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Summary of Thesis titled:

Factors Affecting The Development of Engineering Consulting Firms

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Abstract

There are several factors that affect the development of design firms and if these factors are identified, measures can be taken to upgrade the engineering consulting firms. The present study concern isolating the key factors that affect the development of engineering and consulting firms in Saudi Arabia based on study carried out in 2003-2004.

A hierarchical model of development factors was developed to build a questionnaire based on Analytical Hierarchy Process (AHP). Twenty (20) Experts were consulted. Data collected by means of personal interviews was analyzed with expert Choice 2000 software based on AHP.

The research concluded that, the clients and company's recourses are the important areas that affect development and government factors, is the area which is passive towards development. Client satisfaction, marketing, growth of key industries, size and qualification of human group, and type of client are the important development factors of engineering consulting firms.

Chapter 1

INTRODUCTION

1.1 Introduction

Engineering Consulting is a knowledge-intensive business service that has been seen as the key factor in the generation and definition of new technology in advanced industrial economics. For the development of a country like Saudi Arabia the need and significance of well developed engineering consulting firms can not be over emphasized. The Kingdom of Saudi Arabia is a probably one of the countries that has spent the most on per capita basis on engineering projects.

The consultancy profession in Saudi Arabia is regulated by the ministry of commerce who issue license to practice architectural and engineering consultancy. The city municipality is the authorial agency that implements professional licensing procedure. Engineering council is the other organization that provides proper atmosphere for developing the engineering profession.

Currently there are more than 1650 engineering firms in Saudi Arabia, of which a inadequate portion are well developed and enjoys a good standing along with developed countries. Various factors such as, influence of government policies, development of technological capability, international linkage and technology transfer are considered to be instrumental in development of engineering consulting firms. Analysis of existing structure of E/C firms in Saudi Arabia along with these factors can be helpful in identifying the influence factors. And if the most important influencing factors are identified, measures can be taken to apply them in order to upgrade the engineering consulting firms.

Consulting engineering services are the means by which the project concepts are translated into real form through successive application of intellectual inputs. Consulting engineering services are linked to several aspects of industrial development such as identification of critical technological needs, technology transfer, and local engineering capability.

Previous studies have been conducted in different countries discussed the development of engineering consultant firms in that countries. Haplin (1990), presented factors affecting the technology development in the United States. Hussain (2002), discussed about the development of engineering consultant capabilities and cooperation in Engineering Consultancy in the Asia Pacific region. Hecker (1997), while discussing the need for successful consulting engineering has reported the factors promoting to the success. Al-Besher (1998), has put forth a conceptual model for Consultant Selection in Saudi Arabia criteria that can be used for consultant selection.

This study is proposed to assess the view of design professional on the relative importance of the factors identified from the literature analysis and to come up with most important development factors.

1.2 Objectives

- 1- To identify various factors that affect the development of engineering consulting firms.
- 2- To highlight their order of importance and investigate the most important development factors for engineering consulting firms based on accumulative knowledge and judgment of experts;
 - To perform overall ranking based on consultants.
 - To perform ranking of development factors according to executive respondents
 - To perform ranking of development factors according to technical staff.
- 3- To investigate the correlation between the ranking for various types of respondents.

1.3 Limitations

1. Due to the nature of the questionnaire, (pair-wise comparison) direct interviews were conducted with experts. (consultants and Design Professionals)

2. Around 20 consultant or design professionals, with a minimum of 10 years experience in construction projects worth greater than 10 Million Saudi Riyals, were only interviewed only. Sample size of the research to be interviewed was kept small, so that the information obtained is reliable and to maintain the quality of information.
3. The study also assumes that the participants of the interview are well trained, experienced, and capable of performing the selection process.
4. Because of time and financial constraints, the study is limited to the eastern Province of Saudi Arabia.

Chapter 2

PREVIOUS STUDIES

2.1 DEVELOPMENT OF ENGINEERING CONSULTING FIRMS

Consulting engineering make up a typical sub sector of the knowledge industry and are to be regarded as an important development resource. The current engineering paradigm focuses almost strictly on the short term cost/benefit analysis with respect to the engineer, client, society and ecology. Development of E/C firms refers to the transformation of present industry into a highly competitive industry that is successful in developing new markets at home and abroad as sequence of its ability to provide innovative, high-quality consulting engineering services.

In Saudi Arabia engineering consulting is looked at like any other type of business. There are many Saudi engineering firms established in the Kingdome which are small and fragmented not capable of handling the larger projects. These firms are true in the ownership but no in the work force or processes and rely heavily on the competence of the foreign firms. Therefore there is an urgent need for the development of Saudi E/C firms to be able to secure and manage large size projects without relying on the western firms and their expertise.

