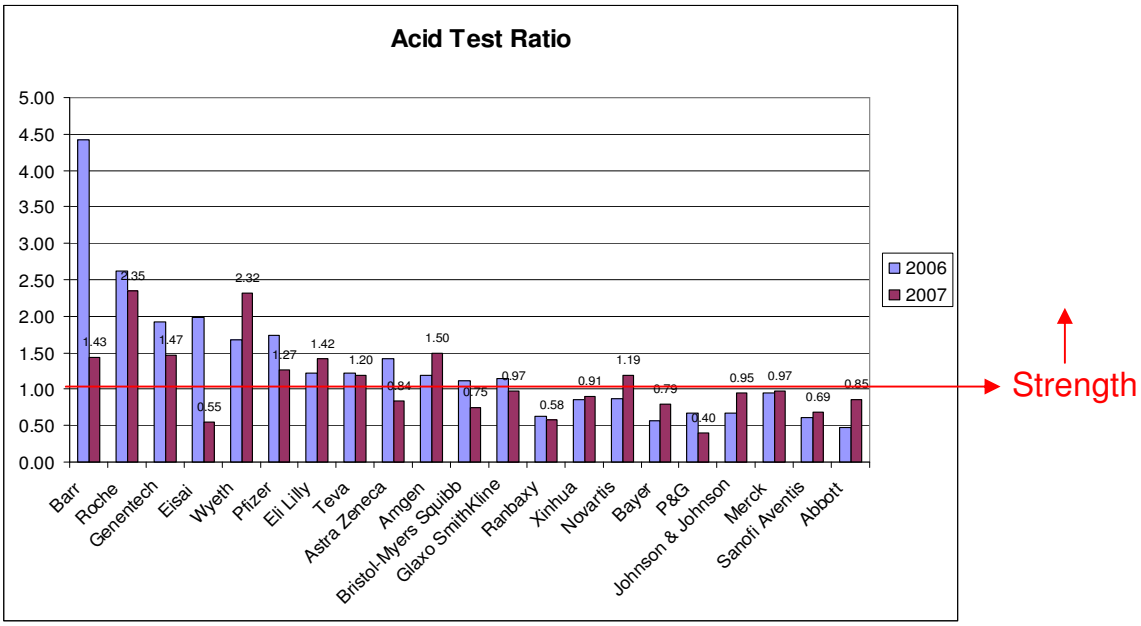


Figure 4: Debt Ratio of Representative Pharmaceutical Companies

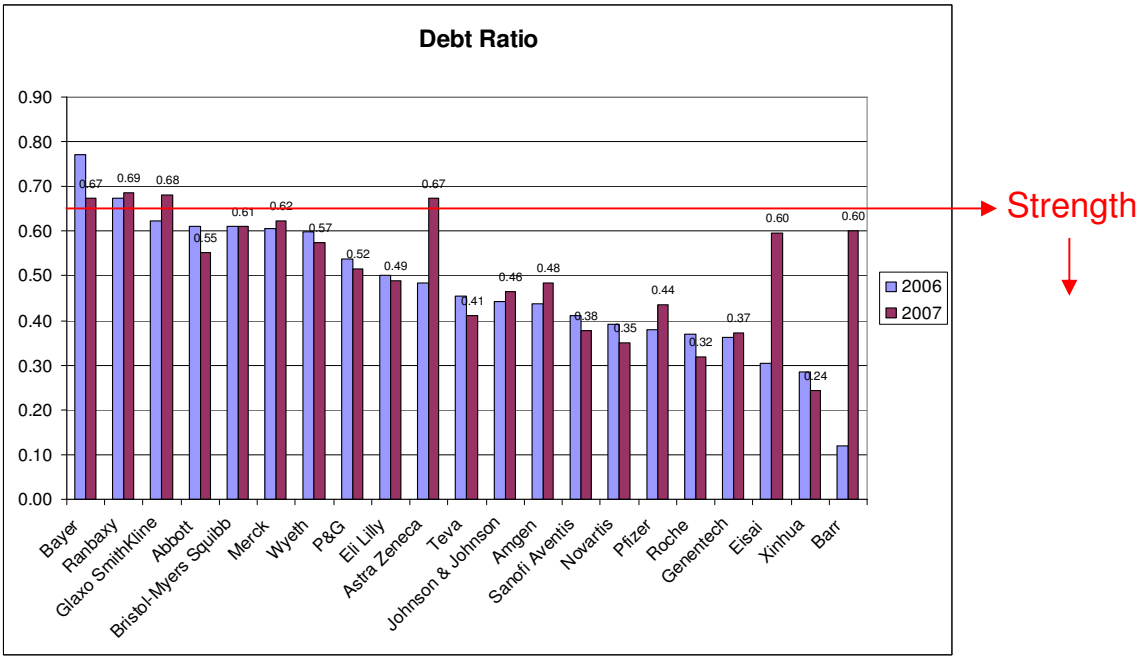
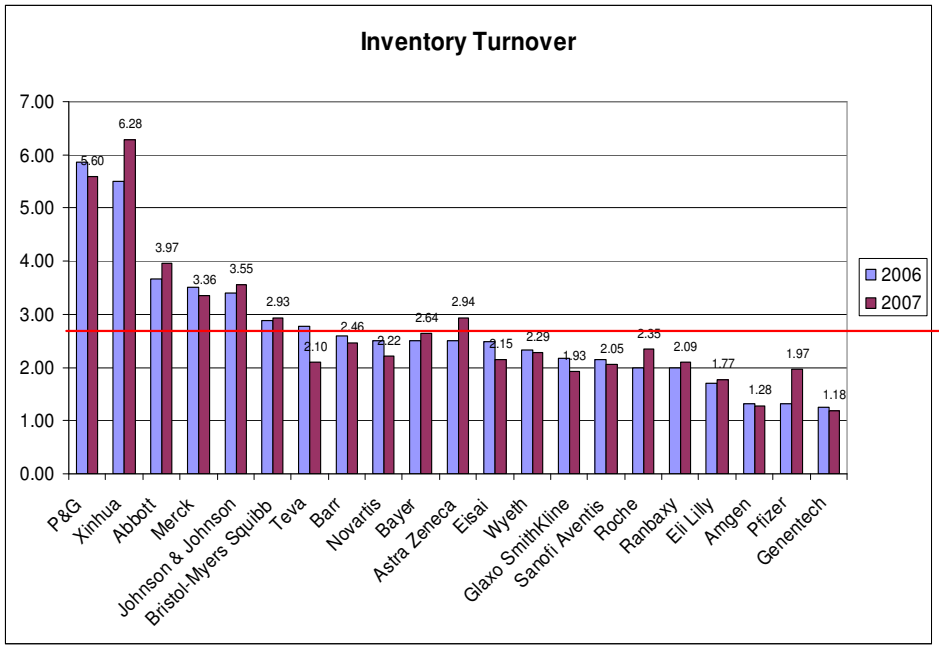
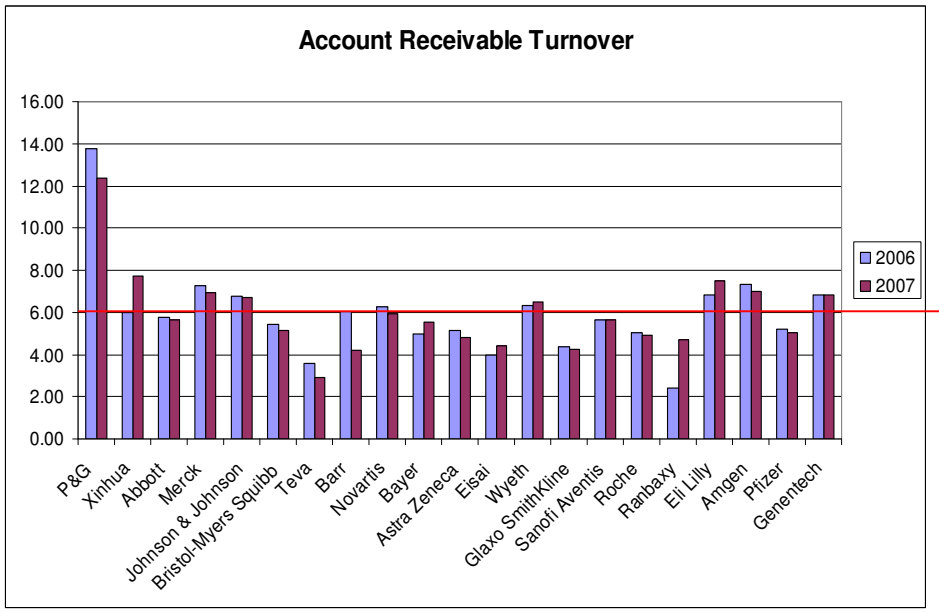


Figure 5: Inventory Turnover, Accounts Receivable Turnover, Days' Sales in Receivables of Representative Pharmaceutical Companies

(a)


Inventory Turnover
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
5.60
6.28
3.97
3.36
3.55
2.93
2.10
2.46
2.22
2.64
2.94
2.15
2.29
1.93
2.05
2.35
2.09
1.77
1.28
1.97
1.18
P&G
Xinhua
Abbott
Merck
Johnson & Johnson
Bristol-Myers Squibb
Teva
Barr
Novartis
Bayer
Astra Zeneca
Eisai
Wyeth
Glaxo SmithKline
Sanofi Aventis
Roche
Ranbaxy
Eli Lilly
Amgen
Pfizer
Genentech
2006
2007
Avg. = 2.7

(b)


Account Receivable Turnover
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
P&G
Xinhua
Abbott
Merck
Johnson & Johnson
Bristol-Myers Squibb
Teva
Barr
Novartis
Bayer
Astra Zeneca
Eisai
Wyeth
Glaxo SmithKline
Sanofi Aventis
Roche
Ranbaxy
Eli Lilly
Amgen
Pfizer
Genentech
2006
2007
Avg. = 6.0

(c)

