MULTI-CRITERIA DECISION MAKING MODEL

FOR THE SELECTION OF A/E PROFESSIONALS

BY

AZFAR AMAAN

A Thesis Presented to the

DEANSHIP OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

MAY 2012

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN 31261, SAUDI ARABIA

DEANSHIP OF GRADUATE STUDIES

This thesis, written by Azfar Amaan under the direction of his thesis advisor and approved by his thesis committee, has been presented to and accepted by the Dean of Graduate Studies, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in CONSTRUCTION ENGINEERING & MANAGEMENT**.

Thesis Committee

Dr. Sadi Assaf (Advisor)

Dr. Ashraf Elazouni (Member)

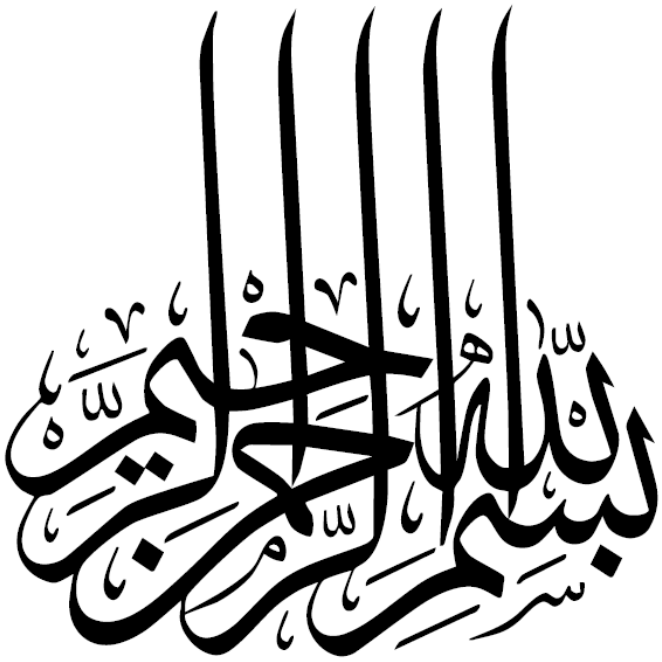
Dr. Mohammad A. Hassanain (Member)

Dr. Khalaf A. Al-Ofi
Department Chairman

Dr. Salam A. Zummo
Dean of Graduate Studies

29/5/12

عمادة الدراسات العليا
DEANSHIP OF GRADUATE STUDIES



Dedicated to

Ammijaan…..

ACKNOWLEDGEMENT

All praise belongs to Almighty Allah (S.W.T.) for bestowing me with health, knowledge and patience to carry out this work and complete my M.S. successfully at King Fahd University of Petroleum and Minerals, Dhahran. I am happy to have a chance to glorify His name in the sincerest way through this small accomplishment and ask Him to accept my efforts.

My profound gratitude and appreciation goes to my thesis advisor Dr. Sadi Assaf for his constant help, guidance and motivation during the course of my study and research work. It was his motivation and inspiration that helped me through all difficulties. His priceless suggestions made this work interesting. With due respect, I would like to acknowledge my committee members Dr. Elazouni Ashraf and Dr. Mohammad A. Hassnain for their encouragement and guidance. I would also like to acknowledge all the CEM faculty members.

I also thank my fellow graduate students in the department and also the graduate students at KFUPM. It would be very difficult to name all of them, thus to name few, acknowledgement to Eng. Riyaz, Abdur Rahman, Eng. Sarfaraz, Eng. Najid, Eng. Faizan, Eng. Hasan Baig, Eng. Azhar, Pervez, Ghufran, Omer, Fasi, Eng. Aqeel, Azhar, Eng. Masood, Dr. Safdar Hussain, Fawzy for making my stay at KFUPM a memorable and enjoyable one.

Special thanks to my parents, brother and grandparents for their encouragement, support and constant prayer for my success.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

THESIS ABSTRACT (ENGLISH)

NAME: AZFAR AMAAN

TITLE: MULTI-CRITERIA DECISION MAKING MODEL FOR THE SELECTION OF A/E PROFESSIONALS

MAJOR: CONSTRUCTION ENGINEERING AND MANAGEMENT

DATE: MAY 2012

A/E professional are part of engineering consultancy which aids in meeting design and construction need of the client. Owners can't look for all the aspects of construction by themselves, so they hire Architect/Engineer professional to be sure for efficient implementation of construction project. Generally lack of in house engineer initiates the need of A/E professional for a project. A/E professional helps in cash flow & fund availability, in acquiring resources, political or organizational problems, regulatory problems, and training needs are some other areas for which they could be hired. This research deals with the process of selection of A/E professional through a proper channel leaving out under qualified A/E professional for the better development of services and infrastructure in public and private sector in Saudi Arabia & India and also help in identifying the critical criteria's for the selection of A/E professional for two Asian countries and the conceptual model developed through it will help in selecting best A/E professional on fair basis considering all available options.

MASTER OF SCIENCE DEGREE
KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
Dhahran, Saudi Arabia

THESIS ABSTRACT (ARABIC)

الإسم : أظفر أمان

العنوان : نموذج متعدد المعايير لاختيار المهندسين المعماريين المتخصصين

التخصص : إدارة وهندسة التشييد

التاريخ : مايو 2012

يعتبر مهندسين التشييد جزء من الاستشارات الهندسية التي تساعد على مراقبة وضبط الجودة على التصاميم والتنفيذ ذلك بالنيابة عن صاحب المشروع . تعتبر متابعة جميع الاعمال المتعلقة بالمشروع مهمى صعبة على صاحب المشروع ، لذلك فأنه يلجأ لتعيير استشاري عمارة وتشييد متخصص يقوم بجميع مهام المتابعة والتدقيق على المقاول ويحرص على أن جميع بنود ومواصفات العقد يتم العمل بها . في العموم ، تعتبر قلة توفر المهندسين المتخصصين في مراقبة العمل هي السبب الرئيسي في تعيين استشاري من الخارج للاشراف على سير العمل . يساعد الاستشاري ايضا في متابعة السيولة النقدية وتوفرالموادر المالية المطلوبة لنجاح المشروع ، وتوفير الموادر الأخري والمشاعدة في حل المشاكل المتعلقة بالشركات والسياسات والجهات المشرعة ، بالإضافة إلى تدريب الموظفيف الجدد على التخصصات المطلوبة . تعتبر رسالة الماجستير هذه والبحث المصاحب لها مشروع لالية اختيار الاستشاري من خلال نموذج متخصص يتم من خلاله الاعتماد على قدرات وخبرات الاستشاري واستبعاد الغير مؤهل . من خلال تطبيق هذا النموذج ، سيتم تطوير ألية الاختيار والمساعدة على تحيقيق افضل النتائج في مشايع البينة التحتية في القطاعين الخاص والعام وذلك في المملكة العربية السعودية والهند . بالاضافة إلى ذلك ، سيساعد النموذج في تحديد الخصائص والمواصفات التي يجب توفرها في الاستشاري . هذا النموذج يستعرض ألية الاختيار في دولتين اسيويتين (المملكة العربية السعودية والهند) ، وذلك لضمان الاختيار العادل والمبني على اسس علمية وذلك بالأخذ بالاعتبار جميع الخيارات المتاحة .

