ASSUMPTION UNIVERSITY

DECISION SUPPORT SYSTEM FOR A CORPORATE LEVEL TECHNOLOGY INVESTMENT

by

Gour Chandra Saha

Final Report of the Three - Credit Course
CS 6998 System Development Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
in Computer Information Systems
Assumption University

December 1993

port

ABAC
GRADUATE SCHOOL LIBRARY

DECISION SUPPORT SYSTEM FOR A CORPORATE LEVEL TECHNOLOGY INVESTMENT

by

Gour Chandra Saha

Final report of the three-credit course
CS 6998 System Development Project

Submitted in partial fulfilment
of the requirements for the degree of
Master of Science
in Computer Information Systems

Assumption University
December 1993

Project Title : Decision Support System For a Corporate Level Technology Investment

Name : Gour Chandra Saha

Project Advisor : Assoc. Prof. Dr. Kanchit Malaivongs

Academic year : 1993

The Graduate School of Assumption University had approved this final report of the three-credit course, CS 6998 System Development Project, submitted in partial fulfilment of the requirements for the degree of Master of Science in Computer Information Systems.

Approval Committee:

Assoc. Prof. Dr. Kanchit Malaivongs Advisor	Prof. Dr. Srisakdi Charmonman Member
Dr. Sudhiporn Patumtaewapibal Member	Assoc. Prof. Somchai Thayarnyong Member

December 1993

ABSTRACT

The project provides a basis of comparison between two or more technological investments. The traditional Net Present Value (NPV) by itself does not contribute explicitly towards technology. The model used in this project simulates the determining of a Technology Contribution Coefficient (TCC) as well as the Net Present Value for each investment alternative.

Ordinarily, technology is seen as mere physical tools and facilities. It is, however, a transformer of resources for, in addition, it requires human skills, accumulated knowledge and institutional arrangements. This project uses a framework of the four basic components of technology for computation of TCC, namely, 1) Technoware 2) Humanware 3) Inforware and 4) Orgaware.

Net Technology Value (NTV) has been proposed (which is different from the original model) as the product of TCC and NPV. NTV is supposed to measure an operative capability of a technological contribution. A higher NTV will facilitate the decision maker for a better selection of an investment alternative.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

ACKNOWLEDGMENT

First and foremost, I would like to express my deep gratitude to my advisor, Dr. Kanchit Malaivongs for his inspiring guidance and advice. My lecturers of M.Sc course have also helped me greatly and I am conscious of my indebtedness to them.

My sincerest appreciation goes to Professor Nawaz Sharif, Ph.D, who in fact, initiated me to the concept and the model I developed in my project.

I would be failing in my duty if I do not thank my well-wishers Dr and Mrs Anand Reddy who provided the necessary encouragement in my work. My wife, Mrs. Rita Saha, of course, has been a constant support through all the strenuous work of the project, and I thank her too very deeply.

ASSUMPTION UNIVERSITY OF THAILAND
OMNIA
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

TABLE OF CONTENTS

Page

Abstract iii

Acknowledgement iv

List of Tables & Figure vi

1. INTRODUCTION 1

    1.1 Background 1

    1.2 Objectives 2

    1.3 Scope of the Project 2

2. LITERATURE REVIEW 3

3. PROPOSED MODEL 5

    3.1 Model Scenario 5

    3.2 Inputs to the Model 6

        3.2.1 Technoware 7

        3.2.2 Humanware 7

        3.2.3 Inforware 7

        3.2.4 Orgaware 8

    3.3 Output of the model 9

4. HABIGANJ GAS FIELD - A CASE STUDY 11

    4.1 Company: an introduction 11

    4.2 Findings 13

    4.3 Discussion 34

5. CONCLUSION & RECOMMENDATIONS 35

    5.1 Conclusions 35

    5.2 Recommendations 36

References 37

Page

APPENDIX

A. Questionnaire 38

B. Program Listing 44

C. Manual 70

D. Net Technology Value - A Detailed Calculation with Example. 71

LIST OF TABLES & FIGURE

Page

1. Summary of component contribution of the project (Technoware) 31

2. Summary of component contribution of the project (Humanware) 31

3. Summary of component contribution of the project (Inforware) 32

4. Summary of component contribution of the project (Orgaware) 32

5. Summary of Technology Contribution Coefficient (TCC), Net Present Value (NPV), and Net Technology Value (NTV) 33

Figure-1 Graphical Representation of NTV 9

1. INTRODUCTION

1.1 Background

The role of technology in economic growth has long been accepted in the context of industrialized economies. It has been said that for good or for ill, economic growth draws its vital nourishment from technology without which, no matter how favourable all other factors might be, modern development would have been essentially inconceivable.

Many attempts have been made to assess the specific contribution of technology in economic growth. In practice most technology orientation are restricted to the company level. Evaluation of the technological transformation activities at a company level are based on capital and labour inputs and economic value added. These approaches consider technological aspects only implicitly. So it would be useful to have a methodology focusing its attention explicitly on technological aspects.

This report attempts to develop a decision support system to study the performance of an investment in technology from an explicit technological perspective.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

1.2. Objective

The objectives of the project on the `**DSS for a Corporate Level Technology Investment**' are as follows :

1. To design a Conceptual Decision Support System to assist managers in decision making whether the technology and the investment are mutually justifiable.
2. To develop and test a DSS software package for the model which is written in Turbo Pascal.

1.3 Scope of the project

The study covers

i) all the components of technology (Technoware, Humanware, Inforware and Orgaware) in an investment at a transformation facility at a corporate level.

ii) business of all kinds, manufacturing as well as service institutions, will be within the scope of study.

iii) a quantitative model for measuring the Net Technology Value (NTV) is developed by using the Technology Contribution Coefficient (TCC) and Net Present Value Analysis.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969

2. LITERATURE REVIEW

Investment in technology appears to be posing difficulties to many investors. It is probably due to the lack of appreciation of the difference between science and technology and their interrelationships. An example in point is when we buy a very sophisticated computer with a low price, we assume the technology is very cheap. We hardly consider the cost of spare parts, training and maintenance manual etc.

A recent study of United Nations has differentiated the two terms as follows [1]:

`Science may be said to be the quest for objective laws governing natural phenomena free of any concern about possible economic applications. In this sense, science is simply the pursuit of truth itself. On the other hand technology has the practical goal of making directly useful applications of scientific principles and laws to human life or the process of production. Thus technology may be said to be concerned with "know-how" while science focuses on "know-why". Science thus generates knowledge while technology facilitates the production of material wealth.'

In another study of United Nations Technology is defined as knowledge of how something is made. The study has differentiated technology andd the product of technology. Accordingly, technology is knowledge while product of technology is the object that we obtain from a relatively higher set up [4].

In the earlier study, technology is viewed as a combination of both the physical tool and the related know-how. If viewed in this manner, technology is likely to have four basic components namely [2] :

1. Technoware (Facilities) - it refers to object embodied technology and consists of items such as tools, equipment, machines, vehicles and physical infrastructure.

2. Humanware (Abilities) - it refers to person-embodied technology and includes aspects such as knowledge, skill, labour, etc.

3. Inforware (Facts) - refers to document embodied technology and relates to aspects such as processes, procedures, techniques, methods, publications, documents and blueprints.

4. Orgaware (Framework) - It is required to facilitate the effective integration of Technoware, Humanware and Inforware.

The technometric model that is proposed in the study basically seeks to measure the joint contribution of the four components of tecnology and the value added as a result of technological applications. [3] Thus the model is defined as :

$$TCA = TCC * VA$$

Here, TCA, TCC and VA refer to Technology Content Added, Technology Contribution Coefficient and Value Added respectively.

$$TCC = \alpha * T^{\beta t} * H^{\beta H} * I^{\beta I} * O^{\beta o}$$

Here, the T, H, I, O refer to the individual contributions made by the Technoware, Humanware, Inforware and Orgaware. The β. refers to the intensity of contribution of each component. α is the climate factor under which the technology investment is made.

3. PROPOSED MODEL

3.1 Model Scenario

The various considerations outlined in the UN study above indicate that while measures based on 'economic value added' have a useful role in evaluating the performance of a manufacturing facility.

This study is mainly designed for generalizing the model, not only in a manufacturing facility but also in a service institution. In a manufacturing concern, the value added concept is measured as the shadow price or percentage of gross output.

From an investment perspective, this study proposes a more comprehensive model which uses NPV instead of VA. Thus with a view to generalize the situation, this study stipulates that viability of an investment for a corporate level technology should be analyzed in three levels:

1. Operative capability - It measures the joint contribution of TCC and NPV. A technometric model being proposed for measuring the capability is as follows:

Net Technology Value (NTV) = TCC * NPV

Here, TCC and NPV are technology contribution coefficient and net present value respectively.

TCC is measured according to the UN model, which is

$$TCC = \alpha * T^{\beta t} * H^{\beta H} * I^{\beta I} * O^{\beta o}$$

α is required mainly for a comparative technology investment study. Since, this project is made in Thailand and doesn't compare with those in other countries, we assume the value of α is 1.

Thus

$$TCC = T^{\beta t} * H^{\beta H} * I^{\beta I} * O^{\beta o}$$

A generic model of Net Present Value is given as follows : NPV = Cash Flow discounted in present value - Investment

2. Acquisitive Capability - It is the ability of the company to acquire a technology under diverse circumstances. The capability should be evaluated from technology transfer point of view. For instance, are we buying the equipment(s) from local market or international market. If the technology is bought from an international market, we will be dependent on external consultant.

3. Innovative Capability - it is the ability of the company to explore the frontiers of science and create technology that is not possible to obtain. It will measure the extent of independence of the company. If a required technology is not available in the market, locally or internationally, will we be able to develop it?

Acquisitive capability and Innovative capability must be assessed in a qualitative way.

3.2 Inputs to the model

A questionnaire with respect to T, H, I and O has been developed. Items are grouped according to the components and the relative importance of the components measured on the basis the questionnaire for the computation of TCC.

The items are as follows :

3.2.1 Technoware :

- Machinery or equipment to be required.
- Technology life-cycle where the output of the facility lies.
- Scale of operations or throughput (If the throughput is very high, we need very specialized technology)
- Complexity of operations
- Quality
- Extra cost of safety measure

3.2.2 Humanware :

- Total number of employees to be required, and its break-up, such as
    - Number of unskilled workers.
    - Number of semi-skilled/skilled workers.
    - Number of technical and R & D personnel.
    - Number of management staffs.
- Average education level of the workers
- Average number of years of experience of the workers

3.2.3 Inforware :

- Extent of MIS requirement.
- Extent of database/books/publications available.
- Extent of QC intended.
- Technical know-how fees/project consultancy fees with respect to total cost of the project.