2.2 OBSTACLES TO DEVELOPMENT

From previous studies there are many obstacles to the development of engineering consulting firms

According to UNIDO, 1995 there are several developing countries lack transparent effective legislation and policies that foster the establishment and operation of local consulting services. Other obstacles include:

1. A limited domestic market
2. The technology-intensive nature of these services and the need for subsequent continuous improvement.
3. The need for managerial and organizational skills that are weal in developing countries.

4. Foreign donor agencies and countries tend to support their own firms which has made difficult for local firms to compete against foreign firms.

5. Professional contacts and cooperative arrangements that foreign consultant have with international equipment suppliers which tend to give them a competitive edge over local firms.

According to Adas (2002), management problems and outdated practices in Saudi Arabia are still causing high attrition and entry exit rates among the construction firms.

Sedairy (1995), concluded in his research about the marketing practices of A/C in public projects that the indiscriminate marketing techniques are unlikely to meet any success and direct marketing techniques are effective.

Al-Rughaib (1996), indicated in his research that consulting and architectural offices rarely use IT with low level of automation in design.

2.3 IMPORTANT FACTORS FROM PREVIOUS STUDIES

Haplin (1990), presented the following which are factors affecting technology development in the united states.

1. Need for competition in design.
2. Lack of patent incentives.
3. Contract polices rewarding mediocrity
4. Restrictive building codes.
5. Liability issues
6. Lack of government support of innovation
 - a. Educational support in AEC area.
 - b. Coordination of research support.
 - c. Improvement of incentive for innovation
 - d. Provision of subsidies.
 - e. Revision of income tax polices.

Hussain (2002), argued about the development of engineering consultants is Asia and Pacific region. The points discussed in these preceding were:

1. Development of domestic consulting houses
2. Role of domestic consultants in implementation of major projects.

3. Regulatory control of engineering services sector.

Future challenges for engineering consultants discussed were:

1. BOT projects
2. Liberalized global market place
3. Contractor's In-House capacities
4. Low competitive costs
5. Poor recognition of consultants.
6. Inappropriate selection of consultants.

Hecker (1997), while discussing successful consulting engineering reported the importance and need of:

1. Non-technical skills to the consulting engineer.
2. Importance of providing basic soft skills training in undergraduate program.
3. Specific measures that organizations should take to promote lifetime learning.

Al-Besher (1998), considered the following criteria in his thesis (A Conceptual Model for Consultant Selection in Saudi Arabia):

1. Current work load.
2. Experience.
3. Economic constraints
4. Quality Control.

An extensive literature view was conducted including a review of current and past professional publications in the engineering consulting area. This review included all academic and professional journals, textbooks, papers from conference proceedings, and the reports from organizations like AIA, FEDIC, UNIDO etc.

Based on this analysis a list of the following development factors was proposed:

A. Governmental factors

1. Legal system
2. Engineering council.
3. Professional practice restrictions.
4. Role of local municipality.

B. Organizational factors:

1. Organization Structure.
2. Specialized experience of the organization
3. Management & Administration.
4. In-Houses capacity of the organization
5. Strategic planning.

C. Macro Economic factors:

1. Unemployment
2. Private investment
3. Growth of key industries
4. Joint Ventures

D. Development of science & Technology:

1. Appropriate selection of technology.
2. Available IT infrastructure.
3. Research and development.
4. Training and Education.

E. Clients:

1. Type of Client.
2. Size of customer pool.
3. Investment Potential
4. Client consultant relationship
5. Client satisfaction

F. Company Resources:

1. Size and qualification of human group.
2. Personnel finance
3. Availability of craft and operation skills
4. Marketing.
5. Availability of required infrastructure.

Chapter 3 Methodology

3.1 INTRODUCTION

The specific research methodology utilized in this research is a combination of quantitative and qualitative approaches in applied research that is common for the construction engineering and management related problems. The combination of both approaches will assist in solving the over all problem.

The concentration of research is initially was on acquiring the knowledge about E/C firms. The qualitative approach applied in this research is the development of list of factors that affect the development of E/C firms, to develop an AHP based questionnaire and to conduct personal interviews with the design professionals. The questionnaire approach is the analysis done based on AHP and the statistical analysis. Finally conclusions and recommendations are given.