درجة الماجستير في العلوم

جامعة الملك فهد للبترول والمعادن

الظهران ، المملكة العربية السعودية

CHAPTER 1

1 INTRODUCTION

1.1 Background

Today modern city is not recognized by its natural beauty but through infrastructure it has. Now we recognize different cities by assets they have not by its natural resource. For example there was a time when Dubai was known for deserts but in present world when we think of Dubai, first thing which hits the mind is Burj Al Arab.

Unlike the earlier time present construction industry became complex. Along with development of every industry construction industry has evolved simultaneously. According to a famous quotation when five blind men touches a big elephant they encounters different part, also present construction industry is like a big elephant where we have to look for different parts like planning, designing, financing, construction and operation.

Owners can't look for all the aspects of construction by themselves so they hire Architect/Engineer professional to be sure for efficient implementation of construction project. Current construction industry is divided into four major segments which are residential, commercial, industrial and heavy construction and all of them require A/E supervision.

If we look at the boom in the field of construction current stats shows Asia at the top specially countries like Saudi Arabia, UAE, China, India etc. If we talk about Saudi

Arabia and India in particular both are developing their infrastructure at full pace presently.

A/E professional are part of engineering consultancy which aids in meeting design and construction need of the client. Engineering consultancy is a broad field and hence consultants should be selected on the basis of need of the client. These consultancy services are provided in the field such as structural, mechanical, construction, electrical, environmental and many more field. Every client has particular set of problem for which they need consultants to fix them, but the clients should not blindly follow their suggestions and hence could negotiate for changes. Consultancy is very usual and beneficial process of development and can also be used to learn problem handling techniques for future. Generally lack of in house engineer initiates the need of A/E professional for a project. It's also the nature of problem and availability of resources which demands the hiring of A/E professional. They should be hired for appropriate reasons not for implementing inappropriate decision [1-2]. Because of lack of in house engineer A/E professional are hired for doing specific kind of work on contractual basis. Currently all the owners are seeking better infrastructure and services for which they require technical expertise and try to avoid legal constrains and hence they seek help from group of people who are not their employees.

This research deals with the process of consultant selection through a proper channel leaving out under qualified consultants for the better development of services and infrastructure in public and private sector in Saudi Arabia & India.

1.2 Statement of Problem

In house engineer tries their best to provide solution to the problem but still they are several areas they lack expertise and hence left with no choice but other than hiring A/E professional for their need.

There is different political and social background in both the countries so first there is a need to understand the rule of hiring A/E professional.

In Saudi Arabia, according to tendering practice and regulation “consulting services and other such services such as studies, drawing up specifications and supervision of implementation thereof shall be secured through direct purchase if the value thereof not exceeds one million Saudi riyals. If the value exceeds one million riyal, such services shall be secured through the invitation of at least three consulting firms to submit their proposal within a period to be determined by the soliciting agency. ”[3-4]

In India A/E professionals are hired because:

(a) Lack in in-house expertise

(b) For high quality of work

(c) For better efficiency and economy

(d) For special services

Method of selecting consultant in India:

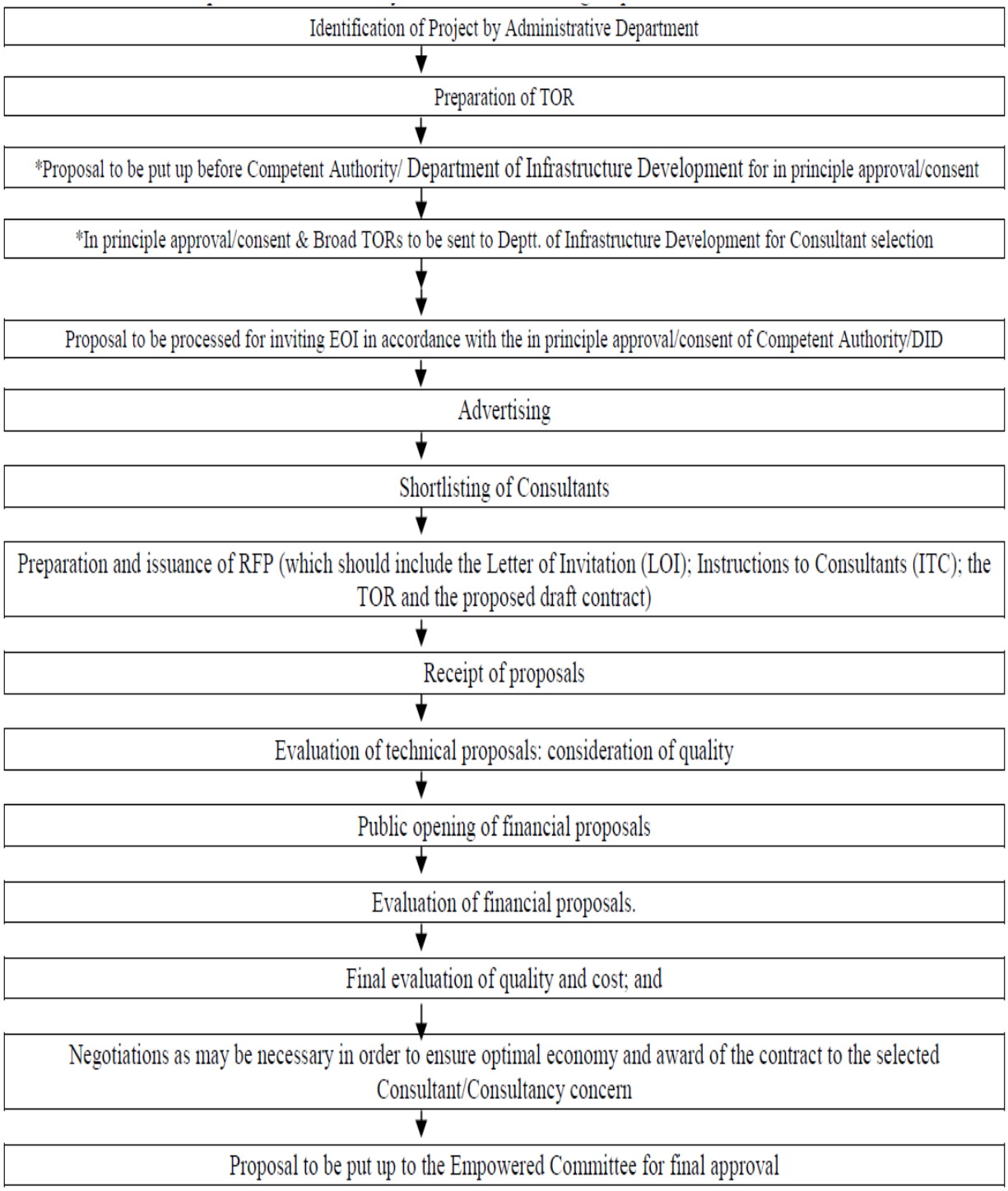


Figure 1-1: Method of Consultant Selection in India

Though there are some loopholes in the selection process which are effecting the quality of the project such as[3, 5]:

- Clients can have their own selection criteria.
- Best proposal is decided on finances in most cases i.e. low fee not quality.
- Wide variety of local and international A/E professional makes selection tedious.