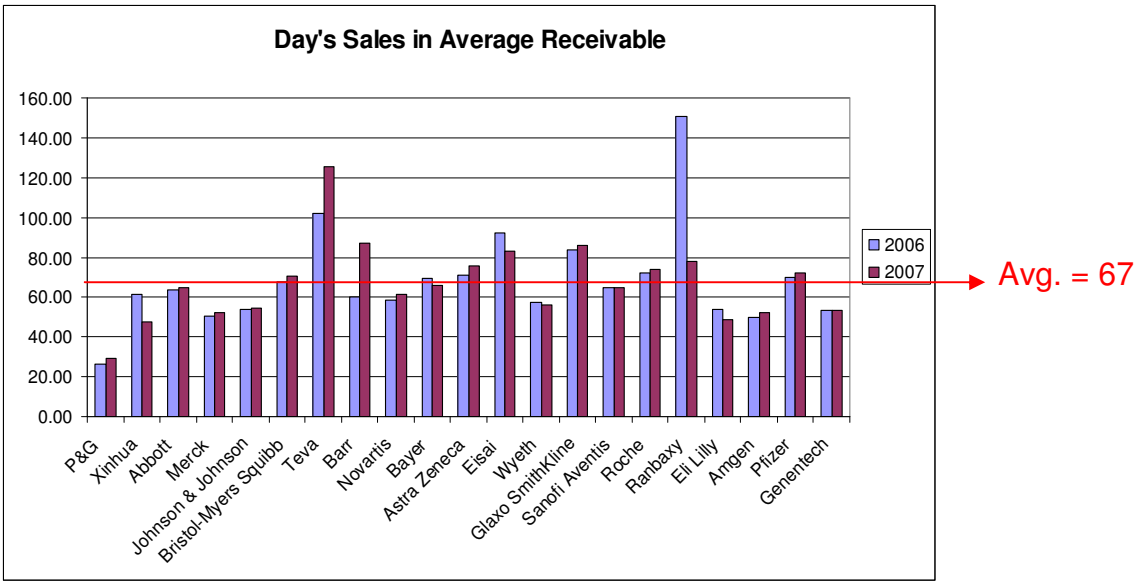


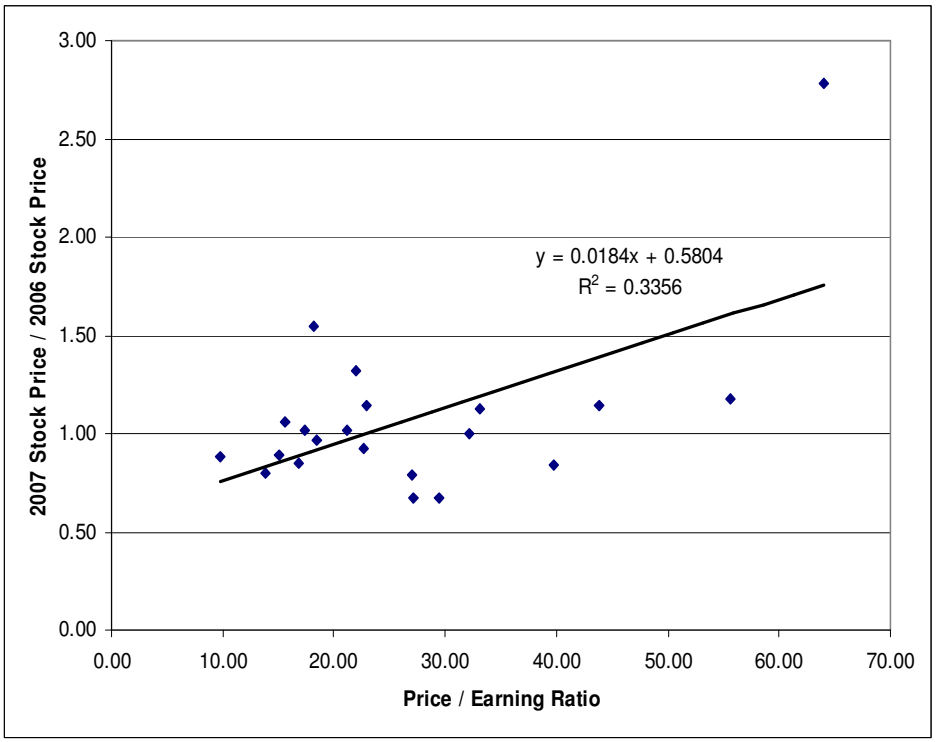
Table 1: The Stock Price, Price/Earning Ratio and Ratio of Market Price to Book Value of Representative Pharmaceutical Companies for 2006

Company	Year End Stock Price	Price/earning ratio	Price/book ratio
Astra Zeneca	54	13.85	5.81
Glaxo SmithKline	29	15.09	9.00
Barr	50	15.63	3.22
Wyeth	52	16.77	4.77
Johnson & Johnson	66	17.37	5.24
Bayer	54	18.18	2.38
Novartis	57	18.39	3.24
Eli Lilly	52	21.22	5.37
Merck	44	22.00	7.46
Sanofi Aventis	92	22.67	2.00
Procter & Gamble	64	22.94	4.14
Roche	203	26.96	5.28
Amgen	68	27.09	4.18
Eisai	56	29.47	3.74
Bristol-Myers Squibb	26	32.10	5.73
Genentech	80	39.80	8.89
Abbott	49	43.75	5.40
Pfizer	26	9.77	3.22
Teva	40	55.56	2.85
Xinhua	0.4	64.00	1.07
Ranbaxy	8	33.09	5.08

Table 2: The Stock Price, Price/Earning Ratio and Ratio of Market Price to Book Value of Representative Pharmaceutical Companies for 2007

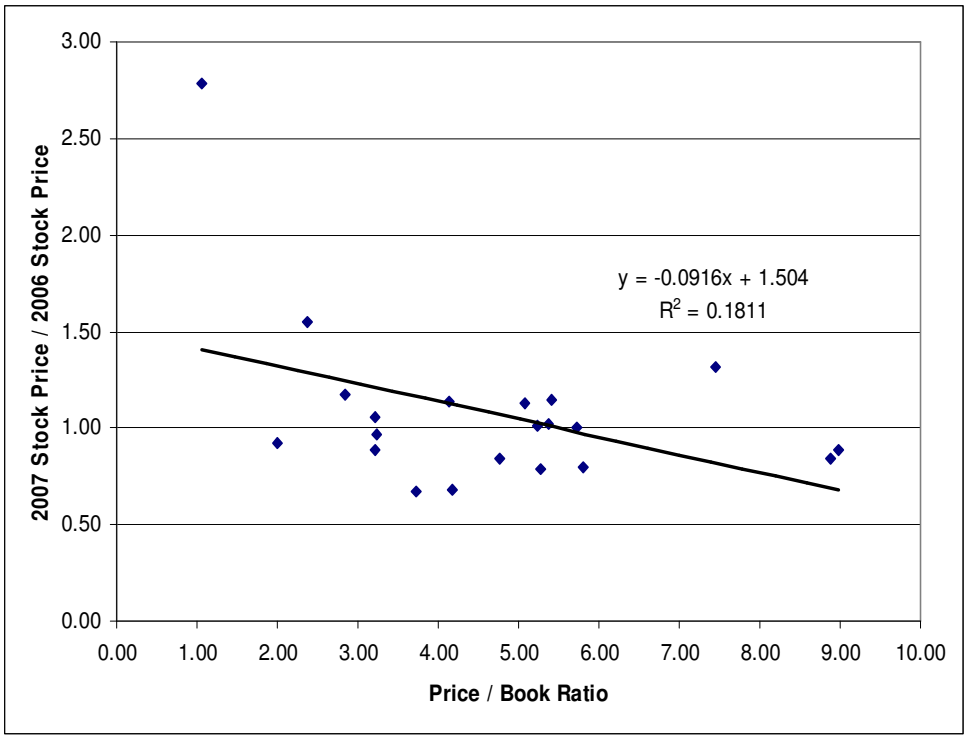
Company	Year End Stock Price	Price/earning ratio	Price/book ratio
Astra Zeneca	43	11.53	4.32
Glaxo SmithKline	26	13.65	7.76
Barr	53	40.46	3.07
Wyeth	44	13.02	3.23
Johnson & Johnson	67	18.46	4.50
Bayer	91	10.62	2.06
Novartis	55	10.72	2.52
Eli Lilly	53	19.56	4.44
Merck	58	38.93	9.52
Sanofi Aventis	92	16.20	1.91
Procter & Gamble	73	24.01	4.46
Roche	172	17.47	3.16
Amgen	46	16.31	2.80
Eisai	38	N/A	2.66
Bristol-Myers Squibb	26	23.85	5.42
Genentech	67	25.87	5.92
Abbott	56	24.24	4.98
Pfizer	23	19.66	3.14
Teva	47	19.75	2.76
Xinhua	1.2	127.14	2.44
Ranbaxy	10	33.28	5.50

Figure 6: Relation of Stock Price Change to Price / Earning Ratio from 2006 to 2007



Note: 2007 price / 2006 price > 1 if stock appreciated; this value < 1 if stock depreciated

Figure 7: Relation of Stock Price Change to Price / Book Ratio from 2006 to 2007



Note: 2007 price / 2006 price > 1 if stock appreciated; this value < 1 if stock depreciated

Journal of Organizational Innovation

The Future Perspective of International Human Resource Management

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ABSTRACT

In this study, the future perspective of international human resource management (IHRM) is considered in Section 1. Section 2 addresses international HRM's contribution to the multinational company. This is followed by international HRM problem for the global enterprise in Section 3. IRHM professionalization are discussed in Section 4. Finally, international motivation for international HRM are studied.

Keywords: Human Resource Management, Multinational Companies

INTRODUCTION

Nowadays, the future of IHRM is a new field. Augmented international business activity is creating organizational problems of integration and coordination. MNEs increase in numbers of nations and regions of the world, by applying joint ventures, alliances, and other forms of linkages to conduct their global business and to gain access to international resources, and difficult to manage. Augmentingly, top level attention must pay to the merger of labors who represent national cultures and multiple corporate, multiple languages, and have various consumers, product, and business issues. In consequence, the MNEs find more difficult to the development of IHRM systems that deal with global human resource issues for example: healthcare systems and pension, employee, management development and compensation

systems, as well as management recruitment. IHR managers ought to be able to provide the company with the human resource expertise to support implement and design such strategies. MNEs in the future need to support the following works for their IHR executives.

- To develop a network to help top management to understand complex organizational structure.
- To develop capacities for information processing about HR problems throughout the world, for decision making in IHRM to adapt with new global requirements.
- To develop competence of the senior IHR staff so that they are able to be contribute partners in the strategic management of the global business.
- To assure IHR involvement as an integral partner in formulating the international strategy for the company.

IHRM will be crucial for managers to have experience in the IHR department. IHRM will corporate with the management of the business at managerial, strategic, and operational levels; IHR managers need to have more experience in team work themselves and more training in how to make teams work effectively together; IHR managers need to develop internal counseling abilities. In an international company of the future, IHR departments need more closely linked with actual management of the business, through development of IHR culture, values, policies, vision, programs, processes, as well as practices that support the strategy and vision of the firm. MNEs will need IHR managers who are able to do more than handle the preparation, selection, compensation, and relocation of expatriates. MNEs require IHR managers to help in the strategic management of their global business, develop IHR policies for operations located around the world, as well as hire and develop highly productive workforces in multiple nations. The success

of IHRM in the future will depend on the ability of firms to develop IHR executives with broad international perspectives, global strong technical skills, and experience.

International HRM's Contribution to the Multinational company

Contribution of international HRM in the multinational companies composes of three forms such as the change partner, constructor, and leader:

The change partner - Concentrating HR basics on returns to the external consumers and competitive performance is a passing to the change partner. This supports organizational change, the need for which is invariable sparked off by external changes: changing consumer demands, technological developments, and competitive shifts. Managers, including HR managers, must learn the focus on operational activities, and the project role as change agent.