3.2.4 Orgaware :

- Capacity utilization of the facilities.
- Ratio of R & D expenditures to sales.
- Management techniques

Each item in the above four components is measured in 5- point rating scale. We average out the rating for each component and find out the value of T, H, I, and O.

Next input to the model is the relative importance of each component. The users will be asked to put their relative importance to a 5-point rating scale. for instance, an investor wants to set up a computer school, while the other investor wants to set up a language school. In case of setting up a computer school T's relative importance is higher than I. On the other hand 'I' will be more important compared to T for the second investor.

There would be 16 paired comparisons that would be shown in the form of a 4 x 4 matrix.

Eigen value analysis is conducted in order to determine the eigen vector. The vector is than normalized that implies a constant return to scale.

Last inputs are for the computation of Net Present Value. Since the model is highly generalized, the inputs are only as follows :

- Cost of Land
- Cost of Building
- Cost of Machineries or Equipments
- Cost of other physical infrastructure
- Working capital

- Revenue per period.

- Number of years of life of investment

To facilitate the model above, a graphical representation of NTV may be useful :

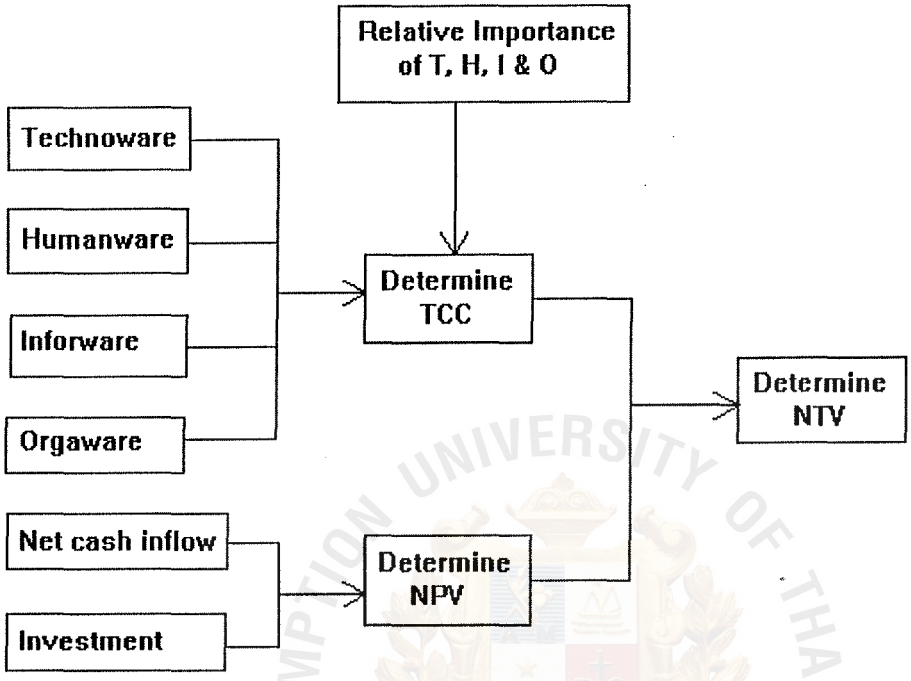

Figure-1 Graphical Representation of NTV

3.4 Output of the Project

The major output of the project is the Net Technology value (NTV). In a very broad sense it may be said that from a technological viewpoint, an investment with a higher TCC has a greater technological capability than one with a lower TCC. The NTV value of a firm with high NPV but a low TCC may be exceeded by a firm with a medium NPV but a high TCC. Thus in technology investment, we must explore ways and means of increasing not only NPV but also the TCC.

Decision Support System consists of three major components: Model, Database and Interface. For database and interface, a computer program is written in Pascal. The Program is made as user-friendly as possible.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

ABAC
GRADUATE SCHOOL LIBRARY

4. HABIGANJ GAS FIELD - A CASE STUDY

221 ค.1

4.1 Company : an Introduction

Bangladesh Gas Field Company Limited is a semi government organization run by Petro Bangla - the oil, gas, and mineral resources corporation of Bangladesh. The company has five gas fields and as many process plants under its ownership. The complexity and robustness of the operation of gas extraction and processing have aggrandised the technological investment of the company both in terms of money and engineering skills. Being a profit-seeking organization, it has been using its management staff at its peak efficiency in order to get a maximum return on the big investment. Thus the money, the technology and the management - all the three features of the company make it an ideal case study of technological investment. As the company, with all its five gas fields, does not fit into the software developed by the author, for lack of complete set of required data, only one of the gas fields, i.e Habiganj Gas Field and its accompanying process plant have been selected as the subject of the present case study.

Habiganj Gas Field and process plant first came into picture in 1968. The geological survey, drilling and installation of the plant were performed by the famous British Shell Oil Company and later the establishment was handed over to Bangladesh Gas Fields Company Limited. Since its inception, it has undergone sizeable changes in its equipments and management procedures. Now the equipments are sophisticated and consistent with the contemporary technology, but the control system still lacks in the degree of modernization. The equipments as well as the control units are mechanical ones. The scale and complexity of the operation can be said to be of a medium degree considering the size of the plant (amount of input/output), ease of operation and maintenance and control. The company's main product is processed gas, and has at

present reached it's late growth stage of life cycle (assuming that the use of gas will be ever increasing until an alternative energy source is found). Since the quality of the main product (gas) and the by-product (small percentage of oil) is regulated by the government code and policies, it has maintained itself at a high level. One very important aspect of the establishment is that the safety system is good enough but can still be improved.

The gas field at present is run by a total of 70 employees. This figure includes more than 60% unskilled workers (learning stage), 12% skilled workers (who can operate independently), about 7% engineers, (diploma and degree) and 5% management staff (managers and administrative officers). Although a few workers are highly educated, still the average level does not go beyond higher secondary school education. Likewise, the average level of experience is somewhat between 2-3 years, although some have been working for 15-20 years. Inter-organizational communication is very slow and poor in the absence of computers and latest journals. Still it does not create much problem as mostly routine jobs are performed and the operations and maintenance manuals are available. For its repeatitive nature of the job, and availability of precise information on steady demand, ordinary production planning techniques are used.

The Habiganj gas field, having a number of stand-by units for assured operation has a capacity utilization of around 70-80%.

This gas field is estimated to have land of 10 million Taka (approximately seven million baht), Building of Tk. 2.5 (1.5 million baht) and equipment of Tk.2000 million (1400 million baht)and other phisical infrustructures of Tk.0.5 million (0.3 million baht). Expenditure per month is apptoximately Tk. 0,5 million(0.3 million baht) while net earning (after tax is paid)amounts to Tk.12.0 milliion (8 million baht) per month. Life of the establishment is taken to be 40 years.

4.2 Findings

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

WELCOME TO THE INVESTECH DECISION SUPPORT SYSTEM !

This Decision Support System provides you a basis of comparison between two or more technological investments. The traditional Net Present Value(NPV) itself does not take care of an explicit contribution towards technology. Hence this system model deals with the determining of a Technology Contribution Coefficient (TCC) as well as the Net Present Value for each investment alternative.

For your investment decision, the higher NTV (Net Technology Value) means the better operative capability for the technology concerned. An acquisitive and innovative capability assessment must be made subjectively by the decision maker.

Press Enter when you finish

We consider that you are going to invest in a certain technology. Please select the choices very carefully. You may require expert opinion for selection of certain choice. In general in 1 to 5 point scale, 1 represents the least contribution while 5 represents the highest contribution for technology.

Press Enter When You Finish

INTRODUCTION

Technology is generally perceived as machineries. But it is actually much more than only machineries. In the olden days, when computers could only read machine language (0 or 1) people needed very long time to get things done by computers. With the increase in technology computers have become more sophisticated and human efforts have been drastically reduced. In operation of an automatic camera, users abilities and skills are very low. Here stands the relationship between Technoware or facilities and Humanware or abilities. Technoware and Humanware are inversely correlated - which means a higher technoware or facility needs lower humanware or abilities.

With the help of manual or inforware or documents, people now can obtain various levels of skills and undertake different profession of their choice.

Orgaware or framework is the ability to integrate facilities, abilities and facts effectively. Hence in this system, Technology is considered as the contribution of all these four components, namely, Technoware, Humanware, Inforware, and Orgaware.

What kind of machinery or equipment do you require ?

1. Manual / No equipment
2. Mechanical
3. Semi-automated
4. Automated (computrized Control)
5. Integrated (robotics)

Select the choice [1..5] : 2

MANUAL IS SOLELY MUSCLE DRIVEN; MECHANICAL IS WHERE ATTENDENT IS NEEDED FOR CONTROL AS WELL AS FOR OPERATION; SEMI-AUTOMATED IS WHERE ATTENDENT IS NEEDED FOR FEW OPERATIONS; AUTOMATED IS WHERE ATTENDENT IS NOT REQUIRED FOR OPERATIONS,BUT REQUIRED FOR CONTROL.

ASSUMPTION UNIVERSITY OF THAILAND SINCE 1969

At what stage of the technology life cycle the output of the transformation facility lies ?

1. Decline stage
2. Introductory stage
3. Early growth stage
4. Mid-growth stage
5. Maturity

Select the choice [1..5] : 4

DECLINE IS OUTDATED PRODUCT, SUCH AS BLACK & WHITE TV; MATURITY IS WHEN THE PRODUCT USAGE IS AT THE PEAK, SUCH AS AUTOMOBILE; FAX MACHINE IS NOW AT MID-GROWTH STAGE; COLOR COPIER IS AT EARLY GROWTH STAGE.

What scale of operations(throughput) do you intend to set up?

1. Very low
2. Low
3. Medium
4. High
5. Very high

Select the choice [1..5] : 3

VERY LOW REFERS TO A SITUATION WHERE THE ACTUAL PRODUCTION RATE IS NEGLIGIBLE COMPARED TO ITS CAPACITY.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

What degree of complexity of operations do you have in your facility ?

1. Very low
2. Low
3. Medium
4. High
5. Very high

Select the choice [1..5] : 3

COMPLEXITY OF OPERATIONS DENOTE DEGREE OF DIFFICULTIES ASSOCIATED WITH THE TRANSFORMATIONAL OPERATIONS.

What is the expected quality of your product or service ?

1. Loweat possible that can be sold
2. Low to some extent
3. Medium
4. High
5. Best in the market

Select the choice [1..5] : 4

QUALITY OF THE CONCERNED PRODUCT IS SUBJECT TO A COMPARISON WITH EXISTING SIMILAR PRODUCT IN THE MARKET.