If inappropriate A/E professional is selected there would be collateral damage to the project such as[3]:

- Exclusion of good consultants results in undesired quality design and services.
- Faulty cost estimate.
- Increase in life cycle cost
- Project is subjected to high risk
- Selected consultant will never be able to satisfy client and hence their relationship will not be healthy throughout the project.

This research will help in finding most appropriate A/E professional and hence the problem states that

> "The research aims to develop a conceptual model for selecting A/E professional based on multiple criteria decision making for public and private sector companies working in Saudi Arabia & India."

1.3 Research Objective

There is not much research done in the field of hiring A/E professional for construction projects in Saudi Arabia & India. The previous researches are decade old and are not taken to a global level.

The main objective of this research is

1) To establish the most critical criterion for selection of consultant in public and private sector in KSA and India.
2) To develop conceptual AHP model for selection of consultant or A/E professionals.
3) To validate the model by using it for selecting A/E professional and comparing the results with actual selection.

The advantages of this conceptual model will be:

- This model could be used in any construction project.
- It will help in identification critical criteria for selecting A/E professional.
- It will eliminate the chances of foul selection process.
- Most able and appropriate consultant will be selected through fair means.
- There is different requirement for different kind of projects and this model will provide flexibility to choose consultant as per the need and situation.
- It will helps in abolishing the traditional method of selecting A/E professional based on low bids and will allow the real performers to come forward which help be beneficial for both A/E professional and the owners.

1.4 Limitation of the Research

1) Though the criteria are selected globally but the research is limited to only KSA and India.
2) It is assumed that professional responsible for the selection of A/E professionals is fair and efficient.

1.5 Significance of Research

When there is scarcity of expert and advisors within the concern authority responsible for the development of infrastructure of the organization it becomes quite obvious to seek outside help. In order to improve the quality of project selecting a good consultant is first important step. Because consultant is an expert who has done similar projects before and is in better position to advice on arising gains and demerits which one could face during the course of a project.

"This research will help in identifying the critical criterions for the selection of A/E professional for two Asian countries and the conceptual model developed through it will help in selecting best A/E professional on fair basis considering all options."

When we hire someone to make coffee for us don't expect a miracle, expect a coffee. In a same way A/E professional will not do something out of the box or something impossible but surely he will help in providing:

- Additional skills
- Intelligence advice
- Outside perspective

- Cost control & quality of project

1.6 Thesis Organization Chart

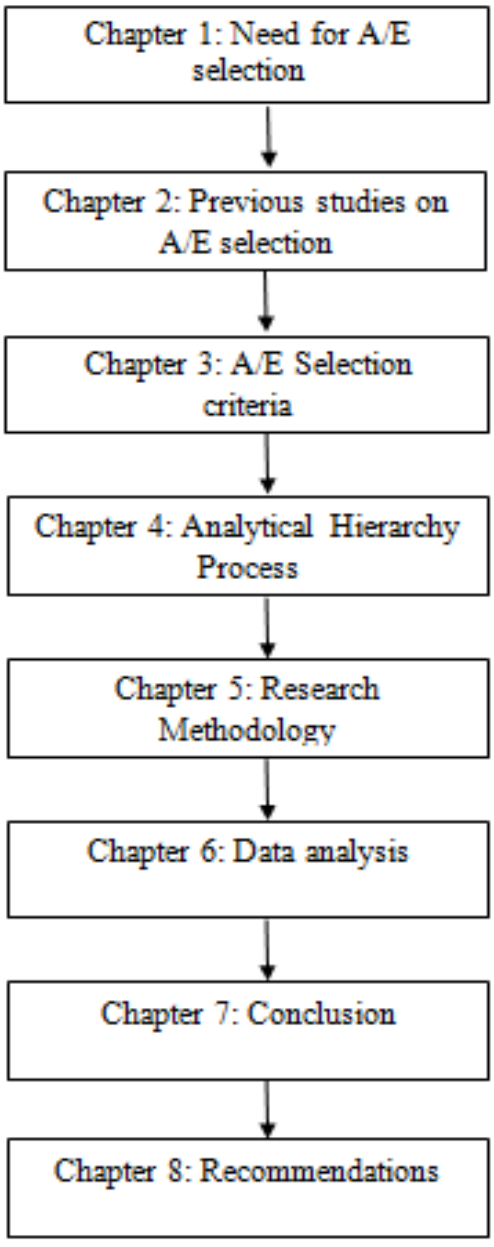


Figure 1-2 Organization Chart

CHAPTER 2

2 LITERATURE REVIEW

2.1 Introduction

Time is always changing and adapting to changing needs and demands keep the things moving. So designers and consultants, has equipped themselves to the changing needs of the engineering society. In order to get top quality service now the owners monitor and control quality of deliverables with the help A/E professionals.

Everyone wants to excel fairly in the competitions, through performance, integrity, entrepreneurship, and the ability to grow with qualities in order to support the needs and the objectives. But lack of expertise and in house experience force the owners/organizations to take necessary measures to safeguard them self from bad quality of work and cost overrun and hence opts for engineering consultants. The objective of owner is to get appropriate facility and effective expenditure. Engineering consultant helps in achieving these goals. They have high level of technical expertise and are aware of best practice outside. A/E professional are needed in a project at different stages and on the ground which they are selected determine the outcome of project. From new homes, schools and hospitals to newly-energized towns and cities, A/E professional have been shaping the world's infrastructure for decades, so it is obvious to determine the criteria which can help in selection process and the conceptual model developed will help in selecting appropriate A/E professional based on multiple criteria decision making process.

2.2 Basic Terminologies

A/E professional: is a professional who offers expertise and advice to clients in return of money. Client: a client could be anybody who needs professional expert especially public sector, although private owners, industry, universities etc are also potential clients.

Basic encounter between client and the A/E professional

The client:

- May have no idea of budget allocation.
- May not be able to acknowledge the problem.
- May be aware of the problem and needs outside assistance.
- May or may not fully realize the benefits a "full treatment" will have on his operation.