Constructor - IHRM generalists d' accord on the essential for the "new" skills of facilitating and influence, implementing change, and presenting a solid knowledge of the business. HR foundations need to be concentrated on competitive performance, not just on satisfying internal requirements. One can argue that if the function needs to be taken seriously, it is necessary to accept that the key responsibility of HR is to enhance the competitive position of the enterprise.

Leader - The change agent and the constructor become so too obsessively concentrated on the challenges of performance improvement and competitive capability development that they neglect emphasize on traditional individual outcomes such as employee satisfaction and motivation. The danger of excessive emphasizes on performance at the expense of the employee is to be taken especially seriously in the international HRM arena because the agenda is so concentrated on the challenges of international competition and creating value for external customers. Multinational companies sometimes tend to listen only to be "rationalized" when needed.

Nowadays, there are a variety of IHRM activities such as outsourced activities, tasks that are best undertaken by local companies or nations activities that ought to be managed by regional or global service centers. At present, IT opened up new ways of IHRM large administrative department undertook the following works: responding to standard employee questions about benefits, payroll processing, employment rules and pensions, occupational health, and basic generic training. Outsourcing can be one way of organizing IHRM operations, such as: payroll processing, pension fund management, or generic training. By contracting with third parties, high quality at low cost can be maintained and accomplished.

International HRM Problems for The Global Enterprise

Various problems in global enterprise are concerned with the responsibilities of the international HRM department. It deals with various nations cultures. Cultural differences can effect selection, management of human resources, and training. One of the critical challenges to IHRM, and to successful global business, concerning constraints imposed by cultural differences between nations. Particularly, varying attitudes about the role of management and business about education can facilitate the transfer of services, products, and business practices to overseas locations. Different cultures affect different status to members of their cultures, varying attitudes toward nature and time, and differing attitudes toward groups and individuals. Cultural difference affects the variations in management practices around the world. In consequence multinational enterprises should understand the major differences in management style practiced in different nations for worldwide coordination. Imposing a parent company style or culture on a foreign subsidiary can create resistance. Cultural differences among senior managers are one of the crucial obstacles to creating an acquisition work. Various activities of management is able to be influenced by in cultural values and practices criteria and methods for selecting employees,

importance of family linkages in employee placement and selection, nature of benefits provided employees, and the nature of education and job preparation for host country nationals. Comprehension of cultural difference can guide to general managers and IHRM managers as they structure policies and practices in foreign operations. Other issues can come from variety of national, cultural, social, government systems, and educational with which MNEs must interact. Severally, there may be considerable demand for international services from the IHRM function when the number of expatriates arises increasingly. Critical issues of IHRM are as follows.

IHRM be suitable for

- How does the whole expatriation process be managed? How are performance judged and management when criteria differ from nations to nation?
- Which nationalities ought to be managers in the main subsidiaries, and headquarters?
- How much consistency in IHRM policies ought to be insisted on? Which policies ought to be international and which local? If global, whose cultural practices and laws should be applied?
- Whether IHRM designed at headquarters can apply at local level by whom and do international teams be apply?
- How does IHRM be suitable for international strategy?

IHRM Professionalization

IHR as a management function need to continue professionalizing. IHRM requires to be recognized by top executives, strategic planners, and line managers as essential to the success of an international company. So IHRM department and programs must receive high priority attention and resources. It should be crucial for global managers to have experience in the IHR department, and it shall be just as important for IHR managers to possess experience in global assignments. MNEs shall require IHR executives who are able to do more than handle the

selection, relocation, training, and compensation of expatriates. MNEs shall require and expect their IHR executives to assist in the strategic management of their international businesses, to develop IHR policies, and hire, as well as develop highly productive labor forces in multiple nations. The development of strategic IHR manager is becoming a central concentration on the IHR profession. Global business requires to set up regional HR positions and assign international responsibilities to corporate HR managers and select, motivate, as well as develop HR professionals. For HR professionals, cross border alliances (CBAs) provide excellent opportunities to apply their expertise to HR problems that are crucially essential to the success of the business. The HR leader and staff ought to be involved in the formation of the CBA from the earliest planning stages. As CBAs become more common, the role of HR professionals needs the competency to blend local and global HR activities. Human resource professionals play an essential role in the internationalization process by supporting companies evaluate the HR possibilities and prospects involved in moving to different regions of the world. HR professionals working in CBAs must deal with problems such as language translation, and relations with the host government. Human resource professionals in all international business face the issue of designing and administering programs for more than one national group of employees, therefore they ought to take a more global view.

Nowadays, IHRM professionals needs to know global perspective, partner orientation, strategic visioning, industry knowledge, understanding competitors, managing cultural diversity, adaptability, team work process facilitation, communicating and consulting, parenting and partnering, and network building, as well as negotiating.

5. International Motivation for International HRM

Predicting how employees in different nations shall react to different pay plans never easy. Americans prefer unequal, performance based distribution of rewards and the Chinese like more equal distribution. The Chinese also like to see socio-emotional awards for example: as parties and managerial friendliness distributed unequally. The Americans look socio-emotional awards ought to be distributed to everyone equally. Americans and Russians place priority emphasis on individual performance when distributing rewards, while presenting less concern for treating everyone equally. Nowadays, cultural differences affect employees react to alternative forms of performance based pay.

Performance based pay plans sustain to attract the attention of various human resource managers. The success of incentive plans can motivate job performance. To be effective, performance based pay must successfully have various challenges. Most essentially fair and valid performance measurement and feedback serve as the foundation of performance based pay. Other challenges are lining worker performance with the organization's strategic objectives and worker behaviors, as well as gaining employee acceptance and exactly predicting the cost implication of performance based pay. If an organization possesses valid performance measures, and if everybody thinks the system is fair, as well as tied to the objectives of the organization, paying for performance ought to increase profitability.

Performance based pay has various forms such as: performance of individuals, the performance of teams or the entire organization. Some forms concentrate on short term performance and supply employees immediate rewards, while others emphasize labor on long term results and defer rewards far into the future. Performance based pay depends on various factors: the level at which job performance is able to accurately be measured; the willingness of managers to devote time needed to design; the extent of cooperation between departments,

continuously ameliorate systems and monitor; and degree of trust in the organization as well as the culture.

SUMMARY

Nowadays, international human resource management are sustained ambiguity to understand, especially, the basic IHRM ethics involves what the global HR manager ought to do when an employment practice that is viewed as wrong in the home country or illegal is acceptable and legal in the host country, the foreign standards or attitudes are viewed as lower than those held in the home country, for example: race or sex discrimination in hiring, compensation, or job placement; providing unsafe working conditions; or apply of child labor.

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Journal of Organizational Innovation

A Study of the Development of Networks, Media and Society

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ABSTRACT

It is getting ever more popular for people to use the Internet in recent years. Because of the convenience and instantaneous properties of the Internet, work through the Internet is promoted by governments all over the world. The purpose of this study is to examine the relationship between The Internet use and society. Four indicators were used to measure The Internet use. They are: experience with the Internet, years of The Internet use, time spent on The Internet for seeking information, and time spent on The Internet for interaction with other people. The research findings are discussed in detail in the paper.

Keywords: The Internet, Media, Networks, WWW, Virtual Community

1. INTRODUCTION

1.1 The history of the Internet

The Internet is a network of networks. It is world Wide Area Network (WAN). Through common protocols, it disseminates knowledge and shares resource. Satty (1990) said that the definition of the Internet is: "Distributed terminals will be able to connect one another through a specific protocol and the users can interact on it". Undoubtedly, we will expect that computer networks will be better due to its development and potential. For example: the Internet named

"network of networks", it makes world wide users on the Internet just like neighborhoods and improves the quality & quantity of information dissemination. It is strongly expected to help make great progress in achieving the goals of global village.

Calvert (1990) stated that The Internet started in the end of 1960. U.S Ministry of national defense developed a plan called “ARPANet” to share resource and to insure that when situated in a war, even some networks were broken down and the whole network is still able to work out. This could be seen as the origin of the Internet. In 1962, Lander Company used packet network to connect Lander, Massachusetts Institute of Technology and UCLA. In the fall of 1969, under a preliminary project, earlier network repeaters were set up at University of California, Los Angeles, and transmitted data back and forth with many universities and research institutions. Scientist could share research achievements with each other everywhere and anytime through this network.

The basic hypothesis of The Internet is that there is no central control system. That means when the system meets serious disaster, it is not necessary to find the main switch to shut down the whole system. Hwang (2003) stated that the communication network uses two innovation technologies discussed as below.

1. Each computer’s mission is just like a post office, it can decide to transmit the message to ports of destination. If there is a line on busy or being broken down, the system still can be able to transmit the message through other available lines.
2. The message will divided into many small packets. Small packets can be transmitted to stations through various lines and help improve the transmission efficiency.

The advanced network contributed to set up packets exchange and then delivered the associated protocol for communication. What ever system a computer belongs to, under common

communication/transmission agreement, computer terminals can go through communication through network (Willis & Dickinson, 2004).

In the mid of 1980, the U.S. National Science Foundation developed another network. In 1984, they still supported to build high-speed wide area network. In 1993, the American president hoped through integrating the transmission network, computer, database and consumption electronic to support electronic traffic, distance learning and medical insurance services. That means NII does not only combine software, hardware and technology, but also provide a simple and effective way for communication.

1.2 Application of The Internet

According to the statistic, the Internet's users were almost 2.99 billion till the end of 1999. And another research of ACNielson Marketing Consultant Company reports that the Taiwan's media are very diversified and growth quickly recent decade. The degree for audience to contact TV and broadcast are not as frequent as before. Berge, (1998) inducted that People are certain that the importance of The Internet increases every day. Childs (1969) said that the development of The Internet up to now has become one of the main information resources.

The development of the Internet is flourishing and the main reason is to provide various functions for activities. Moore (2001) stated that the computer network provides the services such as WWW, BBS and FTP, and it has become a synthetic media. As to the characteristics, it is accessible, capacious and high interaction. And it leads users to transmit information in difference space at anytime. In this regards, it develops to form a new type for living and creates an environment for people to interact constantly. As well, the most value for the Internet is to build up a virtual community to gather the potential users to get together.

On the other way, initially the use of the Internet was focused on the field of initial military application and research application, and then gradually on the field of business application. The U.S Commerce Department pointed out: the business who trades on the Internet to carry out electronic commerce has contributed a trade amount of up to US$1019 hundred million. Taking the trading volume from B2B market into consideration, we can predict this trade amount will growth rapidly in the next three years. Charles (2005) stated that besides the interest of business, network constructs a new social framework at the same time and forms an important link with people's life. The social relationship and interaction with people on the Internet are also concerned by many researches.

1.3 The Development of The Internet media

Except constant increase of the number of Network users, Network's diversified functions make the development of business application prosperous and successful. Rumble (2001) stated that network also causes great effect on transmission industry over what we could see before. Network's diversified functions not only transmit information but also provide animation, image and pronunciation. Network has become the fourth main media besides newspaper, broadcast and TV.