ABAC
GRADUATE SCHOOL LIBRARY

What extent of extra cost for safety measure are expected to incur ?

1. Negligibile
2. Low
3. Medium
4. High
5. Very high

Select the choice [1..5] : 3

NEGLIGIBLE COST IN SETTING UP SAFETY MEASURE RESULTS IN AN UNSAFE ENVIRONMENT.

How many total employees do you require ? 70
Specify the details :

Number of unskilled workers?	50
Number of semiskilled/skilled workers?	10
Number of technical and R & D personnel?	6
Number of management staff?	4

4

TOTAL EMPLOYEES INCLUDE UNSKILLED, SKILLED, TECHNICAL, R&D AND MANAGEMENT PERSONNEL; UNSKILLED WORKERS ARE WHO CANNOT PRODUCE ANY PRODUCT INDEPENDENTLY; TECHNICAL AND R&D PERSONNEL ARE RESPONSIBLE FOR RESEARCH, DESIGN, DEVELOPMENT AND OPERATIONS.

SINCE 1969

What is the average level of education of your workers ? (excluding Manager and technical personnel)

1. No education
2. Primary school
3. Secondary school
4. Vocational school
5. University

Select the choice [1..5] : 3

What is the average number of years of experience of your workers (Note! only workers)?

1. 1 or 10 years or more
2. 2 or 9 years
3. 3 or 8 years
4. 4 or 7 years
5. 5 or 6 years

Select the choice [1..5] : 3

Experts say that 5 to 6 years of experience are the best for a technology. Any period of experience, less or more, are not a favorable contribution towards technology.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969

What extent of MIS do you want to require ?

1. No MIS
2. Manual Reporting
3. Semi-computerized
4. Computerized (LAN)
5. Computerized (international link)

Select the choice [1..5] : 2

What extent of database/books/publications are available ?

1. Very low
2. Low
3. Medium
4. High
5. Very high

Select the choice [1..5] : 2

ASSUMPTION UNIVERSITY OF THAILAND
มหาวิทยาลัยอัสสัมชัญ

What extent of QC do you intend to set up ?

1. Absence of QC set up
2. Intermediate values
3. QC at limited level
4. Intermediate values
5. QC at all levels

Select the choice [1..5] : 4

What is the percentage of project consultancy fees with respect to the total cost of the project ?

1. 0.0 - less than 2.5%
2. 2.5 - less than 5.0%
3. 5.0 - less than 7.5%
4. 7.5 - less than 10.0%
5. More than 10.0%

Select the choice [1..5] : 5

According to experts,in an investment of high technology, 10% or more are spent for consultancies.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969

What is the estimated utilization of the production capacity after one year?

1. Less than 60%
2. 60 - less than 70%
3. 70 - less than 80%
4. 80 - less than 90%
5. More than 90%

Select the choice [1..5] : 3

What is the ratio of R&D expenditure to sales ?

1. Less than 0.5%
2. 0.5 - less than 1.0%
3. 1.0 - less than 1.5%
4. 1.5 - less than 2.0%
5. More than 2.0%

Select the choice [1..5] : 1

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

ABAC
GRADUATE SCHOOL LIBRARY

What is the inventory management technique that you are going to use ?

1. Ordinary production plan
2. Just in time inventory
3. Zero base budgeting
4. Subcontracting
5. Networking with Suppliers and custome

Select the choice [1..5] : 1

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

The following six questions are about the relative importance of the four components. Pairwise Comparison Technique has been used for this comparison, i.e T vs H, T vs I, T vs O, H vs I, H vs O, and I vs O. The data obtained will form a triangular matrix as follows:

	T	H	I	O
T	1			
H		1		
I			1	
O				1

If T (Technoware) seems, for instance, 3 times more important than H (Humanware), then automatically H will be .333 times as less important as T.

Relative Importance Scale for Evaluating Component Contribution Intensity

Intensity Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to one objective.
3	Essential or strong importance	Good evidence and logical criteria exist to show that one is more important.
5	Absolute importance	The evidence in favor of one activity over another is of the highest possible order of affirmation.

Technoware's relative importance to Humanware is

(Select 1..5 or an inverse thereof)

Select the choice : 3

Technoware is facilities, Humanware is abilities, Inforware is facts and Orgaware is framework. In a computer school, for example, Technoware is more important than Humanware. Use any decimal value for inverse relative importance.

Technoware's relative importance to Inforware is

(Select 1..5 or an inverse thereof)

Select the choice : 2

Technoware is facilities, Humanware is abilities, Inforware is facts and Orgaware is framework. In a computer school, for example, Technoware is more important than Humanware. Use any decimal value for inverse relative importance.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

Technoware's relative importance to Orgaware is

(Select 1..5 or an inverse thereof)

Select the choice : 4

Technoware is facilities, Humanware is abilities, Inforware is facts and Orgaware is framework. In a computer school, for example, Technoware is more important than Humanware. Use any decimal value for inverse relative importance.

Humanware's relative importance to Inforware is

(Select 1..5 or an inverse thereof)

Select the choice : 1

Technoware is facilities, Humanware is abilities, Inforware is facts and Orgaware is framework. In a computer school, for example, Technoware is more important than Humanware. Use any decimal value for inverse relative importance.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

Humanware's relative importance to Orgaware is

(Select 1..5 or an inverse thereof)

Select the choice : 3

Technoware is facilities, Humanware is abilities, Inforware is facts and Orgaware is framework. In a computer school, for example, Technoware is more important than Humanware. Use any decimal value for inverse relative importance.

Inforware's relative importance to Orgaware is

(Select 1..5 or an inverse thereof)

Select the choice : 1

Technoware is facilities, Humanware is abilities, Inforware is facts and Orgaware is framework. In a computer school, for example, Technoware is more important than Humanware. Use any decimal value for inverse relative importance.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

FINANCIAL ANALYSIS

The following portion is the financial analysis of the technological project you are investing in. The Net Present Value (NPV) has been used for this analysis. It discounts the value of the stream of the after-tax cash flows back to the present. The word NET suggests that all cash flows are taken into account, both in-flows and outflows. NPV considers the time value of money and it considers all of the cash flows over the entire life of the project. The specimen of the items used in this analysis is given in the next screen to help the users understand what he must make ready before going to the actual problem.

Please enter when yoy finish

In the next screen, you have to mention the following:

Estimated costs (in thousand baht)

LAND .....

BUILDING .....

MACHINARIES OR EQUIPMENT .....

OTHER PHYSICAL INFRUSTRUCTURE ..

(These four costs (above) are the initial cash outflows)

INTEREST RATE AT THE BANK (IN PERCENTAGE) ...

(If you borrow from the bank)

ESTIMATED LIFE OF THE PROJECT (IN YEARS) ...

YEAR	ESTIMATED REVENUE (thousand baht)	ESTIMATED EXPENSE (thousand baht)
1	.....	.....
2	.....	.....
.	.....	.....

upto the estimated life of the project.

Press Enter When You Finish

Mention the following costs that you require for the project (in thousand baht) :

Land	: 7000
Building	: 1500
Mechinaries or equipments	: 1400000
Other physical infrastructure	: 300

What is the interest rate in the bank (in percentage)? 16

What is the estimated life of the project (in year)? 40

How much is your expected periodic revenue and expenses (in thousand baht)?

Year	Revenue	Expenses
1	96000	6000
2	96000	6000
3	96000	6000
4	96000	6000
5	96000	6000
6	96000	6000
7	96000	6000
8	96000	6000
9	96000	6000
10	96000	6000
11	96000	6000
12	96000	6000
13	96000	6000
14	96000	6000
15	96000	6000
16	96000	6000
17	96000	6000
18	96000	6000

ASSUMPTION UNIVERSITY OF THAILAND

19	96000	6000
20	96000	6000
21	96000	6000
22	96000	6000
23	96000	6000
24	96000	6000
25	96000	6000
26	96000	6000
27	96000	6000
28	96000	6000
29	96000	6000
30	96000	6000
31	96000	6000
32	96000	6000
33	96000	6000
34	96000	6000
35	96000	6000
36	96000	6000
37	96000	6000
38	96000	6000
39	96000	6000
40	96000	6000

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

SUMMARY OF COMPONENT CONTRIBUTION OF THE PROJECT
(TECHNOWARE)

TECHNOWARE	(1 to 5) POINT SCALE	CONTRIBUTION
Kind of Machinery	2	
Technology life cycle	4	
Scale of Operations	3	
Complexity of operations	3	0.633
Quality of Product	4	
Cost of Safty Measure	3	

* 1 = Lowest Contribution, 5 = Highest Contribution

SUMMARY OF COMPONENT (HUMANWARE) CONTRIBUTION OF THE PROJECT

HUMANWARE	NUMBER OF PEOPLE	PERCENTAGE	1 TO 5 POINT	CONTRIBUTION
UNSKILLED WORKER	50	71.4	1	
SEMISKILLED/SKILLED	10	14.3	2	
TECHNICAL/R&D	6	8.6	2	
MANAGEMENT STAFF	4	5.7	2	0.433
LEVEL OF EDUCATION			3	
YEARS OF EXPERIENCE			3	

* 1 = Least Contribution, 5 = Highest contribution

SUMMARY OF COMPONENT CONTRIBUTION OF THE PROJECT (INFORWARE)

INFORWARE	(1 to 5) POINT SCALE	CONTRIBUTION
Extent of MIS	2	
Extent of Database, Books or Publications	2	
Extent of Q-Control	4	0.650
Project Consultancy Fee (1 = 0-2.5%, 5 = >10%)	5	

* 1 = Lowest Contribution, 5 = Highest Contribution

SUMMARY OF COMPONENT CONTRIBUTION OF THE PROJECT (ORGAWARE)

ORGAWARE	(1 to 5) POINT SCALE	CONTRIBUTION
Capacity Utilization (1 = < 60%, 5 = >90%)	3	
Ratio of R&D Expenditure (1 = < 0.5%, 5 = >2.0%)	1	0.333
Management Technique	1	

* 1 = Lowest Contribution, 5 = Highest Contribution

SUMMARY OF TECHNOLOGY CONTRIBUTION COEFFICIENT (TCC), NET PRESENT VALUE (NPV), AND NET TECHNOLOGY VALUE (NTV)

TECHNOLOGY COMPONENTS	COMPONENT CONTRIBUTIONS	COMPONENT CONTRIBUTION INTENSITY	TCC*	NPV	NTV
Technoware (T)	0.633	0.477			
Humanware (H)	0.433	0.221			
Inforware (I)	0.650	0.183	0.542	-847785	-459559
Orgaware (O)	0.333	0.119			

* TCC=1-->Highest Contribution, TCC=0-->Least Contribution
The higher NTV represents better operative capability

THANK YOU FOR USING

INVESTECH DECISION SUPPORT SYSTEM !!