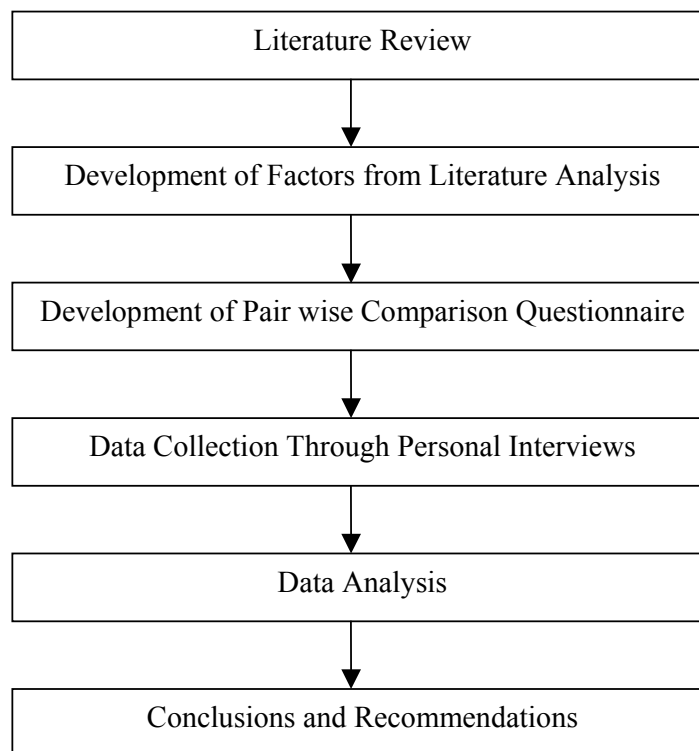


Figure 3.1: Research methodology Flow Chart

3.2 LITERATURE REVIEW

The primary objective of the literature review is to study various research studies done in past and need for the further research. Detailed literature review gives the comprehensive knowledge about the factors related to the development of engineering consulting firms.

3.3 DEVELOPMENT OF A LIST OF FACTORS

An initial list of development factors was developed from previous studies which were further constricted based on the particular domain under which it was considered. Finally a list of 27 sub factors/alternatives were developed, these 27 sub factors/alternatives were grouped under 6 principal factors or categories. Based on the objective of the research i.e., to come up with the most important development factors and the area, which needs more attention for the development. A hierarchy of development factors was developed. There are two reasons for grouping the factors into hierarchies. First, factors of similar nature should logically be grouped into one cluster to facilitate the pair wise comparison questionnaire and secondly, it is known that an individual can not simultaneously compare more than 7 ± 2 elements with satisfactory consistency and hence hierarchical decomposition is desirable.

Following is a list of factors that is used in the questionnaire to be evaluated by personal interviews. These factors are grouped into six categories, and each category in turn consisting of sub factors to be ranked. The factors of similar nature grouped under one cluster to facilitate pair wise comparison during the survey.

PF#1 Governmental Factors

SF#1 Legal System

SF#2 Engineering Council

SF#3 Professional practice restrictions

SF#4 Roles of Municipalities

PF#2 Organizational Factors

- SF#5 Organization Structure
- SF#6 Specialized Experience of the organization
- SF#7 Management and Administration
- SF#8 In House capacity of the organization
- SF#9 Strategic planning

PF#3 Macro Economic Environment

- SF#10 Unemployment
- SF#11 Private Investment
- SF#12 Growths of key industries
- SF#13 Joint Ventures

PF#4 Development of Science and Technology

- SF#14 Appropriate selection of technology
- SF#15 Available IT Infrastructure
- SF#16 Research and development
- SF#17 Training and Education

PF#5 Clients

- SF#18 Type of Client
- SF#19 Size of customer pool
- SF#20 Investment Potential
- SF#21 Client Consultant relationship
- SF#22 Client Satisfaction

PF#6 Company's Resources

- SF#23 Size and qualification of human group.
- SF#24 Personnel Finance
- SF#25 Availability of craft and operative skills
- SF#26 Marketing
- SF#27 Availability of required resources.

3.4 DEVELOPMENT OF A PAIR WISE QUESTIONNAIR

A questionnaire was developed for personal interviews to be taken with the design professionals. The questionnaire was split into two parts. First, asking about the general information of the respondents and second, pair wise comparison tables were developed for the respondents to compare the development factors based on the fundamental scale present in Analytical Hierarchy Process which is a multiple criteria decision making list. The data obtained from the interviews was analyzed using the software “Expert Choice 2000” to obtain the ranking of factors.