WWW is the best example describing spectacular events of the development of network media. The Global information Network brings public to experience a new media. The tradition media such as newspaper, TV, magazines and broadcast, today set up a website to provide various sources of on-line image to attract audience. In 1997, there were at least 2000 newspaper, broadcast and magazine that set up their owned station. Till 2000, Newslink provided services to link with other network media, and there are up to 18,000 newspaper, magazine and broadcast to register on it. The same situation also happened in Taiwan. Now, there are about 1000 network

media that register on yahoo.com in Taiwan. Therefore, Moore (2001) stated that the ratio of the application on business has gradually exceeded that on military according to the development to this day of Network media. According to the discussion on the development of The Internet, the situation of uses and network media, these evidences have shown that The Internet development is very flourishing. The Internet has great impact and effect on media.

2. LITERATURE REVIEW

2.1 Media and society:

Lassewell, a scholar of social relationship, pointed out that mass media has three specific social functions:

(1) Media's surveillance on the environment

The media's messages are usually treated as live news in that day.

(2) Media's explanation on the environment

They provide adequate responses to the society's problems through an editorial page.

(3) Social value and norm

Media will have society inheritance information to be carried on from generation to generation.

Wright added the fourth social function: media can provide transmission contents which have entertainment effect.

Holmberg (1996) stated that media plays an important role in modern society for it is a source of power. Media are not only a potential instrument that can affect, control and innovate the society, but also a place where develops many public affairs and activities. Media can also make society reality to identity and the main source of many images; therefore, Niko & Suhonen & Sutinen (2002) stated that it is also the place to construct values of society and

group. By the way, media are also an unequal tool of leisure time, activity centers and entertainments.

To sum up, Smith (1998) stated that media plays as a middleman to distinguish audience and society realistic. Media is also a window to open public's eyes and still can be used to filter events from society realistic and make a message to transmit to audience. Besides, it also plays as public affairs forum to make for society stabilization, enlarge public's eyes, improve audience's knowledge, educate public and raise public's participation in public affairs.

On the other hand, news media has power to monitor politics and economics and protect public interest. As to mass media, if the public doesn't believe news media, it will seriously affect the governments trustworthy and induce the public to doubt the monitor function of news. Therefore, trustworthy is very important.

Keeny & Raffia (1999) stated that to summary; news media has two major functions:

1. As an information middleman, it transmits correct messages to audience, and
2. News media can monitor government's operation.

That means news media must have great trustworthy so that the public will believe what news says and the news media can play a righteous role to monitor government objectively. Keegan, D. (1990) said that for newly network media, if it can be trusted by the public, it should grow very quickly and advance media communication to flow speedy. On the other side, if it is not trustable, it may cause the public to question it and not to use it frequently. To compare with traditional media, the network has developed a new relationship with society where we live.

2.2 Network, media and society

Bates (1996) stated that The Internet has become an important power which is not

negligible. It puts great unprecedented impact on transmission industry, and has become the fourth major transmission media. To think about the effect of The Internet from society communication, The Internet technology impacts the concept of communication directly. Dolling (1997) stated that the difference from mass media is: The Internet has the characteristic of interact and response. As to personnel, The Internet provides information, active interaction. But, mass media make the public become a passive message receiver.

Recently, there are more and more traditional media trying to take part in on-line publication. According to data of 1998, one out of five American used the Internet to read messages including mainly science, health care, finances and technology. This ratio is much greater than 6% of two years ago (1996).

Peterson, M. (1998) said that The Internet has changed the user's life habits and social relationship for users. The Internet reduces the time to contact with people and traditional media effectively.

To sum up, The Internet really has great impact on social relationship, not only change the people's life style but also remold the relation mode. The Internet has become a new channel for people to get information and brings a challenge to traditional media. We can see the importance of network from media's history such as the initial publish of print media, broadcast, TV and till now the rise of The Internet. Khan (2002) stated that each medium has its own generation. The increase on news source means the audience has more options to choose message. What are the criteria for the audience to choose the available information source when located in an environment of an overflowing information network? The answers are cheaper expenses for using media and trustworthy of media. It is obvious that the concept of The Internet trustworthy is quiet different from that of traditional media.

As an emerging medium, Keegan (1996) inducted that network has different characteristic and dissemination type from traditional media. In dissemination type, network is costless and easy to use, and also a source of a lot of information. Compare to the monitor function of traditional media, network has less limits on organizing news and is more resistant to political pressure for selecting a subject matter, thus, makes their reports more approach to the truth. But on the other hand, the various anonymous opinions on the Internet, which have not been proved yet cause a negative effect on network media. That is, these unproved opinions will lower down the trustworthy of network media.

2.3 The type of network dissemination

As dissemination scholar stated, it's not the message content itself disseminated by disseminators to change people's life and affect people's thinking, but the corporation group of network media does. As a definition of computer intermediary dissemination: it happens all over the world and uses TCP/IP, client-server modes to transmit data. The environment of share information is constructed by computer. It means that The Internet has become one of mass media and has been able to connect the public dissemination and the characteristics of mass media with different types of transmission.

To be brief, Khan (2002) stated that during the network dissemination age, the most different transmission type between dissemination types of network and that of traditional mass media is not the type that message transmitted by less disseminator to the most message receivers. In The Internet, users can transmit message with two-way communication and interact with one another.

After the rise of The Internet, Kearsley (2003) stated that the role of media played in the society must be reexamined. In The Internet, receiver can become disseminator because the new

technology can result in revolution. Reciprocal intermediary activities will replace or renew the traditional media's responses to reflect the intermediary processes of social truth. There have been obviously different among network dissemination types, the public dissemination and mass media type. New media combines the characteristics of mass media and the public channels. The control power of message has been transferred from message makers to message consumers. New media are not defined as the traditional ways to transmit limited message to homogeneous audience. The audience has more choices for various message sources and new media improve the relation between transmitters and receivers.

2.4 The effect on audience in The Internet dissemination age

Hoffman & Novak' three dissemination models can help us understand the message control power transferred from transmitters to receivers and the change of interaction ways between dissemination processes and media.

(A) Traditional one by one model

This model was a way of transmitting during the period of theory of Media Effect. Because there is no interaction between media content and the public, the audience just receives media content passively. Khan (2002) stated that this model has become the basis of many dissemination models. Traditional mass media are almost belonging to this dissemination way of no interaction, such as newspaper, broadcast, books and magazines. The audience is passive under such a model.

(B) Computer intermediate dissemination

This model developed from traditional one by one model. People are educated to have the concept of interactive feedback in transmission process, and this is the most difference from the traditional model. Under this dissemination model such as telephone and cable TV, the audience

will interact in between. The audience not only receives media content passively, but also feeds responses back to media content.

(C) Hyper-media computer intermediate dissemination model

In this model, media content is the hyper-media and media itself is The Internet. There is also interaction in this model. The difference from the second model is user's interaction type. WWW. Is a solid example in this model? Why is it called hyper-media computer intermediate dissemination? Because the nature of new communication technology has interaction in itself, it is hardly to distinguish public media or mass media.

To comply with the evolution of dissemination history and the revolution of transmission technology, the audience has been playing an important role in hyper-media computer intermediate dissemination model. The audience can be the direct transmitter and able to have more active responses on message.

In opposition to traditional media, the audience plays the role of both information maker and receiver in network dissemination. Moore (2001) stated that network has many characteristics such as various information sources and rich content, and the audience has more choices in information contents. Network is also providing a space to deliver speeches more quickly and speeches will not be limited by the door keeper's idea type or by the screening process.

The rise of The Internet has impacted and changed the communication models. Wedemeyer, C. (1999) stated that the media as an intermediary tool help contact the personal communication and reconstruct the social interaction model. The communication model formed by The Internet technology is not only to dispel the operating crisis out of one-way mass media and centralization, but also to provide communication with more opinions. The lower degree of network keeper, the better is that information will not be controlled by authority type, but the

worse is that irresponsible speeches happen everywhere. As users in The Internet have to judge the confidence of news source. The audience has to learned more news accomplishment in the spread network dissemination environment. The transfer of message makes the network information more variance.

3. METHODOLOGY

From the view of sociology and pedagogy, this study has been conducted to better comprehend the conditions and change of distance learning in Taiwan, especially after the entrance to WTO. Because this change is closely linked with local economic development and directly guided by local government, it determines the educational standards of many of people. It seems to be a barometer, which indicates regional political trends, economic strength and the quality of regional human resource. Distance learning is a significant research area in the educational circle and has been placed in a strategic position where it can drive the development of regional economy.

It can be seen that distance learning is not merely a problem pertaining to educational related subjects; but also, it involves human politics, economics and social studies. Currently, some scholars bring with them special liabilities in probing into distance learning problems. For example, statistical studies of studying the profit problems of distance learning constantly focus on short-term interests and neglect long range interests. When education investments exceed return, hesitation emerges. “Wait until the strength is stronger and then think about the development of distance learning.”

The research of the pedagogical scholars can follow the wrong path and compared with higher education, distance learning may always seem like a low-level education and reflect no national power. Therefore, it appears that it should be in a secondary place. Now the government

has become aware of the importance of distance learning, but, does not know how to improve it. Where should improvement start? How much manpower, money and material should be devoted? How will it be reflected in society? All of these questions should be investigated. The outdated methods of the fifties do not function anymore. How should the government handle all of these kinds of problems?

This study involves comparisons of distance learning in developed districts and in backward districts. It used qualitative analysis to discover the similarities and differences in the districts where there exists distance learning and those where no distance learning systems exists.

3.1 Research Questions

The research questions for this study are as follow:

1. What are the differences in the present situations of distance learning in different regions of Taiwan?
2. What is the influence of distance learning on the local economic development in the areas with and without distance learning?
3. What are the problems and effects of distance learning reform?
4. What are the methods of improving distance learning in Taiwan?

3.2 Research Design

This study compared the distance learning in developed districts and backward districts. It involved longitudinal and transverse comparisons. Longitudinal comparison chiefly centered on the analysis of the status quo and the future development tendencies of distance learning in a certain region. Transverse comparison mainly referred to the comparison among economically developed regions and backward districts.

3.3Procedures

Qualitative analysis was used to discover the similarities and differences in the districts where there exists distance learning and those where it doesn't exist. Emphasis was placed on the interdisciplinary study, organically connected manpower, economy, and education, in order to give prominence to interdisciplinary characteristic of research.

3.4 Data Collection

This study selected some objects, for instance, that included different kinds of schools and enterprise employees, and then explored the inner connections and uncertain factors between distance learning and economic development through investigations and case studies.

3.5 Analysis of Data

When collecting data, triangular corroboration analysis, an effective method for qualitative research, was used while studying distance learning and economic development. Data was gathered using various sources or methods to keep the data coherent, truthful and accurate when evaluating outcomes.