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969

4.3 Discussion

The net technology value in Habiganj Gas Field is -459.5 million Taka (US$ -11.5 million), which indicates that the establishment has a very low operative capability. The reason for such negetive value may be traced back to its negetive NPV and low TCC. Again, a low tcc may further be analysed that only technowares or machineries are given the highest priority compared to other components. A negetive NPV value is probabably caused by very high mechineries cost (1.4 billion Taka) and relatively less return in 40 years.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

5. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The technometric model used in this project is slightly different from the one used in the United Nation's Technology Atlas project. Instead of an original 'Value Added' analysis, a Net Present Value (NPV) has been proposed here for a financial evaluation of technology on firm level. Hence, the question of validity and reliability of the model may arise and it needs to be clarified.

The model mentioned has not gone through extensive case studies due to limitation of time and the difficulties of collecting the necessary data. Therefore, only one case study, that of the Habiganj Gas Field in Bangladesh, was taken up. The projected results of the case study match accurately with the actual results of the company's performance. Further, an extensive expert opinion confirms the results and findings of the model.

The model can be used as a decision support tool in many ways. However, the scoring procedures used extensively in the model, may need an expert opinion for a consistent scoring. Out of the many uses, two major uses of the model could be considered at present.

Firstly, the analysis could be used for inter-project comparisons from a technological perspective. Traditional inter-project comparison exercises have focused their attention mainly on financial aspects. when two projects are evaluated using the proposed net technology value, the extent to which one project is better than the other from a technological perspective can be measured by looking at the differences in the

component values. The reasons for the existence of this gaps can be traced back to the contribution and relative importance of the four components of technology as well as net present value of the project.

Secondly, NTV could be used to help national planners to understand the status of a country's investment projects from a technological perspective. For instance, when foreign investment offers are being evaluated in a developing country, a NTV analysis of the proposed investment may help the developing country carry out negotiations on a better footing. If the TCC is high then the developing country government may consider extending favorable terms to the foreign investor while these may have to be tightened if the TCC values are too low.

5.2 Recommendations

The following suggestions are recommended for further improvement of the model and the program:

i.) Extensive case studies should be undertaken for validitating the present model.

ii) While the model mentioned herein reflects only operative capability, an acquisitive and innovative capability could be added to the model in further studies.

iii) The user interface (Program) could be made more friendly in the revised versions.

iv) Analytical Hierarchical Process (AHP) could be used for checking consistency of the users rating for relative importance.

References

1. Technology Atlas Project, Technology Content Assessment, vol. 2, United Nations, Asian and Pacific Centre for Transfer of Technology, Bangalore, India, 1989.
2. The Technology Atlas Team, *Components of Technology for Resources Transformation*, Technological forecasting and social change vol.32 no.1 August 1987 p. 22.
3. The Technology Atlas Team, *Measurement of Technology Content Added*, Technological forecasting and social change vol.32 no.1 August 1987 p. 38.
4. Technology Transfer, An ESCAP Training Manual.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

Appendix A: Questionnaire

Scoring for the computation of TCC.

Technoware

1. What kind of machinery or equipment do you require?
   (1) Manual/No equipment.
   (2) Mechanical
   (3) Semi-automated
   (4) Automated (Computerized Control)
   (5) Integrated (Robotics)
2. At what stage of the technology life cycle the output of the transportation facility lies?
   (1) Decline stage.
   (2) Introductory stage.
   (3) Early growth stage.
   (4) Late-growth stage.
   (5) Maturity.
3. What scale of operations (throughput) do you intend to set up ?
   (1) Very low
   (2) Low
   (3) Modium
   (4) High
   (5) Very high
4. What degree of Complexity of Operations do you have in your facility ?
   (1) Very low (2) Low (3) Modium
   (4) High (5) Very high

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

5. What is expected Quality of your product or service ?

   (1) Lowest prossible that can be sold.

   (2) Low to some extent.

   (3) Medium.

   (4) High.

   (5) Best is the Mkt.

6. What extent of extra cost for safety measure are expected to incur ?

   (1) Negligible

   (2) Low

   (3) Medium

   (4) High

   (5) Very high

Humanware

7. How many total employees do you require? _____

   Specify the details :

   1) Number of unskilled workers _____

      (0 - 10% = 5, 10 - 15% = 5, 15 - 20% = 3, 20 - 25% = 2 > 25% = 1)

   2) Number of Semiskilled/skilled workers _____

      (0 - 10% = 1, 10 - 15% = 2, 15 - 20% = 3, 20 - 25% = 4 and > 25 = 5)

   3) Number of technical and R & D personnel _____

      (0 - 5% = 1, 5 - 10% = 2, 10 - 15% = 3, 15 - 20% = 4 > 20% = 5)

   4) Number of management staffs _____

      (0 - 5% = 1, 5 - 10% = 2, 10 - 15% = 3, 15 - 20% = 4 > 20% = 5)

8. What is the average level of education of your workers ?

    1) No education
    2) Primary School
    3) Secondary School
    4) Vocational School
    5) University

9. What is the average number of years of experience of your workers ?

    1) 1 or 10 years
    2) 2 or 9 years
    3) 3 or 8 years
    4) 4 or 7 years
    5) 5 or 6 years

Inforware

10. What Extent of MIS do you want to require?

    (1) No MIS
    (2) Manual Reporting
    (3) Semi-Computerized
    (4) Computerized (LAN)
    (5) Computerized (International link)

11. What Extent of database/books/publications are available

    (1) Very low
    (2) Low
    (3) Medium
    (4) High
    (5) Very high

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969

12. What extent of QC do you intend to set up?

    (1) Absence of QC set up.

    (2) Intermediate values.

    (3) QC at limited level.

    (4) Intermediate values.

    (5) QC at all levels.

13. What is the percentage of technical know-how fees/project consultancy fees with respect to the total cost of the project?

    (1) 0 - 2.5%

    (2) 2.5 - 5%

    (3) 5 - 7.5%

    (4) 7.5 - 10%

    (5) > 10%

Orgaware

14. What is the estimated capacity utilization of the transportation facilities?

    (1) < 60%

    (2) 60 - 70%

    (3) 70 - 80%

    (4) 80 - 90%

    (5) > 90%

15. What is the ratio of R & D expenditure to sales.

    (1) < .5%

    (2) .5 - 1%

    (3) 1 - 1.5%

    (4) 1.5 - 2.0%

    (5) > 2.0%

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

16. What is the Mgt. techniques that you are going to use ?

(1) Ordinary production plan.

(2) Just in time inventory.

(3) Zero base budgeting.

(4) Subcontracting.

(5) Networking with Supplies & Customers.

Relative Importance Scale

17. T's relative importance to H is

1 2 3 4 5

or

1 1/2 1/3 1/4 1/5

18. T's relative importance to I is

1 2 3 4 5

or

1 1/2 1/3 1/4 1/5

19. T's relative importance to O is

1 2 3 4 5

or

1 1/2 1/3 1/4 1/5

20. H's relative importance to I is

1 2 3 4 5

or

1 1/2 1/3 1/4 1/5

21. H's relative importance to O is

1 2 3 4 5

or

1 1/2 1/3 1/4 1/5

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

ABAC
GRADUATE SCHOOL LIBRARY

22. I's relative importance to O is

1 2 3 4 5

or

1 1/2 1/3 1/4 1/5

Questions for Computation of NPV.

23. Mention the following cost.

(1) Land _____.

(2) Building _____.

(3) Machinaries or equipments _____.

(4) Others physical infrastructure _____.