3.5 DATA COLLECTION THROUGH PERSONAL INTERVIEWS

In this phase of the research, data is collected through personal interviews in order to do pair wise comparison of development factors for E/C firms in Saudi Arabia. The preparation of survey and questionnaire in this research was guided by the established methodologies used in the past by researchers have put forth the procedure for survey and final questionnaire development.

3.6 DATA ANALYSIS

In this phase of the research data collected through personal interviews is screened and separated for participants. The analysis includes the synthesis of most important development factors according to the overall consultants and also according to the executives and technical staff from the sample population.

3.6.1 ANALYTICAL HIERARCHY PROCESS

The analytical hierarchy process is a basic approach to decision making. It is designed to cope with both the rational and the intuitive to select the best from a number of alternatives evaluated with respect to several criteria. In this process, the decision maker carries out simple pair wise comparison judgment which are then used to develop overall priorities for ranking alternatives.

Advantages of AHP

1. AHP is the flexible model that allows individuals or groups to shape ideas and define problems by making their own assumptions and deriving the desired solutions.
2. It is a practical way to understand complex problems by breaking them down into their components and measuring the intangible qualities of those elements quantitatively to determine their priority impact.
3. It offers a new way to integrate hard data with subjective judgments about intangible factors.
4. It consists of a new way to incorporate judgment of several players and resolve conflict among them.
5. It enables the decision makers to test the sensitivity of the problem solution, or outcome, to change the data.

3.6.2 STRUCTURING THE HIERARCHY

Following are the steps to be followed in structuring hierarchy:

1. Identify the overall goal.
2. Identify the sub goals of the overall goal.
3. Identify criteria that must be satisfied in order to fulfill the sub goals of the overall goal.
4. Identify the sub criteria under each criterion.
5. Identify actors, actor goals, actor policies, and the possible outcomes involved in the process.
6. Take the most preferred outcome and compare the ratio benefits to costs of making the decision with those of not making it.

3.7 DEVELOP CONCLUSIONS AND RECOMMENDATIONS

Following the analysis of data conducted through direct interviews, conclusions are developed which will be discussed later. Conclusions developed were based on the current survey of the development factors from respondents. Finally, recommendations are made that can be utilized as a base for the further research and

as directives to the engineering consulting firms to pay careful attention to the most important factors.

Chapter 4

SURVEY RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter outlines the survey response rate, general profile of the research sample and the development of a hierarchical model to be used in this survey. Further, this section covers important development factors in Saudi Arabia according to overall consultants, important principal factors and sub factors according to executives and technical staff from E/C firms synthesized by the software “Expert Choice 2000”.

4.2 RESPONSE RATE

A total of 52 E/C firms from the eastern province of Saudi Arabia were asked to participate in the study and out of which 23 responded. Out of 23 responses 20 were selected and the 3 responses were discarded for not complying with experience as was required in the scope of the research. With the three discarded responses, the response rate was 38%. And out of design professionals contacted 30% has experience of more than 15 years and 70% of them had more than 10 years of experience.

4.2 HIERARCHICAL MODEL FOR THE DEVELOPMENT FACTORS

A hierarchical model presented in Figure based on AHP is developed for the selection of the most important development factors. This is a multi objective decision support tool designed to facilitate sound decision making by using empirical data as well as subjective judgment of the decision makers. Based on the analytic hierarchy process, Expert Choice software provides a mathematically rigorous application and proven process for prioritization and decision making by reducing complex decisions to a series of pair wise comparison, then synthesizing the results. Expert Choice not only helps decision makers arrive at the best decision but also provides a clear rationale for the decision.

The model developed in the figure consists of three levels of hierarchies:

1. Overall objective which is the most important development factors for E/C firms.
2. Principal Factors that affect the development of the E/C firms.
3. Sub factors/alternatives from which the ranking to be done.