In an effort to try to figure out the laws and methods of change and development, development of local distance learning was summarized along with the., cultural level and manpower educational level since 1978 (the beginning of the reform and opening up of Taiwan). On this basis, correlation among educational systems, the economies, and the populations were studied, in order to determine the inter-restrictions among them. Finally, constructive suggestions were put forward on distance learning development, economic development programs, and economic growth patterns.

3.6 Questions Designed for Different levels of Interviews

This interview level was very important. First of all, it helped to find out what the general situation of local distance learning was. Secondly, it helped to discover the state of local

economic development and the average income. Third, it helped to decipher the quality of the local manpower resources. With analysis based on those three factors, the answer to the question how does distance learning influence the economy could be found.

4. CONCLUSIONS

(a) The whole evaluation of trusty in network media

According to the traditional and new media, the evaluation on the trusty of network media is still retained. In the comparison of the trusty on traditional media (newspaper, broadcast, magazine and TV), results also still show the same rank trend as before.

(b) The evaluation index of network media trusty

In trusty index in The Internet: the information, the scores from high to low is deeply, justice and no bias.

(c) The evaluation index of trusty in difference network media

The ranks from high to low was: portal and group sites, government and business site, group and individual site, on-line shopping site and e-mail.

(d) The factors that affect the network media trusty

From all the factors of media trustworthy, the three factors such as age, revenue, education level have significantly negative relationship with the media trusty evaluation by audience. That is, the more the age, revenue and education level are, the lower evaluation value on the network media trustworthy.

(e) The media behaviors

The network management experience, age and the average times surfing on the Internet in a day have significantly negative relationship with the media trusty. That means the more time and experience in using network, the lower evaluation value on network media trusty. To conjecture

the reason, it might be the more time that in network, the crisis events (to assume other's name, forgery) happened easily. Therefore, the public doesn't have confidence in The Internet. Some people (sometimes they are called the network experts) with no network management experience, or with high net age, or with high time-consuming in surfing on the network in a day, think the characteristics of anonymous transmit don't increase the trusty of network media. In one word, Khan (2002) stated that the network veteran has lower evaluation value on network media trustworthy especially when network provides social intercourse. The main reason of lower trustworthy is that they don't have professional screening ability to filter information, and to confirm if the information is correct or not.

The characteristics of information display, such as immediate response, interaction, multi-media and hyper-link, can strengthen the way of displaying information, and make the audience have different ways to understand the same information. But the characteristic of immediateness can't ensure news's trustworthy for news on the net due to time pressure, therefore, the news monitor process will be very rough and have many mistakes.

Wu, Xiao Mei stated that in network broadcast generation, traditional mass media is not the only keeper group. That means traditional news-room is hardly using the original standards to control news now. In network age, news's professional standards have changed. For example: to be professional is newspaperman's duty. In net broadcast, audience will be provided with information and diversification news sources. But, as to content's trust, the audience must have the idea to screen and take responsibility personally.

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Application of Computer Simulation Software to Operation and Inventory Management – A Case Study

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ABSTRACT

The manager of a manufacturing plant would like to know if there are any bottle necks in the current work flow and what the best staffing option is to achieve operation efficiency. The manager is cost conscious; he/she also wants to know how to economically manage the inventory of raw materials to support manufacturing activities, for example, quantity and timing of ordering the materials. A computer simulation study using the Arena software[1] is conducted to answer these questions. Simulation is an imitation of real systems by computational methods. Specifically, queuing models (or flow charts) are constructed to mimic the arrival, process and departure of system entities using the built-in modules (algorisms) of the Arena software. Historical data are input in the models and process parameters such and wait time and resource utilization are calculated in multiple randomized runs. The output of the simulation is analyzed statistically from which the best scenarios are identified to answer the manager's questions.

Key Words: Computer Simulation, Operation and Inventory Management

SYSTEM ANALYSIS

The manufacturing plant is staffed with 13 technicians, and they work 8 hours a day. Everyday scientists request certain number of experiments (trials) to be performed by the plant in order to develop various products. The trials begin with weighing of the raw materials, which can be done by any technician within 1 to 2 hours. The products are manufactured by different technologies depending on their characteristics. The technologies can be described by a series of unit operations, each of which requires different processing equipment. The unit operations are

denoted as Process 1 (37%), Process 2 (10%), Process 3 (22%), Process 4 (4%), Process 5 (8%), Process 6 (0.4%), Process 7 (21%), Process 8, Process 9 and Process 10. The percentiles in parenthesis represent the relative frequency of each operation. Process 8 (89%), Process 9 (73%) and Process 10 (53%) are secondary processes following Process 1 - 4. The technicians are trained to operate different equipment. Some of them can operate more equipment than the others, and therefore, they are assigned to different jobs. In addition, the time it takes to complete the trial varies depending on the process, batch size and the products themselves. Because there are so many variables, a simulation study is necessary to better understand the current work flow and job assignments.

A large number of raw materials are used in the manufacturing of different products. Due to limited space in this report, the inventory management of only one of the materials will be discussed as an example. There are 3537.86 kg of this material in current inventory. The time period between the batches manufactured varies from 83 days to 474 days. When the batches are scheduled, 1200 kg of the material will be withdrawn from inventory. The inventory level is evaluated every 120 days and orders may be placed to replenish the deficit (the trigger point is 2000 kg). The cost for purchasing the material is $272/kg, and the order quantity is usually 1200 kg with exceptions on high demand. It takes 40 to 115 days to receive the material from the vendor. The cost of holding this material in the warehouse is $91/kg. If the material is on back order and the product can not be made, the shortage cost is $264,150/kg. It is not sure yet if the current safety stock level and the order quantity as well as the shortage cost estimate are optimal, and these will be studied in this project.

MODEL DEVELOPMENT

Based on the above system analysis, two queuing models are developed to simulate the work flow in the manufacturing plant and the inventory system.

Work Flow Model

The work flow model is shown with the flow chart in Figure 1. The resources (technicians) are defined in the software and sets of technicians are created for each unit operation as shown in Figure 2 (a, b). When assigning technicians (members in Sets) to the jobs, those who are familiar with a small variety of equipment are assigned to tasks within their experience and the more versatile technicians are reserved for more specialized work. Table 1 lists the type of work the technicians are trained to do:

Inventory Model

The inventory model is shown with the flow chart in Figure 3. The logic and input parameters of the inventory model are defined in Figure 4 (a-c).

INPUT DATA COLLECTION AND ANALYSIS

The past data of project inter-arrival time and process time involved in different steps of the above models are illustrated in Table 2 (a, b). Using Arena's Input Analyzer, probability distribution functions of the above data sets are obtained and the expressions are provided below:

Work Flow Model

Trial Arrival: DISC (0.088, 0.143, 0.353, 0.265, 0.529, 0.388, 0.735, 0.510, 0.736, 0.633, 0.737, 0.756, 0.738, 0.878, 1, 1.001)

Weighing: TRIA (1, 1.5, 2)

Process 1: DISC (0.000, 7.000, 0.167, 8.500, 0.524, 10.000, 0.524, 11.500, 0.571, 13.000, 0.714, 14.500, 0.714, 16.000, 0.833, 17.500, 0.833, 19.000, 0.833, 20.500, 1, 22.000)

Process 2: DISC (0.000, 5.500, 0.565, 6.500, 0.609, 7.500, 1, 8.500)

Process 4: DISC (0.000, 2.290, 0.100, 2.772, 0.100, 3.254, 0.100, 3.736, 0.100, 4.218, 1, 4.700)

Process 8: DISC (0.000, 1.200, 0.147, 2.050, 0.242, 2.900, 0.537, 3.750, 0.832, 4.600, 0.989, 5.451, 0.989, 6.301, 0.989, 7.151, 1, 8.001)

Process 3: DISC (0.000, 12.500, 0.380, 23.500, 0.880, 34.500, 0.880, 45.500, 0.880, 56.500, 1, 65.500)

Process 10: DISC (0.000, 3.070, 0.280, 4.203, 0.460, 5.336, 0.520, 6.469, 0.520, 7.601, 0.720, 8.734, 0.720, 9.867, 1, 11.000)

Process 9: DISC (0.000, 3.500, 0.458, 5.500, 0.479, 7.500, 0.750, 9.500, 0.750, 11.500, 0.750, 13.500, 0.750, 15.500, 1, 16.500)

Process 5: 10.5

Process 6: 14.5

Process 7: DISC (0.000, 1.000, 0.083, 2.250, 0.292, 3.500, 0.688, 4.750, 0.833, 6.000, 0.875, 7.250, 0.875, 8.500, 0.875, 9.750, 1, 11.000)

Inventory Model

Demand size: DISC(0.2,2400, 1,1200)

Delivery lag: UNIF(40, 115)

Interdemand time: UNIF(83, 474)

Interestingly none of Arena's distribution functions fits the raw data (see example histograms and results of Chi square test in Figure 5), hence empirical (discrete) functions have

to be used for input. To illustrate how a good fit of data would look like, a hypothetical distribution is displayed in Figure 6.

MODEL VERIFICATION

Work Flow Model

The model was test run using different input conditions and a long run time to reveal any possible errors. For example, two-year duration did not result in any long queue, which is good. But if more than one resource was assigned to any of the processes, a long queue would appear for that process which triggers a run time error (an interesting finding). I also used arrival rate as opposed to interarrival time in the create module once by mistake, and this caused a long waiting time because the trial arrival is too fast to process. All of these verify the correctness of the model.

Inventory Model

The inventory model was also verified in similar manner. By and large, this model is easier to verify because its structure is simpler and it was adopted from the software manual. A modification was made by creating a variable called Total Shortage Cost and adding a decide module after the customer order to determine if Inventory Level < 0 in order to calculate the shortage cost more accurately.

MAKE RUNS

We ran the work flow model with a two-year run time and five replications. We also modified the model by adding technician T7 and T8 to the resource set for Process 4 to mimic training them for this new task. Then we used OptQuest command of the software to identify optimal scenarios. The control was resource. The constrain was the number of technicians within a range of 12 to 14. The objective was minimum queue for all the processes.

For the inventory model, we ran the simulation ten times for duration of four years. Then we used Process Analyzer (PAN) of the software to evaluate five scenarios with various Q* values while holding s value at 2000 kg. A second PAN was run with various s values and a Q* value of 1200 kg. Thirdly, I changed the model by setting the shortage cost to $0 (this reflects those batches that are experimental instead of for sale) and re-ran the simulation.

OUTPUT DATA ANALYSIS

Work Flow Model

The results of the simulation are shown in the Table 3 (a, b). Average, variance, standard deviation and 95% confidence intervals of data are also provided. The data indicate that the wait time for all the processes is very short using the currently available resources. The wait time for Process 4 is slightly longer than the other processes although this wait time is not bad.

It was noted that the utilization of technicians is significantly different using this simulation model. Therefore, it is necessary to address the fairness of work load and compensation to the technicians. In addition, the simulation does not reveal anything related to job performance. However, these issues are not within the scope of this study and probably should be referred to the Human Resources department.