24. How much is your working capital ?

_____

25. How much is your cash inflow (revenue) per period ?

_____

26. What is the number of years of life of investment ?

_____

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

Appendix B
Program Listing

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
program investech;
{This program is designed for determining technology
 contribution coefficient and net present value for a
 corporate level technology investment.}
uses crt;
const
  n = 16;
type
  quest = record
  qtype : char;
  aa : string[10];
  qcontent1 : string[80];
  qcontent2:string[80];
  choice1:string[40];
  choice2: string[40];
  choice3:string[40];
  choice4:string[40];
  choice5:string[40];
  help1:string[80];
  help2:string[80];
  help3:string[80];
  help4:string[80];
  end;
var
   line,g,oo,fill : integer;
   employ,hln,vln  : integer;
   unskill,go,ab,cd,de  : integer;
   skill   : integer;
   dskill  : integer;
   stskill  : integer;
   percent1 : real;
   percent2 : real;
   percent3 : real;
   percent4 : real;
   t : real;
   h : real;
   p : real;
   o : real;
   xcheck : char;
   qqq, cal, zz, yy : integer;
   land,bldg,equip, infra, cc : real;
   rev,expense,npv,ntv :real;
   num_year : integer;
   sumtech  : integer;
   summan   : integer;
   suminfo  : integer;
   sumorga  : integer;
   result   : integer;
```

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
    result1  : integer;
    result2  : integer;
    result3  : integer;
    wait     : string[40];
    qno      : array[1..n] of quest;
    ans      : array[1..n] of integer;
    z : array[1..4] of real;
    a : array[1..4,1..4] of real;
    b : array[1..4] of real;
    y : array[1..4] of real;
    cf: array[1..30] of real;
    aa : array[1..4] of string;
    i,j,k    : integer;
    tcc,l,per  :real;
    chkpas     : boolean;
    ch         : char;

procedure init_value;
begin
    qno[1].qtype := 'T';
    qno[1].qcontent1 := 'What kind of machinery or equipment do you require ?';
    qno[1].qcontent2 := ' ';
    qno[1].choice1 := '1. Manual / No equipment';
    qno[1].choice2 := '2. Mechanical';
    qno[1].choice3 := '3. Semi-automated';
    qno[1].choice4 := '4. Automated (computrized Control)';
    qno[1].choice5 := '5. Integrated (robotics)';
    qno[1].help1 := 'MANUAL IS SOLELY  MUSCLE DRIVEN; MECHANICALISWHEREATTENDENT IS';
    qno[1].help2 := 'NEEDED  FOR CONTROL AS WELL AS  FOR OPERATION;  SEMI-AUTOMATED IS';
    qno[1].help3 :='WHERE ATTENDENT IS NEEDED FOR FEW OPERATIONS; AUTOMATED IS  WHERE';
    qno[1].help4 :='ATTENDENT IS NOT REQUIRED FOR OPERATIONS,BUT REQUIRED FOR CONTROL.';
    qno[2].qtype :='T';
    qno[2].qcontent1 :='At what stage of the technology life cycle the output';
    qno[2].qcontent2 :='of the transformation facility lies ?';
    qno[2].choice1 :='1. Decline stage';
    qno[2].choice2 :='2. Introductory stage';
    qno[2].choice3 :='3. Early growth stage';
    qno[2].choice4 :='4. Mid-growth stage';
    qno[2].choice5 :='5. Maturity';
    qno[2].help1:='   DECLINE IS OUTDATED PRODUCT, SUCH AS BLACK & WHITE TV;';
    qno[2].help2:='   MATURITY IS WHEN THE  PRODUCT USAGE IS  AT  THE  PEAK,';
    qno[2].help3:='  SUCH AS AUTOMOBILE; FAX MACHINE IS NOW AT MID-GROWTH';
    qno[2].help4:='  STAGE; COLOR COPIER IS AT EARLY GROWTH STAGE.';
    qno[3].qcontent1 :='What scale of operations(throughput) do you intend';
    qno[3].qcontent2:='to set up?';
    qno[3].choice1:='1. Very low';
    qno[3].choice2:='2. Low';
    qno[3].choice3:='3. Medium';
```

```
qno[3].choice4:='4. High';
qno[3].choice5:='5. Very high';
qno[3].help1:='VERY LOW REFERS TO A SITUATION WHERE THE ACTUAL PRODUCTION';
qno[3].help2:='RATE IS NEGLIGIBLE COMPARED TO ITS CAPACITY.';
qno[3].help3:=' ';
qno[3].help4:=' ';
qno[4].qcontent1:='What degree of complexity of operations do you have in';
qno[4].qcontent2:='your facility ?';
qno[4].choice1:='1. Very low';
qno[4].choice2:='2. Low';
qno[4].choice3:='3. Medium';
qno[4].choice4:='4. High';
qno[4].choice5:='5. Very high';     qno[4].help1:=' ';
qno[4].help2:='COMPLEXITY OF OPERATIONS DENOTE DEGREE OF DIFFICULTIES';
qno[4].help3:='ASSOCIATED WITH THE TRANSFORMATIONAL OPERATIONS.';
qno[4].help4:=' ';
qno[5].qcontent1:='What is the expected quality of your product or service ?';
qno[5].qcontent2:=' ';
qno[5].choice1:='1. Loweat possible that can be sold';
qno[5].choice2:='2. Low to some extent';
qno[5].choice3:='3. Medium';
qno[5].choice4:='4. High';
qno[5].choice5:='5. Best in the market';
qno[5].help1:=' ';
qno[5].help2:='QUALITY OF THE CONCERNED PRODUCT IS SUBJECT TO A COMPARISON';
qno[5].help3:='WITH EXISTING SIMILAR PRODUCT IN THE MARKET.';
qno[5].help4:=' ';
qno[6].qcontent1 :='What extent of extra cost for safety measure are';
qno[6].qcontent2 :='expected to incur ?';
qno[6].choice1:='1. Negligibile';
qno[6].choice2:='2. Low';
qno[6].choice3:='3. Medium';
qno[6].choice4:='4. High';
qno[6].choice5:='5. Very high';
qno[6].help1:=' ';
qno[6].help2:='NEGLIGIBLE COST IN SETTING UP SAFETY MEASURE RESULTS';
qno[6].help3:='IN AN UNSAFE ENVIRONMENT.';
qno[6].help4:=' ';
qno[7].qcontent1:=' ';
qno[7].qcontent2:=' ';
qno[7].choice1:=' ';
qno[7].choice2:=' ';
qno[7].choice3:=' ';
qno[7].choice4:=' ';
qno[7].choice5:=' ';
qno[7].help1:='TOTAL EMPLOYEES INCLUDE UNSKILLED, SKILLED, TECHNICAL, R&D ';
qno[7].help2:='AND MANAGEMENT PERSONNEL; UNSKILLED WORKERS ARE WHO CANNOT ';
qno[7].help3:='PRODUCE ANY PRODUCT INDEPENDENTLY; TECHNICAL AND R&D PERSONNEL';
```

```
qno[7].help4:='ARE RESPONSIBLE FOR RESEARCH, DESIGN, DEVELOPMENT AND OPERATIONS.';
qno[8].qcontent1:='What is the average level of education of your workers ?';
qno[8].qcontent2:='(excluding Manager and technical personnel)';
qno[8].choice1:='1. No education';
qno[8].choice2:='2. Primary school';
qno[8].choice3:='3. Secondary school';
qno[8].choice4:='4. Vocational school';
qno[8].choice5:='5. University';
qno[8].help1:=' ';
qno[8].help2:=' ';
qno[8].help3:=' ';
qno[8].help4:=' ';
qno[9].qcontent1:='What is the average number of years of experience of';
qno[9].qcontent2:='your workers (Note! only workers)?';
qno[9].choice1:='1.  1 or 10 years or more';
qno[9].choice2:='2.  2 or 9 years';
qno[9].choice3:='3.  3 or 8 years';
qno[9].choice4:='4.  4 or 7 years';
qno[9].choice5:='5.  5 or 6 years';
qno[9].help1:='Experts say that 5 to 6 years of experience are the best ';
qno[9].help2:='for a technology. Any period of experience, less or more,';
qno[9].help3:='are not a favorable contribution towards technology. ';
qno[9].help4:=' ';
qno[10].qcontent1:='What extent of MIS do you want to require ?';
qno[10].qcontent2:=' ';
qno[10].choice1:='1. No MIS';
qno[10].choice2:='2. Manual Reporting';
qno[10].choice3:='3. Semi-computerized';
qno[10].choice4:='4. Computerized (LAN)';
qno[10].choice5:='5. Computerized (international link)';
qno[10].help1:=' ';
qno[10].help2:=' ';
qno[10].help3:=' ';
qno[10].help4:=' ';
qno[11].qcontent1:='What extent of database/books/publications are';
qno[11].qcontent2:='available ?';
qno[11].choice1:='1. Very low';
qno[11].choice2:='2. Low';
qno[11].choice3:='3. Medium';
qno[11].choice4:='4. High';
qno[11].choice5:='5. Very high';
qno[11].help1:=' ';
qno[11].help2:=' ';
qno[11].help3:=' ';
qno[11].help4:=' ';
qno[12].qcontent1:='What extent of QC do you intend to set up ?';
qno[12].qcontent2:=' ';
qno[12].choice1:='1. Absence of QC set up';
```

```
qno[12].choice1:='1. Absence of QC set up';
qno[12].choice2:='2. Intermediate values';
qno[12].choice3:='3. QC at limited level';
qno[12].choice4:='4. Intermediate values';
qno[12].choice5:='5. QC at all levels';
qno[12].help1:=' ';
qno[12].help2:=' ';
qno[12].help3:=' ';
qno[12].help4:=' ';
qno[13].qcontent1:='What is the percentage of project consultancy fees';
qno[13].qcontent2:='with respect to the total cost of the project ?';
qno[13].choice1:='1.  0.0 - less than 2.5%';
qno[13].choice2:='2.  2.5 - less than 5.0%';
qno[13].choice3:='3.  5.0 - less than 7.5%';
qno[13].choice4:='4.  7.5 - less than 10.0%';
qno[13].choice5:='5.  More than 10.0%';
qno[13].help1:=' ';
qno[13].help2:='According to experts,in an investment of high ';
qno[13].help3:='technology, 10% or more are spent for consultancies.';
qno[13].help4:=' ';
qno[14].qcontent1:='What is the estimated utilization  of the production';
qno[14].qcontent2:='capacity after one year?';
qno[14].choice1:='1.  Less than 60%';
qno[14].choice2:='2.  60 - less than 70%';
qno[14].choice3:='3.  70 - less than 80%';
qno[14].choice4:='4.  80 - less than 90%';
qno[14].choice5:='5.  More than 90%';     qno[14].help1:=' ';
qno[14].help2:=' ';
qno[14].help3:=' ';
qno[14].help4:=' ';
qno[15].qcontent1:='What is the ratio of R&D expenditure to sales ?';
qno[15].qcontent2:='  ';
qno[15].choice1:='1.  Less than 0.5%';
qno[15].choice2:='2.  0.5 - less than 1.0%';
qno[15].choice3:='3.  1.0 - less than 1.5%';
qno[15].choice4:='4.  1.5 - less than 2.0%';
qno[15].choice5:='5.  More than 2.0%';
qno[15].help1:=' ';
qno[15].help2:=' ';
qno[15].help3:=' ';
qno[15].help4:=' ';
qno[16].qcontent1:='What is the inventory management technique that you ';
qno[16].qcontent2:='are going to use ?';
qno[16].choice1:='1. Ordinary production plan';
qno[16].choice2:='2. Just in time inventory';
qno[16].choice3:='3. Zero base budgeting';
qno[16].choice4:='4. Subcontracting';
qno[16].choice5:='5. Networking with Suppliers and customers';
```

```
    qno[16].help1:=' ';
    qno[16].help2:=' ';
    qno[16].help3:=' ';
    qno[16].help4:=' ';
end;
procedure bottom;
begin
    textattr := 36;
    gotoxy(1,20);
    for zz := 1 to 6 do
    for yy := 1 to 80 do
    write(' ');
end;
procedure nohelp;
begin
    textattr := 26;
    gotoxy(1,20);
    for zz := 1 to 6 do
    for yy := 1 to 80 do
    write(' ');
end;
procedure printquest(inx:integer);
    begin
    gotoxy(3,5);
    write(qno[inx].qcontent1);
    gotoxy(3,6);
    write(qno[inx].qcontent2);
    gotoxy(5,8);
    write(qno[inx].choice1);
    gotoxy(5,9);
    write(qno[inx].choice2);
    gotoxy(5,10);
    write(qno[inx].choice3);     gotoxy(5,11);
    write(qno[inx].choice4);
    gotoxy(5,12);
    write(qno[inx].choice5);
    if (inx>=8) and (inx<>9) and (inx<>13) then nohelp else bottom;
    gotoxy(8,20);
    write(qno[inx].help1);
    gotoxy(8,21);
    write(qno[inx].help2);
    gotoxy(8,22);
    write(qno[inx].help3);
    gotoxy(8,23);
    write(qno[inx].help4);
    textattr := 30;
end;
procedure printchoice;
```