It's A/E professional's duty to:

- To understand and acknowledge the problem
- To act with clients interest and integrity.

There are various consulting services where we can define consultant's relationship with client in various kind of contract[6] such as traditional contract, construction manager contract, professional manager contract and professional construction manager contract.

A/E professional can provide following helps [3, 7-8]:

- Quality design
- Construction management
- Budgeting and life cycle costing
- Feasibility and market analysis
- Environmental studies and site selection
- Cost effectiveness and value engineering
- Innovativeness
- Green factors
- Risk analysis and decision analysis

Engineering consulting services are authorized by ministry of commerce and are divided into four major categories[3]

- Saudi engineering office
- Saudi consulting office
- Non Saudi engineering office
- Foreign consulting office

According to ministry of planning & commerce there is hike in field of construction of educational and health facilities the growth is up by almost 13%.

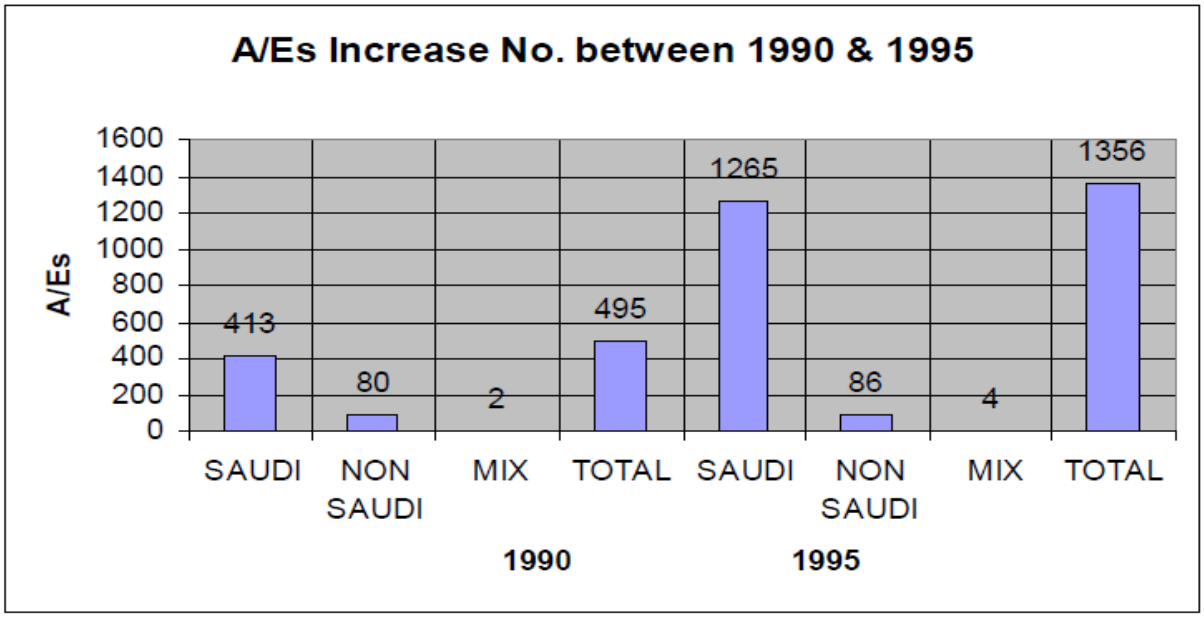
Table 2-1 Consultant Usage & Budget

Activity	2004	2005	2006	2007	2008	Average Annual Growth Rate (%)
Residential or small commercial	34136	39803	49266	47941	50489	10.3
Industrial or large commercial	2133	3043	3494	3088	3499	13.2
Educational and health facilities and mosques	1137	1456	1883	1915	1798	12.1
Social and government services Facilities	179	419	726	827	851	47.7
Total number of building permits	37585	44721	55369	53771	56637	10.8
Ratio of 'residential or small commercial' to total (%)	90.8	89.0	89.0	89.2	89.1	–

(*) Up to end of fourth year of Eighth Development Plan.
Source: Central Department of Statistics and Information.

In Saudi Arabia there are 1356 consultants [3]:

Table 2-2 Number of Consultants per Year



In the year 2010 there was around 2200 consulting offices among different region of Saudi Arabia, distributed as[9]

- Riyadh region – 43%
- Mecca region – 30.4%
- Eastern region – 15.8%
- Medina region – 9.4%
- Asir and remaining region – 1.4%

There is significant increase in the number of consulting services over the last 10 year in Saudi Arabia and hence clearly suggesting that new consultancy bringing new facilities, services and price change in the system hence a model needs to be generated for the selection of A/E professional which could be applied to any private or public sectors.

Indian Consultancy Industry

The development of consultancy services is related to economic and industrial growth. Accurate measure of size of Indian engineering consultancies is not possible though according to a report in 2005 it is estimated that the consultancy business in India engages about 100,000 persons in about 5000 consulting firms.

Strengths and Weaknesses of Indian Consulting Industry

The major strengths are:

- Quick learners
- Competent
- Economic

The major weaknesses are:

- Poor quality standards
- Insufficient equity
- Poor R&D facilities

Method of selection of A/E professional:

- Direct selection method: it is used by the owner when they have full trust in engineering consultant based on its reputation and past relation. This method doesn't suite small and new firms[3, 10].
- Competitive selection method: it's based on fee and design. Agencies for public services concerns with design mainly though private owner concerns with the fee [3, 10-11].
- Comparative selection method: it's the most widely used method where engineering consultants are truly evaluated based on factors such as technical expertise, experience, key personnel, compliance with request etc [3, 10, 12].

2.3 Previous Studies

Before the year 1990:

1) Tuftle in the year 1988 wrote a paper on “Effective use of consulting engineers” and he suggested that when government agencies need engineering services they sometimes contract it to the consulting engineers. This paper tells when a consultant should be retained and how the contractual process should be developed. It was found out that both the owner and the consultant have some flaws. Also it was found out that through defining roles and responsibilities earlier and properly implementation of contract will be more beneficial and effective[13].
2) John in the year 1988 did research on “The process of hiring and managing technical consultant”. The reason for the research was due increasing demand of the technical consultants and their employment in the company. The first step in hiring was validation of need and creating window for job opportunity, then interviewing the candidates and finally ensures that consultants works in compliance with companies goal[14].
3) Alan Basham (1983) wrote an article on “Two envelope system of a building”. According to this system the fee should not be considered until the consultant is selected on other merits. According to him those merits are alternate form of pricing which eventually is beneficial for the owner[15].