The addition of two technicians to the resource set for Process 4 shortens the waiting time for this job (from 11.21 hours to 0.294 hours). At the same time, the wait time for Process 6 increased from 0.788 hours to 3.09 hours as a result of this change. Nevertheless, this increase is not important considering the relatively long process time for this unit operation.

The OptQuest results are displayed in Table 4. The OptQuest run gave many good solutions that meet the objectives. It does not make a big difference if the plant is staffed with 12, 13 or 14 technicians. However, almost all the solutions for having 12 technicians require

significant changes in staffing, i.e. eliminate more than two technicians and duplicate the others having the same skills set. We are not sure if this is practical in reality. There is one choice (simulation 14) of having 12 technicians by eliminating just one technician (T1). But this technician is the only one that does Process 4; therefore it is not a good choice. In summary, the current staffing option (simulation 1) appears to be most suitable to the manufacturing plant.

Inventory Model

The inventory level as a function of time is displayed in Figure 7. The PAN results show that the safety stock level (s) should be set at 1500 kg, although the difference between 1000 kg, 1500 kg, and 2000 kg are not significant (overlapping confidence intervals). This is illustrated in Figure 8 with the best scenario labeled in red. The order quantity (Q*) should be 3300 kg (Scenario 3) because it incurs the lowest average total cost.

If there is no shortage cost, the safety stock level (s) can be lower to 1000 kg and the economic order quantity (Q*) is 3300 kg. These findings are demonstrated in Figure 9. The simulated data for both models are compared with the real situations, and the correlation is satisfactory.

CONCLUSION

Computer simulations were conducted to model the work flow and inventory management of the manufacture plant. The study results suggest that there is no bottle-neck existing in the work flow. Some improvements in wait time can be made by training two technicians to do Process 4. There is no need to either increase or decrease the head count of the plant if the work-load pattern does not change. The safety stock inventory level and economic order quantity should be re-determined based on a more accurate estimate of the shortage cost.

Based on the available information, the optimal safety stock level (s) is 1500 kg and the economic order quantity (Q*) is 3300 kg.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. S. Kolitz for teaching the concepts of computer simulation, Dr. B. Bench for helpful discussions of the subject, and Ms. R. Twentyman for proof-reading the manuscript.

REFERENCES

1. Kelton et. al., Simulation with Arena with CD-ROM, (4th ed), McGraw Hill, 2006

FIGURES AND TABLES

Figure 1: The Flow Chart to Illustrate the Work Flow Model

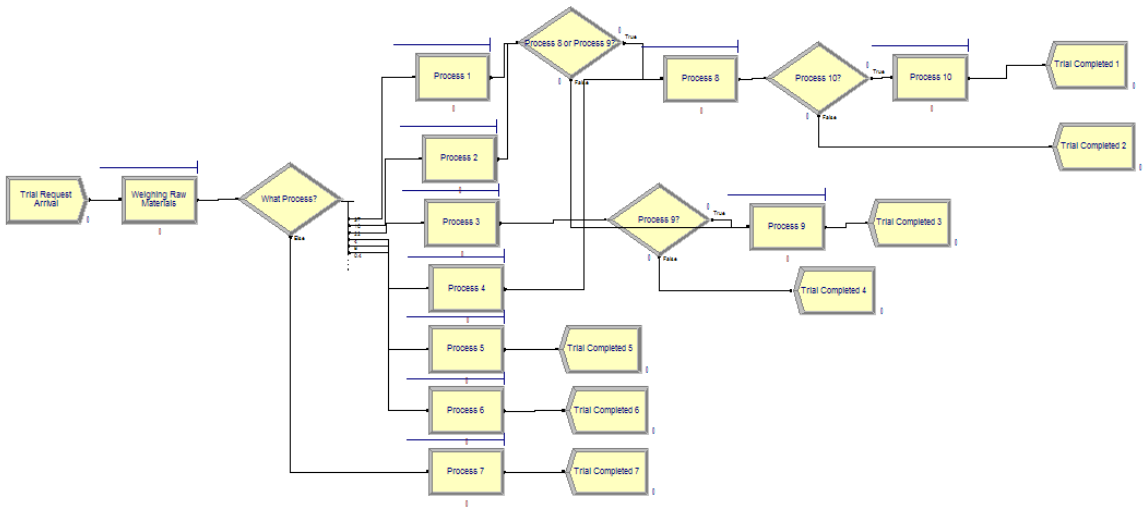


Figure 2: Resource and Sets of Technicians Defined for the Work Flow Model

(a) Resource

Resource - Basic Process

	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics
2	T2	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
3	T3	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
4	T4	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
5	T5	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
6	T6	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
7	T7	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
8	T8	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
9	T9	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
10	T10	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
11	T11	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
12	T12	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
13	T13	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑

Double-click here to add a new row.

(b) Sets of Technicians for Each Process

Set - Basic Process

	Name	Type	Members
1	Process 1	Resource	13 rows
2	Process 2	Resource	13 rows
3	Process 3	Resource	9 rows
4	Process 4	Resource	1 rows
5	Process 5	Resource	3 rows
6	Process 6	Resource	1 rows
7	Process 7	Resource	4 rows
8	Process 8	Resource	11 rows
9	Process 9	Resource	6 rows
10	Proces 10	Resource	9 rows
11	Weighing	Resource	13 rows

Double-click here to add a new row.

Table 1: Training Record to Show the Technicians' Specialty

Technician	Process 1	Process 2	Process 8	Process 10	Process 3	Process 9	Process 4	Process 5	Process 6	Process 7
T1	x	x	x		x		x			
T2	x	x	x	x	x	x				
T3	x	x	x	x	x	x		x		
T4	x	x	x	x	x	x				
T5	x	x	x	x	x	x				
T6	x	x	x		x					x
T7	x	x		x						
T8	x	x	x							x
T9	x	x	x	x	x			x		x
T10	x	x						x	x	x
T11	x	x	x	x						
T12	x	x	x	x	x	x				
T13	x	x	x	x	x	x				

Figure 3: The Flow Chart to Illustrate the Inventory Model

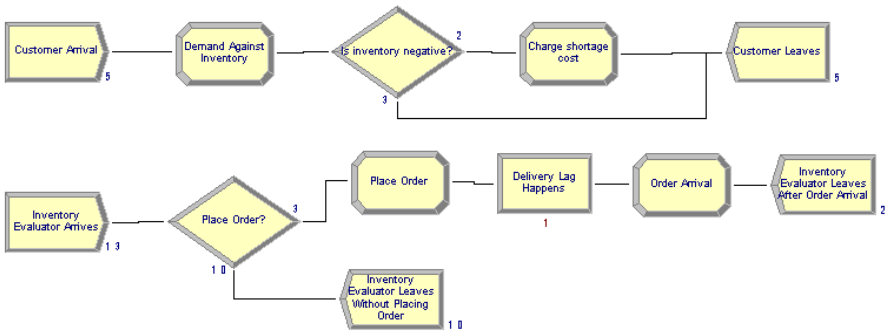
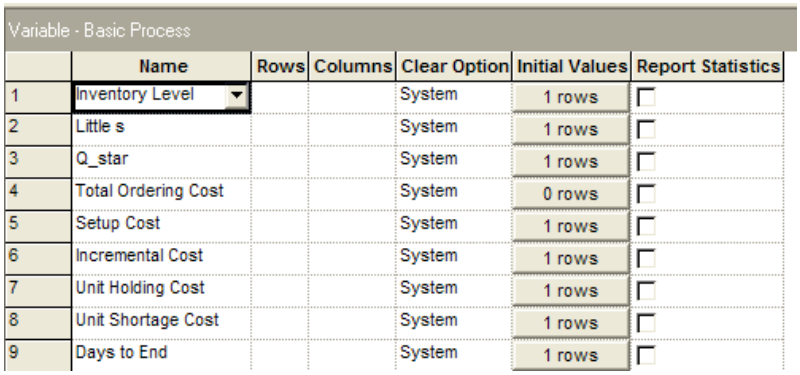


Figure 4: Logic and Input Parameters Defined For the Inventory Model

(a) Variables



Variable - Basic Process

	Name	Rows	Columns	Clear Option	Initial Values	Report Statistics
1	Inventory Level			System	1 rows	
2	Little s			System	1 rows	
3	Q_star			System	1 rows	
4	Total Ordering Cost			System	0 rows	
5	Setup Cost			System	1 rows	
6	Incremental Cost			System	1 rows	
7	Unit Holding Cost			System	1 rows	
8	Unit Shortage Cost			System	1 rows	
9	Days to End			System	1 rows	

Inventory Level: 3537.86

Little s (safety stock level): 2000

Q-star (economic order quantity): 3200

Ordering Cost: 0

Setup Cost: 0

Incremental Cost: 272

Unit Holding Cost: 91

Unit Shortage Cost: 264,150

Days to End: 1460

(b) Expressions

Expression - Advanced Process

	Name	Rows	Columns	Expression Values
1	Demand Size			1 rows
2	Delivery Lag			1 rows
3	Interdemand Time			1 rows
4	Evaluation Interval			1 rows

Demand Size Expression: DISC(0.2,2400, 1,1200)

Delivery Lag Expression: UNIF(40, 115)

Interdemand Time: UNIF(83, 474)

Evaluation Interval: 120

(c) Statistics

Statistic - Advanced Process

	Name	Type	Expression	Report Label
1	Avg Ordering Cost	Output	Total Ordering Cost / Days to End	Avg Ordering Cost
2	Holding Cost	Time-Persistent	Unit Holding Cost * MX(Inventory Level, 0)	Holding Cost
3	Shortage Cost	Time-Persistent	Unit Shortage Cost * MX(-Inventory Level, 0)	Shortage Cost
4	Avg Total Cost	Output	OVALUE(Avg Ordering Cost) + DAVG(Holding Cost) + DAVG(Shortage Cost)	Avg Total Cost

Table 2: Historical Data of Project Interarrival Time and Process Time

(a) Work Flow Model

Trial Arrival (day)	Process 1 (hr)	Process 2 (hr)	Process 3 (hr)	Process 4 (hr)	Process 5 (hr)	Process 6 (hr)	Process 7 (hr)	Process 8 (hr)	Process 9 (hr)	Process 10 (hr)
0.5	7.41	6	29	4.5	10.5	14.5	4.5	1.82	8	3.77
0.3	9	6	29	2.5	10.5		4.5	1.82	16	3.77