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
procedure rechoice;
        begin
          ans[i]:=0;
          gotoxy(20,16);
          write('Select the choice again [1..5] : ');
          readln(ans[i]);
        end;

    begin
     writeln;
     gotoxy(20,16);writeln('Select the choice [1..5] : ');
     gotoxy(53,16);readln(ans[i]);
     while (ans[i]<1) or (ans[i]>5) do rechoice;
    end;

procedure readchoice1;
    begin
     gotoxy(7,8);
     write('How many total employees do you require ? ');
     gotoxy(55,8); write('      '); gotoxy(55,8); readln(employ);
     gotoxy(30,17); write('                    ');
     gotoxy(7,9);
     writeln('Specify the details :');
     gotoxy(12,12);
     writeln('Number of unskilled workers? ');
     gotoxy(55,12); write('     '); gotoxy(12,13);
     writeln('Number of semiskilled/skilled workers? ');
     gotoxy(55,13); write('     '); gotoxy(12,14);
     writeln('Number of technical and R & D personnel? ');
     gotoxy(55,14); write('     '); gotoxy(12,15);
     writeln('Number of management staff? ');
     gotoxy(55,15); write('     '); gotoxy(55,12);
     readln(unskill);
     percent1 := (unskill/employ)*100;
     result := 0;
     if percent1 >= 25.0 then result := 1;
     if (percent1 >= 20.0) and (percent1 < 25.0) then result := 2;
     if (percent1 >= 15.0) and (percent1 < 20.0) then result := 3;
     if (percent1 >= 10.0) and (percent1 < 15.0) then result := 4;     if percent1 < 10.0 then result := 5;
     qqq := unskill;
     if qqq > employ then
      begin
        textattr := 155;
        gotoxy(30,17); write('Total employee mismatch!');
        textattr := 26;
        chkpas :=false;
      end else chkpas:=true;
     cal := employ - qqq;
```

```
        gotoxy (75,17); write('     ');
        gotoxy (75,17); write(cal);
        end;

procedure readchoice2;
      begin
        gotoxy(55,13);
        skill := 0;
        readln(skill);
        percent2 := (skill/employ)*100;
        result1 := 0;
        if percent2 >= 25.0 then result1 := 5;
        if (percent2 >= 20.0) and (percent2 < 25.0) then result1 := 4;
        if (percent2 >= 15.0) and (percent2 < 20.0) then result1 := 3;
        if (percent2 >= 10.0) and (percent2 < 15.0) then result1 := 2;
        if percent2 < 10.0 then result1 := 1;
        qqq := qqq + skill;
        if qqq > employ then
          begin
            textattr := 155;
            gotoxy(30,17); write('Total employee mismatch!');
            textattr := 26;
            chkpas :=false;
          end else chkpas :=true;
        cal := employ - qqq;
        gotoxy (75,17); write('     ');
        gotoxy (75,17); write(cal);
      end;

procedure readchoice3;
      begin
        gotoxy(55,14);
        dskill := 0;
        readln(dskill);
        percent3 := (dskill/employ)*100;
        result2 := 0;
        if percent3  >= 20.0  then result2 := 5;
        if (percent3 >= 15.0) and (percent3 < 20.0) then result2 := 4;
        if (percent3 >= 10.0) and (percent3 < 15.0) then result2 := 3;
        if (percent3 >=  5.0) and (percent3 < 10.0) then result2 := 2;
        if percent3  <   5.0  then result2 := 1;
        qqq := qqq + dskill;
        if qqq > employ then
          begin
            textattr := 155;          gotoxy(30,17); write('Total employee mismatch!');
            textattr := 26;
            chkpas :=false;
          end else chkpas:=true;
```

```
      cal := employ - qqq;
      gotoxy (75,17); write('     ');
      gotoxy (75,17); write(cal);
     end;

procedure readchoice4;
     begin
      if qqq > employ then begin qqq := 0; exit; end;
      gotoxy(55,15);
      stskill := 0;
      readln(stskill);
      percent4 := (stskill/employ)*100;
      result3 := 0;
      if percent4  >= 20.0  then result3 := 5;
      if (percent4 >= 15.0) and (percent4< 20.0) then result3 := 4;
      if (percent4 >= 10.0) and (percent4< 15.0) then result3 := 3;
      if (percent4 >=  5.0) and (percent4 < 10.0) then result3 := 2;
      if percent4  <  5.0  then result3 := 1;
      qqq := qqq + stskill;
      cal := employ - qqq;
      gotoxy (75,17); write('     ');
      gotoxy (75,17); write(cal);
     end;

procedure scr_design;
     begin
     textbackground(blue);
     clrscr;
     textcolor(10);
     gotoxy(15,4);writeln ('WELCOME TO THE INVESTECH DECISION SUPPORT SYSTEM !');
     gotoxy(9,6);
     writeln('This Decision Support System  provides you a basis of comparison');
     gotoxy(9,7);
     writeln('between two or more  technological investments.  The traditional ');
     gotoxy(9,8);
     writeln('Net Present Value(NPV)  itself does not take care of an explicit');
     gotoxy(9,9);
     writeln('contribution  towards technology.  Hence this system model deals');
     gotoxy(9,10);
     writeln('with the determining of a  Technology  Contribution  Coefficient');
     gotoxy(9,11);
     writeln('(TCC) as  well  as the  Net  Present  Value for each  investment');
     gotoxy(9,12);
     writeln('alternative.');
     gotoxy(9,14);
     writeln('For  your investment  decision, the  higher NTV (Net Technology');
     gotoxy(9,15);
     writeln('Value) means the better operative capability for the technology');
```

```
gotoxy(9,16);
writeln('concerned.  An acquisitive and innovative capability assessment');
gotoxy(9,17);       writeln('must be made subjectively by the decision maker.');
gotoxy(24,19);
textcolor(30);
write('Press Enter when you finish');
ch:=readkey;
clrscr;
textcolor(10);
gotoxy(14,7);
writeln('We consider that you are going to  invest in a ');
gotoxy(14,8);
writeln('certain technology. Please select  the choices ');
gotoxy(14,9);
writeln('very carefully. You may require expert opinion');
gotoxy(14,10);
writeln('for selection of certain choice. In general in');
gotoxy(14,11);
writeln('1 to 5 point scale, 1 represents the least con-');
gotoxy(14,12);
writeln('tribution while 5 represents the highest con-');
gotoxy(14,13);
writeln('tribution for technology.');
textcolor(30);
gotoxy(24,19);
write('Press Enter When You Finish');
ch:=readkey;
clrscr;
textcolor(10);
gotoxy(33,3);
writeln('INTRODUCTION');
gotoxy(7,5);
writeln('Technology is generally perceived as machineries. But it is actually');
gotoxy(7,6);
writeln('much more than only machineries.  In the  olden days, when computers');
gotoxy(7,7);
writeln('could  only read  machine  language (0 or 1) people needed very long');
gotoxy(7,8);
write('time to get things done by computers. With the increase in technology');
gotoxy(7,9);
writeln('computers have become more sophisticated and human efforts have been');
gotoxy(7,10);
writeln('drastically  reduced.  In operation  of an  automatic  camera, users');
gotoxy(7,11);
writeln('abilities  and skills  are very low.  Here  stands the  relationship');
gotoxy(7,12);
writeln('between Technoware or facilities and Humanware or abilities. Techno-');
gotoxy(7,13);
```

```
      writeln('ware and  Humanware  are inversely correlated - which means a higher');
      gotoxy(7,14);
      writeln('technoware or facility needs lower humanware or abilities.');
      gotoxy(7,16);
      writeln('With the help of manual or  inforware or  documents, people now can');
      gotoxy(7,17);
      write('obtain various levels of skills and undertake different profession of');
      gotoxy(7,18);
      writeln('their choice.');       gotoxy(7,20);
      writeln('Orgaware or framework  is  the  ability to integrate  facilities, ');
      gotoxy(7,21);
      writeln('abilities and facts effectively.  Hence in this system, Technology is');
      gotoxy(7,22);
      writeln('considered as the contribution of all these four components, namely, ');
      gotoxy(7,23);
      writeln('Technoware, Humanware, Inforware, and Orgaware.');
      read(wait);
      end;
procedure horizontal;
   begin
     for g:=ab to go do
       begin
         gotoxy(g,hln);
         write(chr(196));
       end;
   end;
procedure vertical;
   begin
     for oo:=cd to de do
       begin
        gotoxy(vln,oo);
        write(chr(179));
       end;
    end;
procedure matrix;
 begin
   ab:=24;
   cd:=9;
   de:=18;
   go:=48;
   gotoxy(9,3);
   writeln('The following six questions are about the relative importance');
   gotoxy(9,4);
   writeln('of  the four components.  Pairwise  Comparison  Technique has');
   gotoxy(9,5);
   writeln('been used for this comparison, i.e T vs H, T vs I, T vs O,');
   gotoxy(9,6);
   writeln('H vs I, H vs O, and I vs O. The data obtained will form a ');
```