From the year 1990 to 2000

1) Al Musallami (1992) in his thesis on “consultancy practice in Saudi Arabia and owner’s satisfaction” worked on professional relationship between the owner and the local A/E firm in terms of cost effectiveness, buildability and overall satisfaction. He found out that the owners are moderately satisfied due to high changer order resulting from faulty design as a result of which there is always a hesitation in owner to decide a reasonable fee for these firms[16].
2) Potter & Sanvido (1994 & 1995) has conducted their research on how to select the member of a design build team. He showed concern over the loyalty of the A/E firm as they may be working for sub contractor or contractor and hence might not act in the best interest of the owner[17].
3) Assaf and Jannadi (1994) worked on contractor prequalification. They developed multi criteria decision making model to help in contractor prequalification. The main factors which were used in the models are finances, experience, past reference, current work load, staff availability**,** manpower resources, company organization, office location, and experience in geographic location of project, quality performance and claim attitude. These factors could also be implemented in consultant selection[4].
4) Al Basheer (1998) in his thesis on “Conceptual model for consultant selection in Saudi Arabia”. He established 13 different criteria’s to develop this model and run the survey in order to find its application. This is the only significant research in the field of consultant selection in Saudi Arabia but it’s more than decade old.

This research work is also similar to this above said approach but under new set of conditions[4, 6].

5) Latham (1994) make report on "Constructing the team". He suggested that government project members should be selected in such a way that there should be a minimum need of outsourcing but though if needs arouses the selection should be made on two important factors i.e. quality and price[8].

From the year 2000 and onward:

1) Thomas Ng (2005) worked on "Appraisal of Subcontractor Performance – Criteria and their Importance". According to him quality and productivity is declining due to performance of sub contractor. Though design is not the part of sub contracting but we can still learn from this paper how factors like resources, workmanship and attitude to claims are important for a project which could also be used as selection factor for consultants[18].
2) Ng & Chow (2004) published a paper on "Evaluating engineering consultants' general capabilities during the pre-selection process –a Hong Kong study". The aim of the paper was to develop a framework for evaluating consultant's capabilities during pre-qualification. They conducted a interview to find out the most critical criteria's through point system on the scale of 0 – 5 and they found out that technical ability and quality attributes are the most important factors[12].
3) Ng & Chow (2004) "Framework for Evaluating the Performance of Engineering Consultants" suggested that success of project is now heavily dependent on how consultants performs so it is necessary to have check on their performance. In

order to do set criteria is developed and verified through a survey which is later used in a framework for consultant's performance evaluation[10].

4) Yean Ling (2002) worked on "Model for Predicting Performance of Architects and Engineers". The main classification was between soft and hard attributes divided into 25 sub groups. These attributes and model were used for evaluating A/E performance in design build project. It was found out that the performance could be analyzed by using three attribute mainly "AE's problem solving ability and project approach, AE's speed in producing design drawings, and the AE's level of enthusiasm in tackling a difficult assignment"[19].
5) Cheung, Judy & Martin (2002) worked on "Multi-criteria evaluation model for the selection of architectural consultants". Through a survey a criteria and their relative importance was established. Then these criteria's were used in AHP model in order to develop a model architects selection using software ACSS[11].
6) Ng and chow (2007) worked on "Expectation of performance levels pertinent to consultant performance evaluation". They collected data from different clients on how they evaluate consultants and make a set of criteria's to evaluate the performance by injecting a survey using these criteria's for performance evaluation. It was being found that main performance evaluation criteria's are: " (i) compliance and understandings to client's brief; (ii) compliance to legislative requirements; (iii) identification of client's requirements and project objectives; (iv) quality of design; (v) availability of innovative and alternative solutions; (vi) approach to overall cost-effectiveness; (vii) quality of drawings/documents; and (viii) adequacy of cost estimate"[7].

7) Ling (2002) proposed "A conceptual model for selection of architects by project managers in Singapore". There were total 40 attributes which were selected for survey among the developers who hires consultant and it was found that out of those 34 were useful attributes. These attributes were divided into 4 major categories job performance, contextual performance, network theory of embeddedness and theory of the firm. It was also suggested that consultant should select project manager as their team leader in order for quick response, follow the order and to be more loyal[19].

8) Topcu (2004) worked on "A decision model proposal for construction contractor selection in Turkey". The current selection method was based on three factors quality, time and money but this research divided the process into two main pars i.e. contractor prequalification and the selecting eligible candidate from prequalified contractor. The model was developed for the government sector to hire the best contactor not the lowest bidder[20].

9) Tatjana (2004) makes a "Model for maintenance contractor evaluation and the determination of its selection criteria". This model was developed to select contractor for maintenance of building blocks. The criteria's are selected by keeping into mind objective and interest of the client and finally on the basis of MCDM analysis contractor is selected. The model presented could be used in any building project by slight modifications as per the need of clients[21].

10) Jaskowski (2010) has worked on "Assessing contractor selection criteria weights with fuzzy AHP method application in group decision environment". This research applied a new approach in which bid selection criteria is not taken as the

property of bidder but as an object of procurement and in order to assure adequate quality bidder should be checked on economic and technical capabilities. In this approach fuzzy method is used which is extension of AHP method because it uses group judgment method for the selection process[22].

2.4 Discussion

In this chapter previous research related to A/E professional (consultants) is discussed by explaining their importance and advantage in a project. Teams of engineers and architects understand the variety of design/construction issues that accompany projects such as community issues, construction sequencing and phasing, and unknown conflicts. A/E professional's works with/for client to make sure the project comes in on-time and on budget. It is also discussed that how A/E professional and clients enter a relationship through a contract. As this study will be conducted in two countries hence consultant's selection method is briefly discussed. The literature from three different decades is discussed. The literature mainly consists of criteria needed for consultant selection, AHP model and multiple criteria decision making. Related research like contractor selection and engineering consultant evaluation process are also seen as source of essential criteria and good examples of conceptual model are seen which could be very helpful in course of this research.

CHAPTER 3

3 CRITERIA'S FOR SELECTING A/E PROFESSIONAL

In this research criteria's for selecting the A/E professional is established through extensive literature review from previous research which involves the selection process of A/E professional or other similar research as follows:

1. "A conceptual model for selection of architects by project managers in Singapore" by Yean Yng Ling has following criteria's:

A. Task Performance Factor
   a. General Mental Ability
      - Creative and innovative
      - Good project approach
      - Ability to resolve problem
   b. Job Knowledge
      - Economical design
      - Constructability
      - Relevant design and regulations
      - Contract administration
   c. Task Proficiency
      - Design have technical quality
      - Design have functional quality
      - Designs are accurate and error free
      - Designs are within budget
      - Manageable level of workload
      - Financial stability
   d. Job Experience
      - Total experience
      - Experience in relevant projects