3	7.41	7	29	4.5	10.5		4.5	4	4	3.77
1	7.41	8	29	4.5	10.5		2.5	4	16	3.77
0.5	7.41	8	13	4.5	10.5		2.5	8	16	3.77
0.2	7.41	8	13	4.5	10.5		10.5	1.82	16	8.41
0.2	14	8	13	4.5	10.5		10.5	1.82	8	8.41
0.1	14	6	29	4.5	10.5		2.5	3	4	10.73
25	14	6	29	4.5	10.5		4.5	1.82	16	3.77
0.1	16.53	6	17	4.5	10.5		4.5	3	6	10.73
1	16.53	8	17		10.5		4.5	3	4	3.77
0.1	21.09	8	29		10.5		1.5	3	16	3.77
25	9	8	65		10.5		2.5	3	16	3.77
1	7.41	8	17		10.5		2.5	4.06	4	3.77
0.5	21.09	6	29		10.5		5.5	4.06	4	8.41
0.1	7.41	6	29		10.5		5.5	5.18	4	8.41
4	12	6	65		10.5		5.5	4	4	4.93
0.1	7.41	6	29				5.5	1.82	4	4.93
67	9	8	29				5.5	5.18	16	3.77
1	9	6	65				5.5	4	16	3.77
0.2	9	6	17				5.5	1.82	4	10.73
5	9	6	13				6.5	4	4	8.41
0.5	9	6	17				6.5	4	4	8.41
0.5	7.41		17				4.5	1.82	16	4.93
0.5	7.41		29				4.5	1.82	4	4.93
0.3	16.53		17				4.5	1.82	4	6.09
3	16.53		17				4.5	4.06	4	10.73
1	14		17				4.5	4.06	4	3.77
0.2	14		17				4.5	3	8	4.93
1	14		29				4.5	3	8	8.41
0.3	14		29				10.5	3	8	4.93
3	14		29				10.5	3	8	4.93
1	14		29				10.5	3	4	3.77
0.1	14		29				10.5	3	4	6.09
4	14		17				2.5	3	8	6.09
0.2	14		17				2.5	3	4	8.41
0.5	9		13				1.5	3	8	4.93
1	9		17				1.5	4	4	4.93
0.5	9		29				4.5	2.38	8	8.41
1	9.69		65				1.5	4	4	8.41
0.3	9		65				4.5	2.38	4	10.73
3	9		29				4.5	1.82	8	10.73
0.1	9		13				4.5	1.82	4	10.73
25	9		29				4.5	3	16	10.73
1	9.69		29				4.5	3	8	10.73
0.2	7.41		65				2.5	3	8	10.73
1	9		29				2.5	5	8	10.73
0.3	9		29				2.5	4	16	10.73

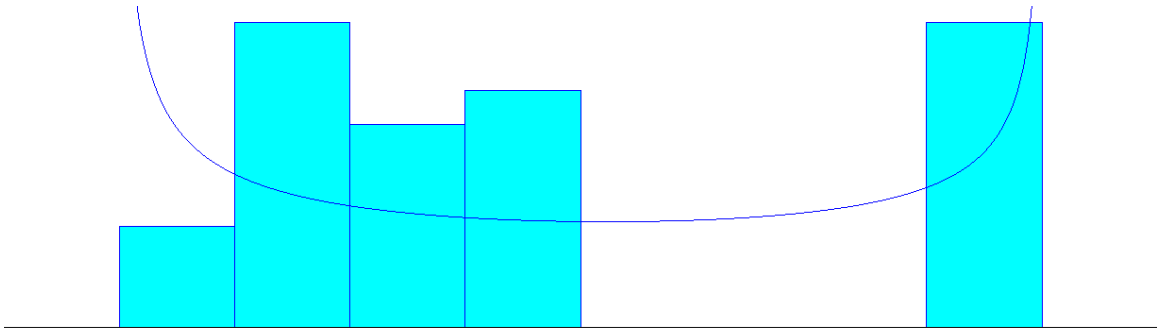
3	7.41		29					5.18		10.73
0.5	9		29					4.06		10.73
1	21.09							4.06		
0.5	16.53							2.38		
0.3	16.53							2.38		
3	9.69							4		
1	9.69							4		
0.3	11.97							2.94		
3	9							5.18		
0.3	21.09							1.82		
3	7.41							4		
	9							4		
0.3	9							2.38		
3	9.69							4.06		
0.1	16.53							2.38		
1	9.69							2.38		
0.1	9.69							1.82		
25	7.41							3		
0.2	9							2.94		
5	11.97							2.94		
0.2	11.97							3		
5	16.53							3		
0.2	9.69							3		
0.2	9.69							4		
5	16.53							4		
0.5	16.53							3		
1	21.09							3		
0.3	21.09							4		
3	21.09							4.06		
0.1	21.09							3		
67	21.09							3		
1	21.09							4		
0.3	21.09							4		
3	21.09							2.38		
0.1	21.09							2.38		
67	21.09							4.06		
0.2								4.06		
5								5.18		
0.3								5.18		
3								5.18		
1								5.18		
0.5								5.18		
0.2								5.18		
5								5.18		
0.2								5.18		
5								5.18		

0.5 1 1 0.5 1								5.18		

(b) Inventory Model

Customer Interarrival Time (days)	Demand size	Delivery Lag (days)
	1200 kg	98
474	2400 kg (order 1200 kg	68
	twice on same day)	40
99	1200 kg	115
101	1200 kg	99
83	1200 kg	95

Figure 5: Example Histograms of Interarrival Time and Results of Chi Square Test for Goodness of Fit



Distribution Summary

Distribution: Beta
Expression: 0.02 + 0.981 * BETA(0.586, 0.632)
Square Error: 0.097424

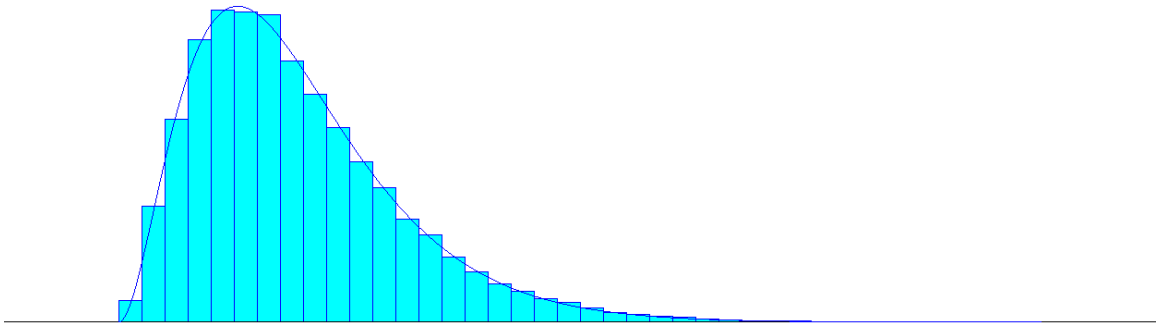
Chi Square Test
Number of intervals = 6
Degrees of freedom = 3
Test Statistic = 38.8
Corresponding p-value < 0.005

Kolmogorov-Smirnov Test
Test Statistic = 0.348
Corresponding p-value < 0.01

Data Summary
Number of Data Points = 68
Min Data Value = 0.111
Max Data Value = 1
Sample Mean = 0.492
Sample Std Dev = 0.329

Histogram Summary
Histogram Range = 0.02 to 1
Number of Intervals = 8

Figure 6: Illustration of Good Fit of a Hypothetical Data Set



mean	41
standard deviation	21
fitted equation	6 + GAMM(12.8, 2.73)
square errors	0.000122
Chi-square test statistics	Test Statistic = 17 Corresponding p-value > 0.75

Table 3: Results of Simulation Runs of the Work Flow Models

(a) Process Wait Time

Replication #	Total Time in System (hr)	Number of Trials Completed	Wait Time (hr)									
			Process 1	Process 2	Process 8	Process 10	Process 3	Process 11	Process 4	Process 5	Process 6	Process 7
1	22.87	1401	0	0	0	0	0	0.00498	10.3300	0	0.00000	0.00979
2	22.96	1365	0	0	0	0	0	0.00000	11.2500	0	1.79400	0.00000
3	23.21	1404	0	0	0	0	0	0.02030	10.6300	0	0.05010	0.00114
4	22.58	1363	0	0	0	0	0	0.00999	11.3700	0	1.94310	0.00180
5	22.73	1402	0	0	0	0	0	0.03862	12.4557	0	0.15280	0.01908
Avg.	22.87	1387	0	0	0	0	0	0.01478	11.2071	0	0.78800	0.00636
Variance	0.0569	442.5	0	0	0	0	0	0.00023	0.6724	0	0.97880	0.00007
STD	0.2384	21.04	0	0	0	0	0	0.01530	0.8200	0	0.98934	0.00809
95% CV	0.2090	18.44	N/A	N/A	N/A	N/A	N/A	0.01341	0.7188	N/A	0.86718	0.00709

(b) Resource Utilization

Technician	Utilization								
	Replication 1	Replication 2	Replication 3	Replication 4	Replication 5	Avg.	Variance	STD	95% CV
T1	0.7371	0.73	0.7368	0.7146	0.702	0.7241	0.0002	0.0154	0.0135
T2	0.6659	0.6904	0.7096	0.6636	0.6804	0.6820	0.0004	0.0189	0.0166
T3	0.1460	0.1111	0.1365	0.1106	0.1407	0.1290	0.0003	0.0169	0.0148
T4	0.5253	0.5283	0.5704	0.5248	0.5396	0.5377	0.0004	0.0192	0.0169
T5	0.4314	0.3835	0.4533	0.3581	0.3761	0.4005	0.0016	0.0401	0.0351
T6	0.3283	0.3505	0.3228	0.2888	0.3445	0.3270	0.0006	0.0242	0.0212
T7	0.6948	0.6977	0.6737	0.6857	0.6624	0.6829	0.0002	0.0148	0.0130
T8	0.7041	0.6935	0.6910	0.6887	0.7023	0.6959	0.0000	0.0069	0.0060
T9	0.08848	0.08456	0.08386	0.0848	0.0974	0.0878	0.0000	0.0056	0.0050
T10	0.3806	0.3555	0.3783	0.3455	0.3700	0.3660	0.0002	0.0151	0.0132
T11	0.5196	0.5061	0.5288	0.5289	0.5306	0.5228	0.0001	0.0103	0.0090
T12	0.1759	0.1451	0.1680	0.1674	0.1714	0.1656	0.0001	0.0119	0.0105
T13	0.0908	0.05758	0.0948	0.07855	0.079	0.0801	0.0002	0.0145	0.0127

Table 4: OptQuest Results to Show the Optimal Compositions of Resource for Achieving Least Process Wait Time