```
    gotoxy(9,7);
    writeln('triangular matrix as follows:');
    hln:=9;
    horizontal;
    vln:=23;
    vertical;
    gotoxy(30,10);
    writeln('T   H   I   O');
    hln:=11;
    horizontal;
    gotoxy(26,12);
    writeln('T   1');
    gotoxy(26,14);
    writeln('H       1');
    gotoxy(26,16);    writeln('I           1');
    gotoxy(26,18);
    writeln('O               1');
    hln:=19;
    horizontal;
    hln:=13;
    horizontal;
    hln:=15;
    horizontal;
    hln:=17;
    horizontal;
    vln:=28;
    vertical;
    vln:=33;
    vertical;
    vln:=38;
    vertical;
    vln:=43;
    vertical;
    vln:=48;
    vertical;
    gotoxy(9,21);
    writeln('If T (Technoware) seems, for instance, 3 times more impor-');
    gotoxy(9,22);
    writeln('tant than H (Humanware), then automatically H will be .333');
    gotoxy(9,23);
    writeln('times as less important as T.');
 end;
procedure rel_imp;
 begin
    ab:=5;
    cd:=6;
    de:=20;
    gotoxy(10,2);
```

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
    writeln('Relative Importance Scale for Evaluating Component');
    gotoxy(10,3);
    writeln('Contribution Intensity');
    go:=65;
    hln:=5;
    horizontal;
    gotoxy(7,6);
    writeln('Intensity     Definition          Explanation');
    gotoxy(7,7);
    writeln('Importance');
    hln:=8;
    horizontal;
    vln:=5;
    vertical;
    gotoxy(6,9);
    writeln('   1       Equal Importance   Two activities contribute');
    gotoxy(6,10);
    writeln('                          equally to one objective.');
    gotoxy(6,12);
    writeln('   3       Essential or       Good evidence and logical ');
    gotoxy(6,13);    writeln('                  strong importance  criteria exist to show that');
    gotoxy(6,14);
    writeln('                          one is more important. ');
    gotoxy(6,16);
    writeln('   5       Absolute           The evidence in favor of ');
    gotoxy(6,17);
    writeln('           importance         one activity over another');
    gotoxy(6,18);
    writeln('                          is of the highest possible');
    gotoxy(6,19);
    writeln('                          order of affirmation.');
    vertical;
    vln:=17;
    vertical;
    vln:=36;
    vertical;
    vln:=65;
    vertical;
    hln:=20;
    horizontal;
 end;
procedure financial;
   begin
    gotoxy(26,5);
    writeln('FINANCIAL ANALYSIS');
    gotoxy(13,7);
    writeln('The following portion is the financial analysis of the');
    gotoxy(13,8);
```

```
writeln('technological  project  you are investing in.  The Net');
gotoxy(13,9);
writeln('Present Value (NPV) has  been used for  this analysis.');
gotoxy(13,10);
writeln('It discounts the value of the stream  of the after-tax');
gotoxy(13,11);
writeln('cash flows back to the present.  The word NET suggests');
gotoxy(13,12);
writeln('that all cash  flows are taken  into account, both in-');
gotoxy(13,13);
writeln('flows  and outflows.  NPV  considers the time value of');
gotoxy(13,14);
writeln('money and it considers  all of the cash flows over the');
gotoxy(13,15);
writeln('entire life of the project.  The specimen of the items');
gotoxy(13,16);
writeln('used in  this analysis is  given in the next screen to');
gotoxy(13,17);
writeln('help the users understand what he  must make ready be-');
gotoxy(13,18);
writeln('fore going to the actual problem.');
gotoxy(24,21);
writeln('Please enter when yoy finish');
ch:=readkey;
clrscr;
gotoxy(13,3);
writeln('In the next screen, you have to mention the following:');      gotoxy(13,4);
writeln('Estimated costs (in thousand baht)');
gotoxy(13,5);
writeln('-----------------------------------');
gotoxy(16,6);
writeln('LAND .....');
gotoxy(16,7);
writeln('BUILDING .....');
gotoxy(16,8);
writeln('MACHINARIES OR EQUIPMENT .....');
gotoxy(16,9);
writeln('OTHER PHYSICAL INFRUSTRUCTURE ..');
gotoxy(13,10);
writeln('(These four costs (above) are the initial cash outflows)');
gotoxy(13,12);
writeln('INTEREST RATE AT THE BANK (IN PERCENTAGE) ...');
gotoxy(16,13);
writeln('(If you borrow from the bank)');
gotoxy(13,14);
writeln('ESTIMATED LIFE OF THE PROJECT (IN YEARS) ...');
gotoxy(13,16);
writeln('YEAR     ESTIMATED REVENUE     ESTIMATED EXPENSE');
```

```
    gotoxy(13,17);
    writeln('          (thousand baht)       (thousand baht)');
    gotoxy(13,18);
    writeln(' 1            ......                ..... ');
    gotoxy(13,19);
    writeln(' 2            ......                ..... ');
    gotoxy(13,20);
    writeln(' .            ......                ..... ');
    gotoxy(13,21);
    writeln('upto the estimated life of the project.');
    gotoxy(24,23);
    writeln('Press Enter When You Finish');
 end;
procedure checkread;
begin
    xcheck := 'N';
    qqq := 0;
    employ := 0;
    readchoice1;
    repeat
    skill := 0; dskill := 0; stskill := 0;
    if chkpas then readchoice2;
    if chkpas then readchoice3;
    if chkpas then readchoice4;
    if qqq <> employ then
     begin
        textattr := 155;
        gotoxy(30,17); write('Total employee mismatch!');
        textattr := 26;
        readchoice1;
     end
    else xcheck := 'Y';
    until  xcheck = 'Y'; end;
function power(a,b : real):real;
   begin
     power := exp(b*ln(a));
   end;

begin
  scr_design;
  init_value;
  for i:=1 to n do
  begin
    clrscr;
    textcolor(10);
    printquest(i);
    if i <> 7 then printchoice else checkread;
    ans[7] :=result+result1+result2+result3;
```

```
 end;
  sumtech:=0;
  summan:=0;
  suminfo:=0;
  sumorga:=0;
 for i:=1 to 6 do
   sumtech:= sumtech+ans[i];
 for i:= 7 to 9 do
    summan:=summan+ans[i];
 for i:=10 to 13 do
    suminfo:=suminfo+ans[i];
 for i:=14 to 16 do
    sumorga:= sumorga+ ans[i];
t:=sumtech/30;
h:=summan/30;
p:=suminfo/20;
o:=sumorga/15;
begin
  clrscr;
  matrix;
  ch:=readkey;
  clrscr;
  rel_imp;
  ch:=readkey;
  clrscr;
  tcc:=0;
  aa[1]:='Technoware';
  aa[2]:='Humanware';
  aa[3]:='Inforware';
  aa[4]:='Orgaware';
  for i:=1 to 4 do
  for j:=(i+1)  to 4 do
    begin
     bottom;
     gotoxy(5,20);
     writeln('Technoware is facilities, Humanware is abilities, Inforware');
     gotoxy(5,21);
     writeln('is facts and Orgaware is framework. In a computer school, for');
     gotoxy(5,22);          writeln('example, Technoware is more important than Humanware. Use any');
     gotoxy(5,23);
     writeln('decimal value for inverse relative importance.');
     textattr:=30;
     gotoxy(5,5);
     writeln (aa[i],'''s relative importance to  ',aa[j],' is');
     gotoxy(5,7);
     writeln ('(Select 1..5 or an inverse thereof)');
     gotoxy(30,15);
     write('Select the choice  : ');
```

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF St. GABRIEL
ABOR OMNIA VINCIT
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
      readln(a[i,j]);
      while (a[i,j]<=0) or (a[i,j]>5) do
      begin
        clrscr;
        a[i,j]:=0;
        gotoxy(5,5);
        writeln(aa[i],'''s relative importance to  ',aa[j],' is');
        textcolor(30);
        gotoxy(5,7);
        writeln('(Select 1..5 or an inverse thereof)');
        textcolor(10);
        gotoxy(30,15);
        write('Select the choice  : ');
        readln(a[i,j]);
       end;
      a[j,i]:=1/a[i,j];
      clrscr;
    end;
    for i:=1 to 4 do
    begin
     a[i,i]:=1;
     z[i] :=0.25;
    end;
    for k:=1 to 5 do
    begin
     l:=0;
     for i:=1 to 4 do
     begin
       y[i]:=0;
       for j:=1 to 4 do
       y[i] :=y[i]+a[i,j]*z[j];
       l:=l+y[i];
     end;
     for i:=1 to 4 do
     begin
        b[i]:=y[i]/l;
        z[i]:=b[i];
     end;
  end;
tcc:=power(t,b[1])*power(h,b[2])*power(p,b[3])*power(o,b[4]);
end;
  begin
    clrscr;
    financial;
    ch:=readkey;        clrscr;
    npv:=0;
    ntv:=0;
    gotoxy(10,3);
```

```
writeln('Mention the following costs that you require ');
gotoxy(10,4);
writeln('for the project (in thousand baht) :');
writeln;
gotoxy(15,6);
write('Land                    : ');
readln(land);
gotoxy(15,7);
write('Building                : ');
readln(bldg);
gotoxy(15,8);
write('Mechinaries or equipments    : ');
readln(equip);
gotoxy(15,9);
write('Other physical infrastructure  : ');
readln(infra);
npv:=-(land+bldg+equip+infra);writeln;
gotoxy(10,11);
write('What is the interest rate in the bank (in percentage)? ');
readln(per);
gotoxy(10,13);
write('What is the estimated life of the project (in year)? ');
readln(num_year);
if num_year < 6 then
  begin
  gotoxy(10,15);
  writeln('How much is your expected periodic revenue');
  gotoxy(10,16);
  writeln('and expenses (in thousand baht) ?');
  gotoxy(10,18);
  writeln('  Year       Revenue       Expenses');
  line := 19;
  end
else
   begin
   clrscr;
   gotoxy(10,1); write('How much is your expected periodic revenue');
   gotoxy(10,2); write('and expenses (in thousand baht)?');
   gotoxy(10,4); write('  Year       Revenue       Expenses');
   line := 5;
   end;
for i:=1 to num_year do
 begin
   if line > 22 then
   begin
      clrscr;
      gotoxy(10,1); write('  Year       Revenue       Expenses');
      line := 2;
```

```
        end;
          gotoxy(13,line);  write(i);
          gotoxy(26,line); read(rev);              gotoxy(44,line); read(expense);
          cf[i]:=rev-expense;
          cc:=per/100;
          npv:=npv+cf[i]/power((1+cc),i);
          line:= line +1;
    end;
end;
ntv:=npv*tcc;
clrscr;
ab:=5;
cd:=6;
de:=20;
go:=60;
gotoxy(10,3);
writeln('SUMMARY OF COMPONENT CONTRIBUTION OF THE PROJECT');
gotoxy(25,4);
writeln('(TECHNOWARE)');
hln:=5;
horizontal;
vln:=5;
vertical;
gotoxy(7,6);
writeln('  TECHNOWARE          (1 to 5)    CONTRIBUTION');
gotoxy(7,7);
writeln('                  POINT SCALE');
hln:=8;
horizontal;
gotoxy(7,9);
writeln('Kind of Machinery');
gotoxy(7,11);
writeln('Technology life cycle');
gotoxy(7,13);
writeln('Scale of Operations');
gotoxy(7,15);
writeln('Complexity of operations');
gotoxy(7,17);
writeln('Quality of Product');
gotoxy(7,19);
writeln('Cost of Safty Measure');
vln:=32;
vertical;
vln:=46;
vertical;
vln:=60;
vertical;
hln:=20;
```

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
horizontal;
fill:=9;
for i:=1 to 6 do
  begin
  gotoxy(38,fill);
  write(ans[i]);
  fill:=fill+2;
  end;
gotoxy(52,15);    write(t:4:3);
gotoxy(5,21);
writeln(' * 1 = Lowest Contribution, 5 = Highest Contribution');
ch := readkey;
clrscr;
go:=72;
gotoxy(10,3);
writeln('SUMMARY OF COMPONENT (HUMANWARE) CONTRIBUTION OF THE PROJECT');
hln:=5;
horizontal;
vln:=5;
vertical;
gotoxy(7,6);
writeln(' HUMANWARE        NUMBER OF  PERCENTAGE   1 TO 5  CONTRIBUTION');
gotoxy(7,7);
writeln('                PEOPLE          POINT  ');
hln:=8;
horizontal;
gotoxy(7,9);
writeln('UNSKILLED WORKER');
gotoxy(7,11);
writeln('SEMISKILLED/SKILLED');
gotoxy(7,13);
writeln('TECHNICAL/R&D');
gotoxy(7,15);
writeln('MANAGEMENT STAFF');
gotoxy(7,17);
writeln('LEVEL OF EDUCATION');
gotoxy(7,19);
writeln('YEARS OF EXPERIENCE');
vln:=28;
vertical;
vln:=39;
vertical;
vln:=51;
vertical;
vln:=60;
vertical;
vln:=73;
vertical;
```

```
hln:=20;
horizontal;
gotoxy(32,9);
write(unskill);
gotoxy(32,11);
write(skill);
gotoxy(32,13);
write(dskill);
gotoxy(32,15);
write(stskill);
gotoxy(43,9);
writeln(percent1:4:1);
gotoxy(43,11);
writeln(percent2:4:1);
gotoxy(43,13);    writeln(percent3:4:1);
gotoxy(43,15);
writeln(percent4:4:1);
gotoxy(55,9);
writeln(result);
gotoxy(55,11);
writeln(result1);
gotoxy(55,13);
writeln(result2);
gotoxy(55,15);
writeln(result3);
fill:=17;
for i:=8 to 9 do
 begin
 gotoxy(55,fill);
 write(ans[i]);
 fill:=fill+2;
 end;
gotoxy(65,14);
write(h:4:3);
gotoxy(5,21);
writeln(' * 1 = Least Contribution, 5 = Highest contribution');
ch:=readkey;
clrscr;
go:=60;
gotoxy(10,3);
writeln('SUMMARY OF COMPONENT CONTRIBUTION OF THE PROJECT');
gotoxy(25,4);
writeln('(INFORWARE)');
hln:=6;
horizontal;
vln:=5;
vertical;
gotoxy(7,7);
```