B. Contextual Performance factor
    a. Conscientiousness
        - Drawings produced speedily
        - Approvals obtained speedily
        - Pays close attention to design and construction
        - Efficiency in tackling problems
        - Ensures that work conforms to specification

    b. Initiatives for offering suggestions to improve design

    c. Control Ability
        - Respect and accept client as team leader
        - Follow clients instruction and order
        - Response time
        - Maintain independence

    d. Social skills to get along other

    e. Commitment
        - Loyal to client
        - Would revise design to approve project objective
        - Interest in job

    f. Leadership

C. Network Factor
    a. Reputation
    b. Ongoing Relationship
    c. Prior Relationship

D. Price Factor
    a. Low Fee
        - Quotes low fee
        - Allow delayed payments

2. "A Conceptual Model For A/E Consultant Selection (Ccsm) In Saudi Arabia" by Dr. Sadi A. Assaf, Dr. Osama A. Jannadi, Dr. Anis Siddiqui, and Mubarak Al-Besher has shortlisted following 13 criteria's :

- Staff and Qualifications
- Experience
- Quality Performance
- Project Management Capability
- Past Performance
- Quality Control
- References
- Current Work Load
- Firm Organization
- Firm Capacity
- Economical Constraints
- Experience in Geographic Location
- Head Office Location

3. “Client and consultant perspectives of prequalification criteria” by ST Ng and R M Skitmoreb has shortlisted following criteria’s for their research:

A. Private Firms and Governmental Firms

   a. Financial stability

   b. Performance

   c. Fraudulent activity

   d. Stability of firm

   e. Management capabilities

   f. Failed contract

   g. Standard of quality

   h. Project complexity

   i. Health and safety

   j. Competitiveness

B. Architectural Firm and Engineering Firms

   a. Performance

   b. Fraudulent activity

   c. Standard of quality

   d. Management capabilities

   e. Financial stability

   f. Progress of work

   g. Stability of firm

   h. Cooperative outlook

   i. Integrity and Relationship with client

4. “Effective Use Of Consulting Engineers” by Erling A. Tufte proposed following criteria for determining when consultants should be retained and how the contractual process should be developed and implemented.

   (1) Experience and references (with a focus on quality, timeliness, work relationships, and concern for work);

   (2) Familiarity with project requirements;

   (3) Work program including schedule;

   (4) Clarity of the proposal;

   (5) Attitude;

   (6) Adequacy of project personnel, equipment, and facilities;

   (7) Compensation;

   (8) Creativity;

   (9) Responsibility;

   (10) Communication; and

   (11) Professional qualifications

5. “Evaluating engineering consultants’ general capabilities during the pre-selection process –a Hong Kong study” by S. Thomas Ng and Lai-Kit Chow identifies the commonly used criteria for pre-selecting engineering consultants through a survey.

A. Technical Capabilities
    a. Previous experience
        - Type of project completed
        - Size of project completed
        - Nature of service provided
        - Specialization
        - Amount of sub contracting
        - Length of time in business
    b. Resources
        - Number of professionals
        - Qualification of personnel
        - Experience of personnel
        - Experience of site staff
        - Availability of computing facilities
B. Management Capabilities
    a. Management staff
        - Number of staff
        - Experience of staff
    b. Service delivery
        - Time management system
        - Time overrun in prior projects
        - Cost overrun in prior projects
        - Amount of claims from prior projects
C. Financial Capabilities
    a. Financial soundness
        - Financial ratio analysis
        - Capacity of work
    b. Professional indemnity insurance
        - Amount of cover
        - Length of cover
        - Any previous claims
D. Quality Attitude
    a. Quality control and assurance
        - Quality control scheme.

6. “Evaluation of Consultant Performance” by Abdulrahman A. Al-Hussain and Ahmed S. Agha the identified criteria’s for performance check on consultants which could be used in selection process itself. considered criteria’s are as :

    - Appreciation of background information
    - Quality of recommendation
    - Availability of innovative ideas
    - Accuracy of cost estimate
    - Quality of report
    - Compliance to clients requirement
    - Compliance to legislative requirement
    - Identification of clients requirement and project objectives
    - Quality of design
    - Quality of drawing
    - Quality of bid documents
    - Bid assessment
    - Quality of report on return bids
    - Supervision of site and administrative staff
    - Administration of contract
    - Handling claims
    - Input of key personnel’s in project
    - Monitoring the project
    - Relationship with clients
    - Management skills
    - Quality management
    - Environmental management
    - Safety management

7. “Framework for Evaluating the Performance of Engineering Consultants” by S. Thomas Ng1 and Lai-Kit Chow developed a multicriteria model for evaluating the performance of engineering consultants which means the research can be used for establishing the criteria’s for consultants selection as they were used to monitor the performance throughout the project. Factors were feasibility, design, bidding, construction and post construction.

8. “Selecting Consultants Through Combined Technical And Fee Assessment: A Hong Kong Study” by S. Thomas Ng, Mohan Kumaraswamy and Lai Kit Chow suggested a proper consultant selection process, which takes into account other quality-based criteria, to ensure the quality of the consultants appointed and examines a Combined Technical and Fee Assessment (CTFA) approach being used in Hong Kong with the help of following criteria’s:

- Consultant’s experience
- Local experience
- International experience
- Relevant to this project
- Organization and staffing
- Experience and number of staff
- Organization structure
- Computer facilities
- Responsibility of key staff

- Current workload
- Methodology and resource planning
- Technical approach
- Contract management and site supervision
- Approach to cost effectiveness
- Ability to produce cost-effective design
- Approach to achieve cost-effectiveness
- Response to brief
- Understanding of objectives
- Identification of key issues
- Understanding of key requirements
- Innovative proposals
- Quality assurance
- System assurance
- Partnering

9. “A fuzzy gap analysis model for evaluating the performance of engineering consultants” by Lai Kit Chow, S. Thomas Ng suggested that performance is an important dimension for prequalifying and selecting ECs and to evaluate the performance following criteria’s have been shortlisted:
    - Identification of client’s requirement and project objective.
    - Quality of design.
    - Compliance and understanding to clients brief.
    - Compliance to legislative requirement.
    - Quality of drawing.
    - Availability of alternative solutions.
    - Overall approach. Adequacy of cost estimate

10. “Consultant Selection: The Two Envelope System of Bidding” by Alan Philip Basham suggested that fee should be decided after selecting consultant and in that research following criteria’s were used

- Proposed Personnel
- Technical qualifications and Proposed work program
- Experience and Past performance
- Organization

11. "Model for Predicting Performance of Architects and Engineers" by Yean Yng Ling identifies those attributes that affect an AE's performance, and to construct a model to predict his performance. Following attributes were generated using the hierarchy tree:

- Cognitive ability
- Creativity and innovativeness
- Problem solving ability and project approach
- Job knowledge
- Job of economic design
- Knowledge of constructability
- Task proficiency
- Technical quality of design
- Functional quality of design
- Accuracy of design
- Workload
- Job experience
- Total experience
- Experience with similar projects
- Speed in producing designs
- Offering suggestions
- Social skills
- Controllability
- Speed of response

12. “Multi-Criteria Evaluation Model For Selection Of Architectural Consultants” by Franco K T Cheung1, Judy Leung Fung Kuen1 and Martin Skitmore suggested that the selection of a competent architect is vital to the success of a development. Price is not the only consideration in the process; decisions rely heavily on subjective judgment. By conducting a questionnaire survey, this research identified the common criteria for selection and their relative importance to an objective selection.