A hierarchical model is shown in Fig. 4.1

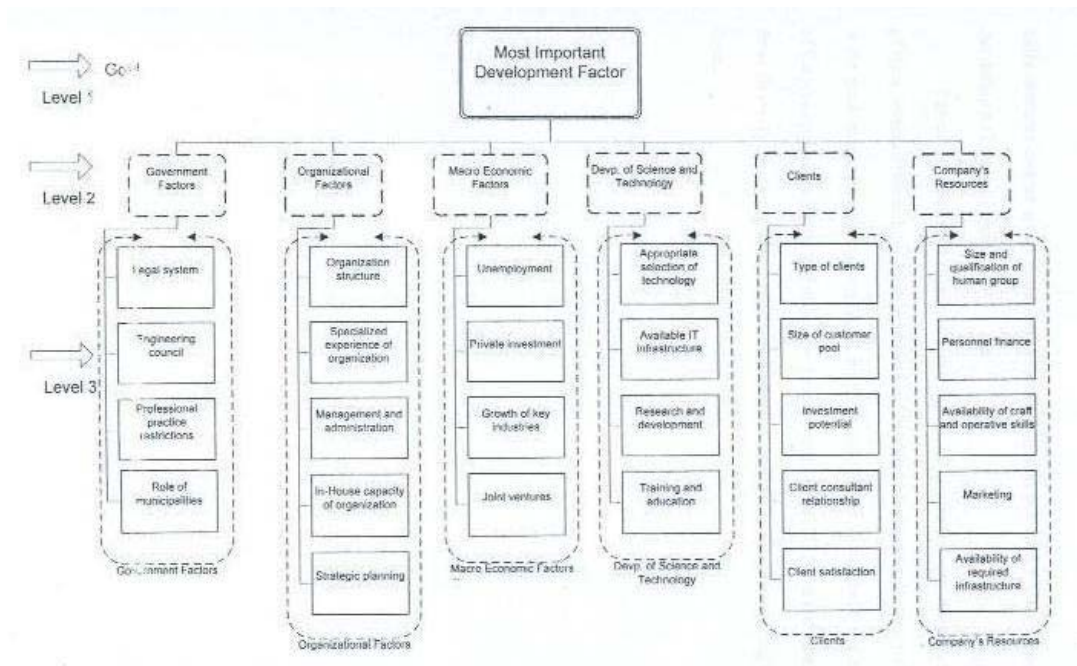


Figure: 4.1: Hierarchical model for development factors

4.3 E/C DEVELOPMENT FACTORS IN SAUDI ARABIA

Fig 4.2 shows the pair wise comparison of sub factors within each factor. Top ten important development factors according to design professionals are:

1. Client Satisfaction
2. Marketing
3. Growth of Key Industries
4. Size and Qualification of human group
5. Type of client
6. Investment Potential
7. Client Consultant Relationship
8. Strategic Planning

9. Private Investment

10. Personnel finance.

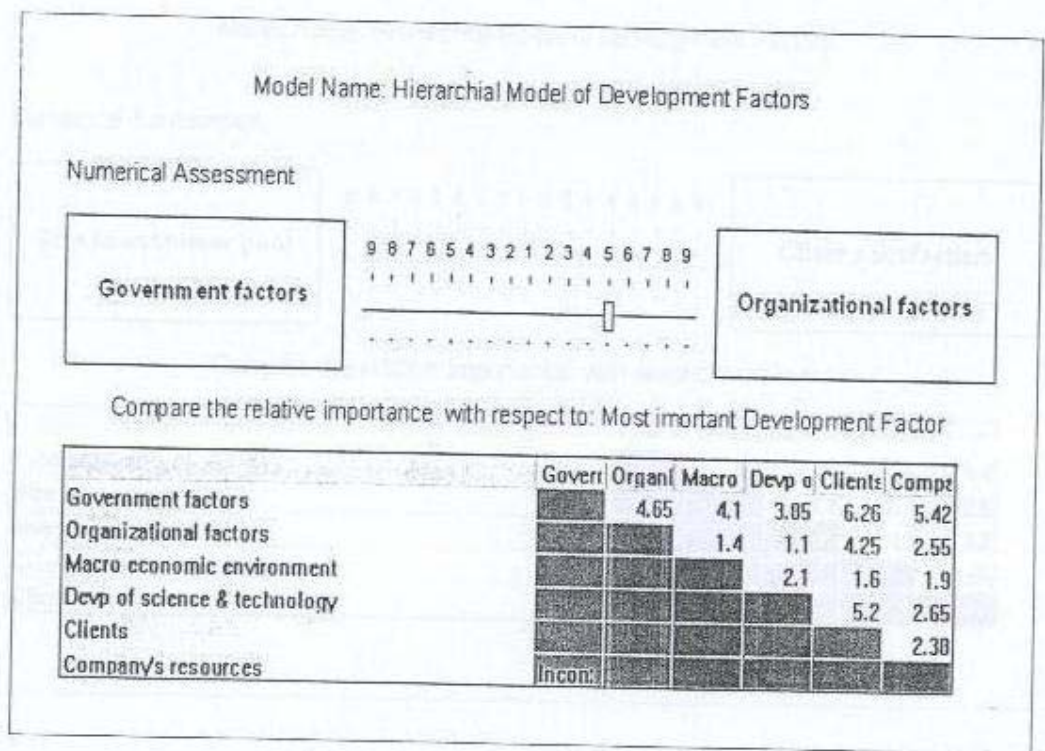


Figure 4.2: Pair wise comparison of sub factor

4.4 PRINCIPAL FACTORS/PRINCIPAL AREAS

Government Factors: this factor doesn't seem important to any of the type of respondent. This principal factor has achieved the least rank six (6) in all categories.