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
 writeln('INFORWARE              (1 to 5)    CONTRIBUTION');
 gotoxy(7,8);
 writeln('                    POINT SCALE');
 hln:=9;
 horizontal;
 gotoxy(7,10);
 writeln('Extent of MIS    ');
 gotoxy(7,12);
 writeln('Extent of Database,  ');
 gotoxy(9,13);
 writeln('Books or Publications');
 gotoxy(7,15);
 writeln('Extent of Q-Control');
 gotoxy(7,17);
 writeln('Project Consultancy Fee');
 gotoxy(9,18);
 writeln('(1 = 0-2.5%, 5 = >10%)');
 vln:=32;
 vertical;
 vln:=46;
 vertical;    vln:=60;
 vertical;
 hln:=20;
 horizontal;
 fill:=10;
 for i:=10 to 13 do
  begin
    gotoxy(38,fill);
    write(ans[i]);
    fill:=fill+2;
    if i=10 then fill:=13;
  end;
gotoxy(52,15);
write(p:4:3);
gotoxy(5,21);
writeln(' * 1 = Lowest Contribution, 5 = Highest Contribution');
ch:=readkey;
clrscr;
go:=60;
gotoxy(10,3);
writeln('SUMMARY OF COMPONENT CONTRIBUTION OF THE PROJECT');
gotoxy(25,4);
writeln('(ORGAWARE)');
hln:=6;
horizontal;
vln:=5;
vertical;
gotoxy(7,7);
```

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
writeln(' ORGAWARE              (1 to 5)    CONTRIBUTION');
gotoxy(7,8);
writeln('                    POINT SCALE');
hln:=9;
horizontal;
gotoxy(7,11);
writeln('Capacity Utilization');
gotoxy(9,12);
writeln('(1 = < 60%, 5 = >90%)');
gotoxy(7,14);
writeln('Ratio of R&D Expenditure');
gotoxy(9,15);
writeln('(1 = < 0.5%, 5 = >2.0%)');
gotoxy(7,17);
writeln('Management Technique ');
vln:=33;
vertical;
vln:=47;
vertical;
vln:=61;
vertical;
hln:=20;
horizontal;
fill:=11;
for i:=14 to 16 do
  begin
    gotoxy(38,fill);        write(ans[i]);
    fill:=fill+3;
  end;
gotoxy(52,15);
write(o:4:3);
gotoxy(5,21);
writeln(' * 1 = Lowest Contribution, 5 = Highest Contribution');
ch:=readkey;
clrscr;
go:=78;
gotoxy(10,3);
writeln('SUMMARY OF TECHNOLOGY CONTRIBUTION COEFFICIENT (TCC), NET');
gotoxy(13,4);
writeln('PRESENT VALUE (NPV), AND NET TECHNOLOGY VALUE (NTV)');
hln:=6;
horizontal;
vln:=5;
vertical;
gotoxy(7,7);
writeln(' TECHNOLOGY    COMPONENT   COMPONENT  ');
gotoxy(7,8);
writeln(' COMPONENTS   CONTRIBUTIONS CONTRIBUTION  TCC*   NPV      NTV');
```

```
gotoxy(38,9);
writeln('INTENSITY');
hln:=11;
horizontal;
gotoxy(7,12);
writeln('Technoware (T)');
gotoxy(7,14);
writeln('Humanware  (H)');
gotoxy(7,16);
writeln('Inforware  (I)');
gotoxy(7,18);
writeln('Orgaware   (O)');
vln:=22;
vertical;
vln:=36;
vertical;
vln:=49;
vertical;
vln:=55;
vertical;
vln:=67;
vertical;
vln:=78;
vertical;
hln:=20;
horizontal;
fill:=12;
gotoxy(27,12);
write(t:4:3);
gotoxy(27,14);
write(h:4:3);
gotoxy(27,16);
write(p:4:3);    gotoxy(27,18);
write(o:4:3);
for i:=1 to 4 do
 begin
   gotoxy(41,fill);
   write(b[i]:4:3);
   fill:=fill+2;
 end;
gotoxy(50,15);
write(tcc:4:3);
gotoxy(56,15);
write(npv:10:0);
gotoxy(69,15);
write(ntv:8:0);
gotoxy(5,21);
writeln('* TCC=1-->Highest Contribution, TCC=0-->Least Contribution');
```

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

```
 gotoxy(5,22);
 writeln('  The higher NTV represents better operative capability');
 ch:=readkey;
 clrscr;
 gotoxy(28,9);
 writeln('THANK YOU FOR USING');
 gotoxy(21,11);
 writeln('INVESTECH DECISION SUPPORT SYSTEM !!');
 ch:=readkey;
end.
```

Appendix C: Manual

The program is housed in the diskette as VESTECH.EXE. Hence, in a DOS environment, by typing VESTECH and pressing the ENTER key afterwards, the user will be able to access into the software. The software, Investech, is very user-friendly and the user actually has to key in the data according to the menu in the screen. Sample Screens can be seen in 'Findings' part of the project. Helps and hints are equipped with almost every screen. One thing is very important for the users to know that in this program cursor cannot be returned to its previous position once Enter key has been pressed. In further version, this author will attempt to focus on the ease of cursor movement. In this connection, the user is strongly suggested to key in only after considerable thinking.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

Appendix D

Net Technology Value - A detailed computation with example :

The complete model is :

$$NTV = TCC \times NPV$$

$$TCC = T^{\beta t} * H^{\beta H} + I^{\beta I} * O^{\beta o}$$

computation of t, h, i and o are simply done by

$$\frac{\text{Total score}}{5 \times \text{Number of items in the component}}$$

For example,

$$t = (2+4+3+3+4+3) / (5 \times 6) = .633$$

For determination of h, score is given after computation of percentage of certain category. Suppose, out of 70 employees 50 are unskilled. The percentage of unskilled people is 71.4 which is scored as 1.

$$\text{Hence, } h = (1+2+2+2+3+3) / (5 \times 6) = .433$$

and so on,

we found i = .65 and o = .333

Appendix D

Net Technology Value - A detailed computation with example :

The complete model is :

$$NTV = TCC \times NPV$$

$$TCC = T^{\beta t} * H^{\beta H} * I^{\beta I} * O^{\beta o}$$

computation of t, h, i and o are simply done by

$$\frac{\text{Total score}}{5 \times \text{Number of items in the component}}$$

For example,

$$t = (2+4+3+3+4+3) / (5 \times 6) = .633$$

For determination of h, score is given after computation of percentage of certain category. Suppose, out of 70 employees 50 are unskilled. The percentage of unskilled people is 71.4 which is scored as 1.

$$\text{Hence, } h = (1+2+2+2+3+3) / (5 \times 6) = .433$$

and so on,

we found i = .65 and o = .333

Determination of Eigen Vector (β_t, β_h, β_i and β_o)

Given, in the Gas Plant example,

Comparison	Rating	Comparison	Rating
t vs h =	3	t vs i =	2
t vs o =	4	h vs i =	1
h vs o =	3	i vs o =	1

Hence,

$$A = \begin{array}{c} \\ t \\ h \\ i \\ o \end{array} \begin{array}{c} \begin{array}{cccc} t & h & i & o \end{array} \\ \begin{bmatrix} 1 & 3 & 2 & 4 \\ .33 & 1 & 1 & 3 \\ .5 & 1 & 1 & 1 \\ .25 & .33 & 1 & 1 \end{bmatrix} \end{array}$$

Iteration-1

$$Y_o = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} \qquad C_o = 1 + 1 + 1 + 1 = 4$$

$$B_o = [\, Y_o \,] / C_o$$

$$B_o = \begin{bmatrix} .25 \\ .25 \\ .25 \\ .25 \end{bmatrix}$$

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

Iteration-2

$$Y_1 = [A] \times [B_o]$$

$$Y_1 = \begin{bmatrix} 2.5 \\ 1.33 \\ .875 \\ .645 \end{bmatrix} \qquad C_1 = 2.5 + 1.33 + .875 + .645 = 5.35$$

$$B_1 = [Y_1] / C_1$$

$$B_1 = \begin{bmatrix} .467 \\ .249 \\ .164 \\ .121 \end{bmatrix}$$

Iteration-3

$$Y_2 = [A] \times [B_1]$$

$$Y_2 = \begin{bmatrix} 2.026 \\ 0.93 \\ 0.768 \\ 0.484 \end{bmatrix} \qquad C_2 = 2.026 + 0.93 + .768 + .484 = 4.208$$

$$B_2 = [Y_2] / C_2$$

$$B_2 = \begin{bmatrix} .481 \\ .221 \\ .183 \\ .115 \end{bmatrix}$$

SINGHON UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

After repeating the process upto iteration-5,

we get

$$B_4 = \begin{bmatrix} .477 \\ .221 \\ .183 \\ .119 \end{bmatrix}$$

Hence, $\beta_t = .477$ $\beta_h = .221$ $\beta_i = .183$ and $\beta_o = .119$

$TCC = (.633)^{.477} \times (.433)^{.221} \times (.65)^{.183} \times (.333)^{.119} = .542$

ABAC
GRADUATE SCHOOL LIBRARY