Firms’ background:-

• Reputation;

• Technical competence/qualification;

• Experience with similar project.

Past performance:-

• Cost control;

• Quality of work;

• Time control.

Capacity to accomplish the work :-

• Present workload;

• Availability of qualified personnel;

• Professional qualification/experience.

Project approach:-

• Approaches to time schedule;

• Approaches to quality;

• Design approach/methodology.

13. In 2001 Queensland public works department published a report on “Engaging and managing consultants” and has proposed following criteria’s for selecting them
    - Conformance to the specification
    - Merits of their proposal
    - Capabilities and experience of consultant
    - Price
14. Allen County Engineer's Office in Ohio in 2011 suggested following criteria’s for selection of consultants:
    1. Firm & Individual Qualifications
        - Firm's number of years in the business
        - Firm's education/expertise of current/available staff
        - Firm’s experience with similar projects
    2. References
        - Quality of design
        - Controlling costs/meeting budgets
        - Communication/cooperation
    3. Proximity to the Engineer’s Office
    4. Past Performance

The criteria's are divided into 7 major categories which are further divided into sub categories:

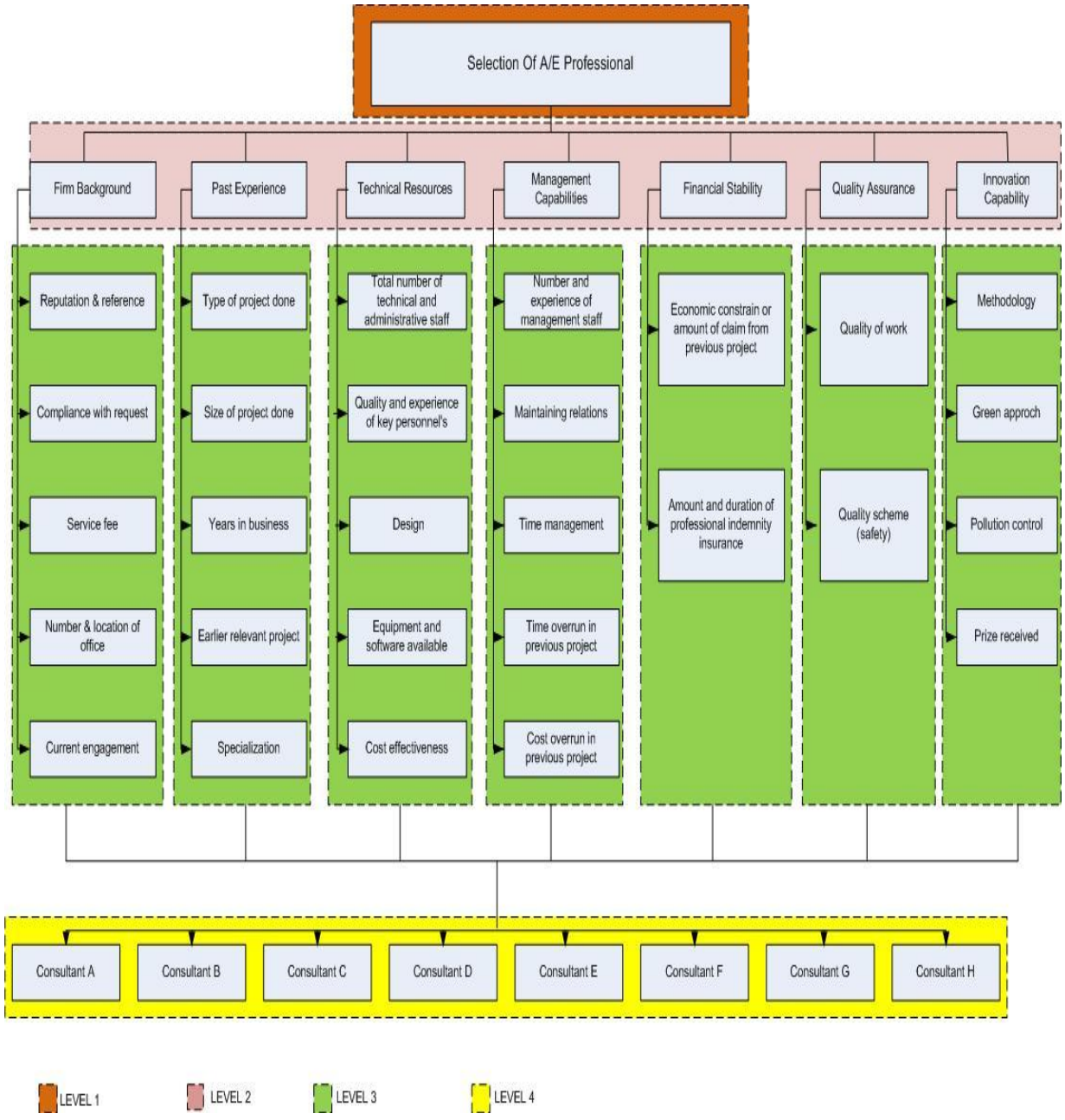


Figure 3-1 The Model

3.1 Firm Background

Every consultancy agency is different. They do not necessarily have the same knowledge or experience. Therefore it would be in every company owners' best interest to have relevant information about potential consultant. Locating the engineering consultant that is right for the job may take a considerable amount of time and effort to ensure that the owner receive everything from the whole process that is needed. It is crucial to check the background, knowledge and experience of each consultant or consultancy firm that could be hired as thoroughly as possible. Following are the things we must look for:

i. Reputation and References:

Some would argue that knowledge is A/E professional's most important intangible asset, but in reality, reputation is. Knowledge can be easily bought, or even sub-contracted, while reputation can't. One could know everything in the world, but if no one knows you know it, the one is not going to make a living with it. The most effective form of marketing is still word-of-mouth referrals, and that relies entirely on reputation. To have good reputation one must:

- Be prolific
- Be ubiquitous
- Be generous
- Be dependable
- Be credible

Based on the reputation reference is provided. Managing references in today's socially networked and often litigious culture is more important than most people might assume.