Organizational Factor: Organization refers to the company's structure with particular reference to the establishment of the function and duties of its several parts. Overall consultant and engineers have ranked this factor as fourth (4). Respondents holding executive positions in management and administration have preferred this after clients and have ranked it as second (2). Technical staff did not seem it as so important and have ranked fifth (5)

Macroeconomic Environment: This principal factor considers all the variables that have an impact on the planning cycle for the development of E/C firms. Overall this

principal factor got third (3) rank along with technical staff. Respondent from executive departments have ranked it as fourth (4).

Development of science and technology: development of science and technology is essential for obtaining and maintaining a competitive engineering and consulting industry. Overall rank attained by this principal factor is fifth (5). Executives have ranked it as fifth (5) and technical staff as fourth (4).

Clients: consultants have ranked this principal factor to be the most important area for the development of E/C firms. Respondent holding technical positions as well as respondent from technical background have ranked clients first (1st), to be the most important factor.

Company's resources: company's resources are one of the vital components for the development of an engineering and consulting firms, overall the consultants have ranked this principal factor as second (2). Executives have ranked this factor as third and technical staff as second (2).

Figures 4.3, 4.4 and 4.5 show the synthesis of principal factors/areas with respect to overall development of E/C firms, executives and technical staff respectively.

Table 4.1 illuminates the ranks of principal factors for different respondents.