Best Solutions																		
Select	Simulation	Objective Value	Status	Confidence	Replications	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
☐	96	0.000000	Feasible	Met	3	2	2	1	1	0	0	2	1	1	1	0	2	0
☐	95	0.000000	Feasible	Met	3	2	2	1	0	2	0	0	2	0	1	0	2	0
☐	97	0.000000	Feasible	Met	3	1	2	1	0	1	0	2	2	1	1	0	1	0
☐	98	0.000000	Feasible	Met	3	1	2	1	0	1	1	2	2	1	1	1	1	0
☐	3	0.000000	Feasible	Met	3	0	0	0	2	0	0	2	2	2	2	0	2	2
☐	7	0.000000	Feasible	Met	3	0	2	2	0	1	0	2	2	1	0	1	2	1
☐	99	0.000000	Feasible	Met	3	2	2	1	1	1	0	2	1	0	1	0	1	0
☐	4	0.000000	Feasible	Met	3	0	1	0	0	2	0	2	1	0	2	1	2	2
☐	100	0.000000	Feasible	Met	3	2	2	1	0	2	0	2	2	0	1	0	2	0
☐	1	0.000000	Feasible	Met	3	1	1	1	1	1	1	1	1	1	1	1	1	1
☐	12	0.000000	Feasible	Met	3	0	0	1	2	0	1	1	1	1	1	1	2	2
☐	6	0.000000	Feasible	Met	3	0	0	1	2	2	1	2	0	0	1	2	0	1
☐	14	0.000000	Feasible	Met	3	0	1	1	1	1	1	1	1	1	1	1	1	1
☐	15	0.000000	Feasible	Met	3	0	0	1	1	1	1	2	1	2	1	1	1	1
☐	16	0.000000	Feasible	Met	3	2	2	2	0	2	2	0	0	0	0	2	0	0
☐	8	0.000000	Feasible	Met	3	0	2	2	0	0	2	0	0	1	1	1	1	2
☐	18	0.000000	Feasible	Met	3	1	1	1	1	1	2	1	1	1	1	1	1	1
☐	9	0.000000	Feasible	Met	3	1	0	2	0	1	2	2	1	0	1	0	2	2
☐	20	0.000000	Feasible	Met	3	1	1	1	1	1	1	1	1	0	1	2	1	1
☐	10	0.000000	Feasible	Met	3	2	2	1	2	2	0	2	1	0	0	0	1	1
☐	5	0.000000	Feasible	Met	3	0	1	0	0	2	2	1	2	2	1	0	0	2
☐	23	0.000000	Feasible	Met	3	1	2	0	2	1	0	0	1	2	1	2	0	0
☐	24	0.000000	Feasible	Met	3	0	0	1	0	0	2	0	1	2	2	2	1	1
☐	25	0.000000	Feasible	Met	3	2	0	2	0	2	2	0	2	0	0	0	2	2
☐	26	0.000000	Feasible	Met	3	0	0	0	1	0	0	2	2	2	2	0	2	2
☐	13	0.000000	Feasible	Met	3	2	2	1	1	1	1	0	1	0	1	1	1	1
☐	28	0.000000	Feasible	Met	3	0	0	0	2	0	0	2	1	2	2	0	2	2
☐	29	0.000000	Feasible	Met	3	0	0	0	1	1	0	2	2	2	1	0	2	1

Figure 7: Display of Inventory Level as a Function of Time

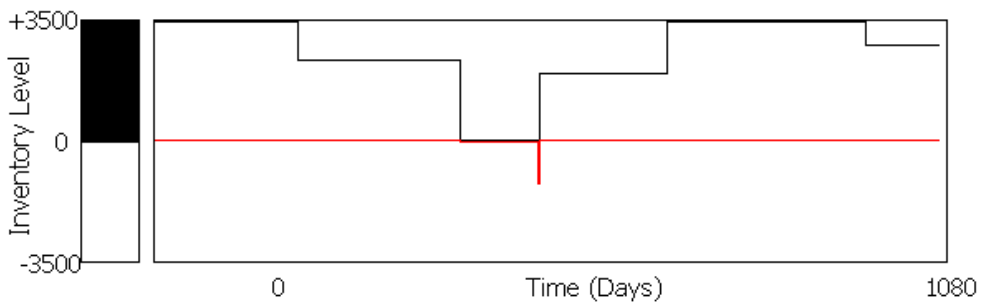
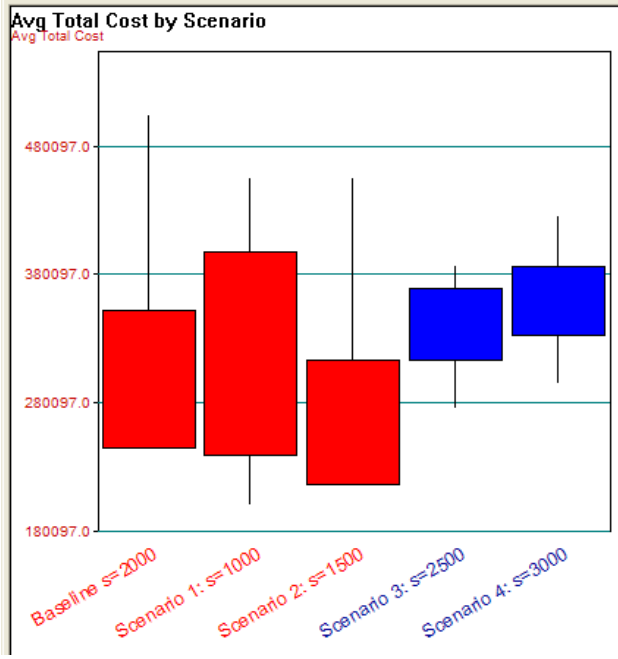


Figure 8: Process Analysis (PAN) Results to Show the Best Inventory Level and Order Quantity

	Scenario Properties			Controls		Responses			
	S	Name	Program File	Reps	Little s	Num Reps	Avg Ordering Cost	Avg Total Cost	Holding Cost	Total Shortage
1		Baseline s=2000	1 : Zhang_Inv	10	2000.0000	10	1311.562	298604.748	263848.178	48829712.40
2		Scenario 1: s=1000	1 : Zhang_Inv	10	1000.0000	10	1013.479	318677.674	195618.211	178187137.2
3		Scenario 2: s=1500	1 : Zhang_Inv	10	1500.0000	10	1073.096	264752.645	230234.541	48829712.40
4		Scenario 3: s=2500	1 : Zhang_Inv	10	2500.0000	10	1371.178	341667.862	323574.180	24414856.20
5		Scenario 4: s=3000	1 : Zhang_Inv	10	3000.0000	10	1609.644	359699.041	341366.893	24414856.20

Double-click here to add a new scenario.

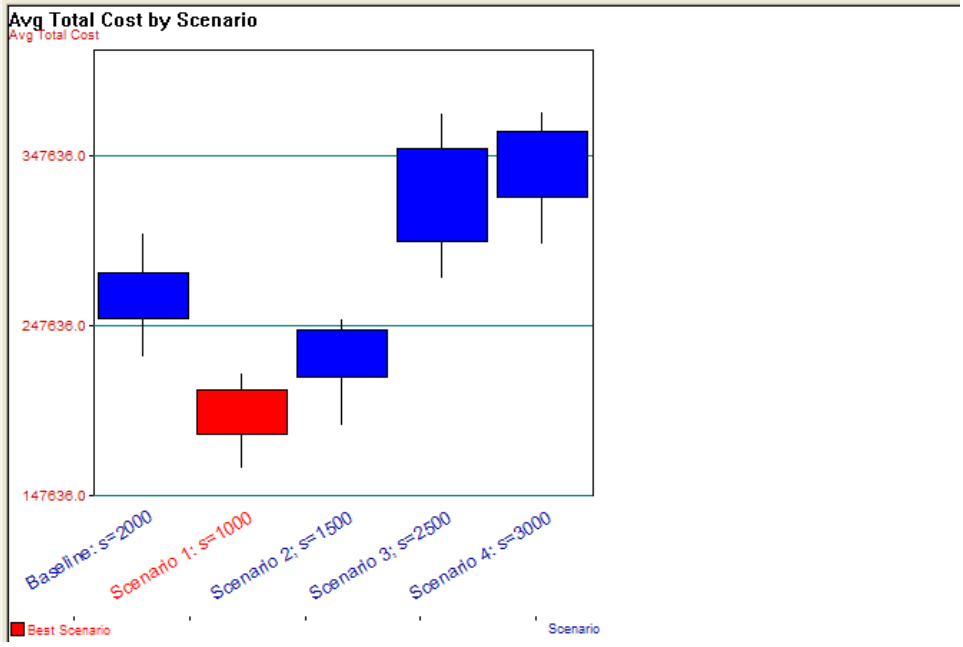


	Scenario Properties			Controls		Responses			
	S	Name	Program File	Reps	q_star	Num Reps	Avg Ordering Cost	Avg Total Cost	Holding Cost	Total Shortage
1		Baseline: Q=3200	1 : Zhang_Inv	10	3200	10	1311.562	298604.748	263848.178	48829712.40
2		Scenario 1; Q=3000	1 : Zhang_Inv	10	3000	10	1229.589	288565.661	250272.570	54112712.40
3		Scenario 2: Q=3100	1 : Zhang_Inv	10	3100	10	1270.575	293585.205	257060.374	51471212.40
4		Scenario 3: Q=3300	1 : Zhang_Inv	10	3300	10	1106.630	268419.255	235676.863	46188212.40
5		Scenario 4: Q=3400	1 : Zhang_Inv	10	3400	10	1140.164	272085.865	241119.185	43546712.40

Figure 9: Process Analysis (PAN) Results to Show the Best Inventory Level and Order Quantity if there is no Shortage Cost

	Scenario Properties			Controls		Responses			
	S	Name	Program File	Reps	Little s	Num Reps	Avg Ordering Cost	Avg Total Cost	Holding Cost	Total Shortage
1		Baseline: s=2000	1 : Zhang_Inv	10	2000.0000	10	1311.562	265159.740	263848.178	0.000
2		Scenario 1: s=1000	1 : Zhang_Inv	10	1000.0000	10	1013.479	196631.690	195618.211	0.000
3		Scenario 2; s=1500	1 : Zhang_Inv	10	1500.0000	10	1073.096	231307.637	230234.541	0.000
4		Scenario 3; s=2500	1 : Zhang_Inv	10	2500.0000	10	1371.178	324945.358	323574.180	0.000
5		Scenario 4: s=3000	1 : Zhang_Inv	10	3000.0000	10	1609.644	342976.537	341366.893	0.000

Double-click here to add a new scenario.



	Scenario Properties			Controls		Responses			
	S	Name	Program File	Reps	q_star	Num Reps	Avg Ordering Cost	Avg Total Cost	Holding Cost	Total Shortage
1		Baseline: Q=3200	1 : Zhang_Inv	10	3200	10	1311.562	265159.740	263848.178	0.000
2		Scenario 1: Q=3000	1 : Zhang_Inv	10	3000	10	1229.589	251502.159	250272.570	0.000
3		Scenario 2; Q=3100	1 : Zhang_Inv	10	3100	10	1270.575	258330.949	257060.374	0.000
4		Scenario 3; Q=3300	1 : Zhang_Inv	10	3300	10	1106.630	236783.493	235676.863	0.000
5		Scenario 4: Q=3400	1 : Zhang_Inv	10	3400	10	1140.164	242259.350	241119.185	0.000