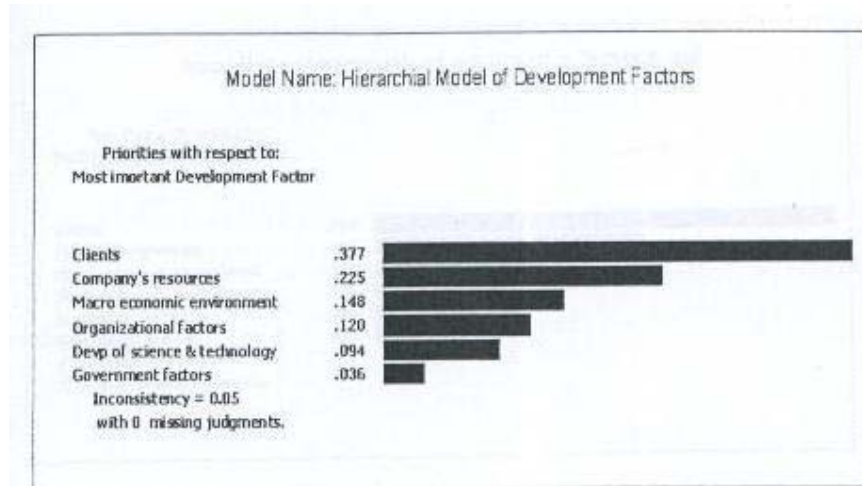


Figure 4.3 Principal factor ranking done by all consultants

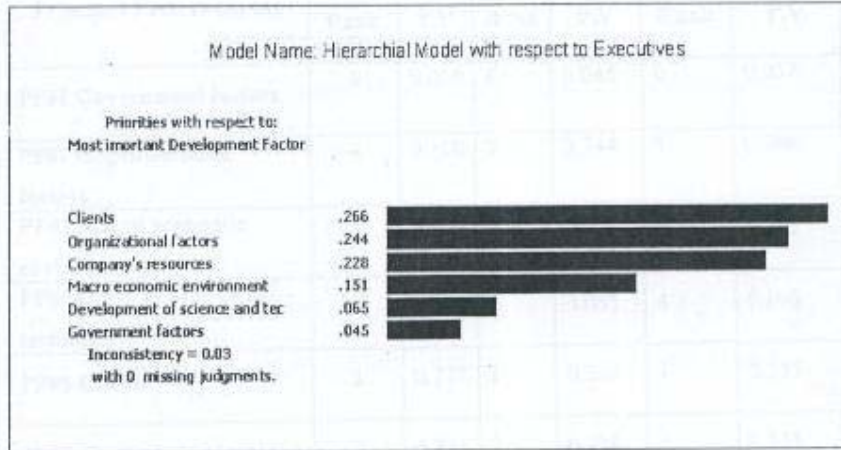


Figure 4.4 Principal factor ranking done by executive respondents

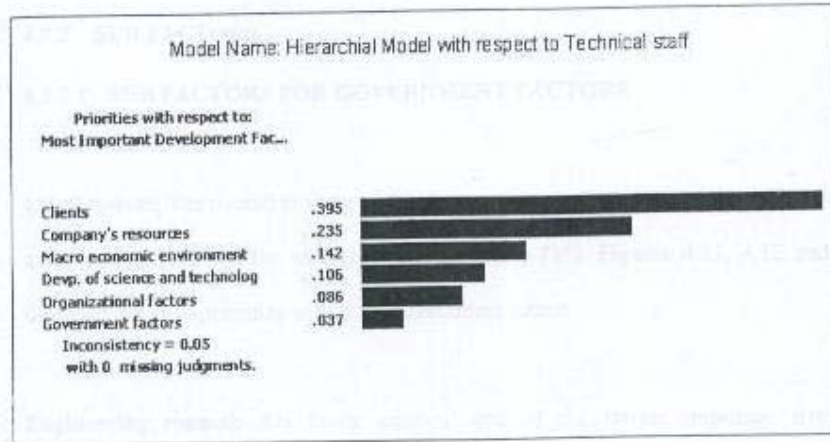


Figure 4.5 Principal factor ranking done by technical staff

Principal Factors/ Areas	Overall	Executives	Technical Staff
	Rank		
PF#1 Governmental Factors	6	6	6
PF#2 Organizational Factors	4	2	5
PF#3 Macro Economic Environment	3	4	3
PF#4 Development of science and technology	5	5	4
PF#5 Clients	1	1	1
PF#6 Company's Resources	2	3	2

Table 4.1: Ranking of Principal factors

4.5 SUB FACTORS

Table 4.2 shows ranking by different respondents.

Sub factor	Overall	Executives	Technical Staff
	Ranking		
PF# 1 Governmental Factors			
Legal System	19	16	14
Engineering Council	27	26	26
Professional practice Restriction	26	25	21
Role of Municipalities	22	27	27
PF#2 Organizational Factors			
Organization Structure	24	9	25
Specialized experience of organization	16	6	22
Management and administration	17	14	15
In-House capacity of organization	21	15	23
Strategic planning	8	2	9
PF#3 Macroeconomic Environment			
Unemployment	25	24	24
Private Investment	9	17	8
Growth of key industries	3	3	4
Joint Ventures	13	12	13
Development of science and technology			
Appropriate selection of technology	11	21	16
Available IT infrastructure	23	19	6
Research and development	14	18	20
Training and education	15	22	19
Clients			
Type of client	5	10	3
Size of customer pool	18	23	18
Investment potential	6	7	7
Client-consultant relation ship	7	13	10
Client satisfaction	1	1	1
Sub factors of Company's Resources			
Size and qualification of human group	4	11	2
Personnel finance	10	4	11
Availability of craft and operative skills	20	20	17
Marketing	2	8	5
Availability of required infrastructure	12	5	12

Table 4.2 Ranking done by different respondents

4.6 AREAS OF GREATER EMPHASIS

Figure 4.6 represents the order of importance of different areas included in this research with respect to the development of E/C firms. Clients according to this study are the most important area that affects the development of E/C firms, and the client satisfaction is the prime development factor. The factor which least affects the development is government factor which according to the respondents is the most passive area which needs attention.

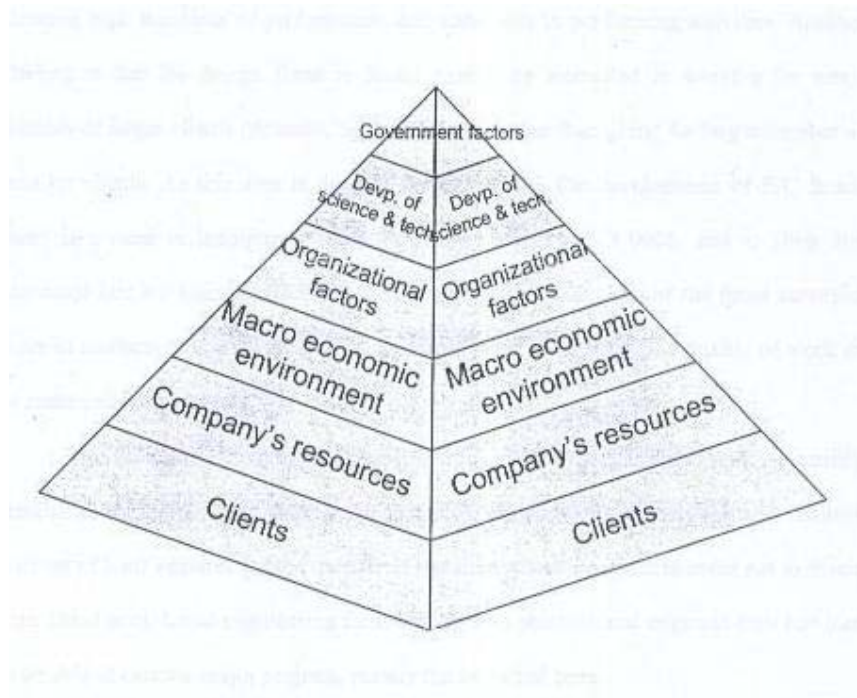


Fig 4.6: Pyramid showing the importance of development areas

Chapter 5

CONCLUSIONS

5.1 SURVEY CONCLUSIONS

The study carried out was to find the development factors from the literature analysis and to develop a questionnaire based on these factors to be ranked by the consultants in Saudi Arabia. This study, to the best of author's knowledge is one of the comprehensive efforts done to pile up the factors related to the engineering and consulting firms and to rank them in Saudi Arabia. Following are the conclusion based on survey:

Top ten (10) development factors according to the consultants on the whole:

1. Client satisfaction
2. Marketing
3. Growth of key industries
4. Size and qualification of human group
5. Type of Client
6. Investment potential of the client.
7. Client consultant relationship
8. Strategic planning.
9. Private investment.
10. Personnel finance of the firm.

Top ten (10) development factors according to the executives from consulting firms:

1. Client satisfaction
2. Strategic Planning
3. Growth of key industries
4. Personnel finance of the firm.
5. Availability of required infrastructure.
6. Investment potential of the client.
7. Client consultant relationship

8. Marketing
9. Organizational Structure.
10. Type of Client

Top ten (10) factors according to the technical staff from consulting firms:

1. Client satisfaction
2. Size and qualification of human group.
3. Type of Client
4. Growth of key industries
5. Marketing
6. Availability of required infrastructure.
7. Investment potential of the client.
8. Private investment.
9. Strategic Planning
10. Client consultant relationship

Top Principal areas of development according to consultants:

1. Client Satisfaction
2. Company's resources
3. Macro economic environment
4. Organizational factors
5. Development of science and technology
6. Government factors

Top Principal areas of development according to executive:

1. Client Satisfaction
2. Organizational factors
3. Company's resources
4. Macro economic environment
5. Development of science and technology

6. Government factors

Top Principal areas of development according to technical staff:

1. Client Satisfaction
2. Company's resources
3. Macro economic environment
4. Development of science and technology
5. Organizational factors
6. Government factors

5.2 GENERAL CONCLUSIONS

1. All the participants have ranked the clients as the most important principal factors.
2. All the participants have ranked government factors as the least important principal factors. Of the participants approached most of them looked unhappy with legal system prevailing the country. They were demanding a unified legal system which would be consistent through out the Kingdome discarding one laid by key players.
3. Executives have preferred organizational factors after clients and technical staff preferred company's resources. Executives by the nature of their post were interested in planning and development at the strategic level and hence have ranked strategic planning and organizational factors higher. Whereas, technical staff stressed on the company's resources and technology related factors higher.
4. Client satisfaction came out as the most important development factor in all categories.

Chapter 6

RECOMMENDATIONS

1. Literature analysis from this research effort reveal that engineering and consulting firms are concentrating on short term project related factors neglecting the overall development of the firm. Therefore, it is recommended to concentrate on the important development factors obtained from this study and take suitable measures that can be applied to upgrade the E/C firms.
2. E/C firms are recommended to incorporate quality certifications lie ISO 9001, and to be abide by standards laid by Aramco, SABIC etc.
3. E/C firms are suggested to communicate with their potential clients and are advised to expand firm's offices to diversify the services being offered.
4. It is recommended that E/C firms invest in research and development, training, and acquire required infrastructure to perform high standards of services.
5. It is recommended to disseminate the knowledge gained through this research effort into academic area. Further more, important development factors and areas should be incorporated into the education programs for the construction executives who later can utilize this information to enhance the performance of E/C firms.
6. This study was carried considering twenty seven (27) development factors and six (6) principal areas of development, it is recommended to consider the important development areas obtained from this study and carryout further research with fewer development factors with larger sample population obtain more significant results.

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Shafiuddin, Mohammed. (2004). ``Factors Affecting the Development of Engineering Consulting Firms``, Master of Science Thesis, King Fahad University of Petroleum & Minerals.