In order to validate your final selection, organization conducts careful reference checks and talk to a reasonable cross section of A/E professional's clients, particularly those in same professional sector and geographical area. Companies use their own contacts to validate references. Most importantly, they check the general references for the consulting firm and the personal references for the individuals in the firm with whom they will be working most closely. Sometimes companies may consider visiting the A/E professional's offices to obtain a firsthand impression of the organization and the support team behind the scenes.

ii. Compliance with request

It's also a very important criteria which helps in determining credibility of the A/E professional as well as its efficiency. There will be several incidence from the start of the project till its end when A/E professional are asked to make some modification in their work as per new needs or requirement of the owner or there could be some unforeseen events which may require certain changes in the process of event which requires immediate attention and hence consultant should be prompt enough to comply with the request at earliest.

iii. Service Fee

Discussing A/E professional's fees can be as awkward as talking salary with a job applicant. Clients and A/E professional typically save the issue until last. Clear communication about fees during the contracting phase, however, can avoid problems

later on. Fees consultants charge normally cannot be compared to salaries paid to organizational staff. A/E professional have an entirely separate (and higher) scale on which they operate, based primarily on the fact that they don't sell all of their available time and that the rates for the time they do sell often include the "costs of doing business" (overhead, benefits, marketing, and the like). Fees for A/E professional may vary, depending on factors of specialty, experience, reputation, overhead structure, etc. There is no certain correlation between quality and fee. That's why the reference-checking phase is so important in establishing fee also.

iv. Number and location of offices:

First impressions are vital for many businesses accommodating customers on-site, as well as corporate offices serving as a visible representation of an organization's success. So when it comes to the location and number of business or corporate office, a comprehensive review of the potential location will certainly prove time well spent. Important consideration in business today is state of the art global communication access. It helps in providing appropriate connectivity and helps in meeting the requirement of client and also provides higher selection chances in different zones because location of project and knowledge of area provide added advantage.

v. Current Engagements:

In instances when an A/E professional is simultaneously being considered for selection on multiple projects, or a consultant's current workload may impact their ability to complete the work as proposed, the firm's current workload and availability of qualified personnel shall be considered in the selection.

3.2 Past Experience

i. Type of project done:

It provides information about strength and diversity of consultant and explains about its ability to adapt in different situation. This will also provide and serves as a record for the client to familiarize himself with consultant's ability for future reference and other project.

ii. Size of project done:

This is most helpful in case of cost plus fee project when scope of project is expected to increase. Also it tells about the infrastructure of a firm to handle big projects. There is certain amount of risk associated with all projects which increases with the size of project and hence if a firm has a prior experience in dealing with high risk project it will become reassuring for client to believe in consultant.

iii. Years in business

Selection of A/E professional rendered by it would be determined by its expertise, skills and experience. The client should ensure that the prospective A/E professional has the capacity to deliver outputs of high standards. The selected A/E professional should be required to perform the specified services with due diligence, efficiency and economy while conforming with generally accepted professional techniques and practices. A good A/E professional can also be expected to observe sound management practices and employ appropriate advanced technology in delivery of its services and all these things comes with experience. Older the firm is, higher is the level of smooth handling of project.

iv. Earlier relevant project

If A/E professional has experience in similar relevant project it will help in better understanding of the following:

- Delays
- Unnecessary or unusable work
- Extra costs
- Conflicts between individuals or groups in the community
- Community-wide dissatisfaction with study results
- Recommendations that cannot be implemented

v. Specialization:

Specialization is the method of doing work for a singular, narrow, or limited scope of products, services, markets, or objectives. It is one of the most reliable and most durable operating platforms that any business can depend on. It builds strong internal capacity to profitably create and deliver value to the point of customer loyalty, delight, and advocacy. Specialization is predicated on having a superior positioning strategy very much difficult for others, more particularly competitors, to follow, imitate, or hurdle. It is best to note that specialization involves the exercise of knowing, understanding, and focusing on core competency in serving specific clients need.

3.3 Technical Resources

i. Number of technical and administrative staff:

Employees are one of company's greatest assets. What they say about the company, how they act in the workplace, and how happy they are in their roles all impact on brand, image, levels of service and ultimately customers' satisfaction. As they are important assets they are expensive too hence it's necessary to exactly know about the number of person required (technical or administrative) not just for a project but over all work of firm and also its necessary to depute and manage them appropriately.

ii. Quality and experience of key personnel's

Certification is the mark of professionalism. The Certified Engineer is an experienced consultant possessing expertise in every aspect of a project from inception to completion. She/he brings to each engineering project knowledge of problem solving and cost effectiveness. The Certified Engineer is a A/E professional who is totally dedicated to providing professional services in the best interests of his clients. If there is both quality and experience then client will never hesitate to take risk on them.

iii. Design:

It is no exaggeration to say that the most important ingredient of any construction project is its design. The quality of design is the single most important factor in determining a project's "lifecycle cost" the initial cost of construction, plus the ongoing costs for operation and maintenance. Professional design services engineering or architecture represent only a small percentage of the construction

budget, and a far smaller percentage of life-cycle cost, so it makes sound economic sense to ensure your consulting engineer or architect has the experience and qualifications needed to deliver a high-quality design.

iv. Software and equipment available:

It's a digital world now where every work is mechanized. It's very difficult to produce good design or a schedule without the help of software's. Every work either small documentation or a big project report everything is in digital format. Hence productivity is largely depends on equipment available and software present to pace the productivity of a firm.

v. Cost effectiveness:

Cost-effectiveness is the tool decision-makers can use to assess and potentially improve the performance of their firm in finance sector. It indicates which interventions provide the highest "value for money" and helps them choose the interventions and program which maximize the profit from the available resources. The owner can't look at all the aspects of a project and decide what best cost effective technique at that instance hence at this point A/E professional comes to play and provide cost effectiveness.

3.4 Management Capabilities

i. Number and experience of management staff:

Effective management and leadership of employees allow the firm to accomplish goals at work. Effective employee management and leadership allow capitalizing on the strengths of other employees and their ability to contribute to the accomplishment of work goals.

ii. Maintaining relations:

One thing is true for all consultants: If they have any work, they have clients. And one of the most important roles is to maintain and enhance relationship with them. Preserving those relationships can be good for referrals and future business, as well as making the time spent on the project more enjoyable and satisfying.

iii. Time management:

Engineering consulting is a challenging business - it all comes down to people, knowledge, and relationships. The A/E professional go to work each day to solve challenging technical problems for the clients. One of the most critical soft skills is that of time management, and a lack of time management skills can do a great deal to hold otherwise talented A/E professional back from achieving their full potential. Consultants should look for ways to adjust their work style to accommodate the schedule, budget and overall requirements of the project. This is particularly true

when faced with pressure to maintain high quality within finite time and budget constraints.

iv. Time overrun in previous projects:

The major factors responsible for time overruns including delays in land acquisition, environment/forest/wildlife clearances, shifting utilities and removal of encroachments, besides law and order problems, inaccurate/incomplete land records, agitation by local groups, lack of coordination among various departments in resolving issues and lack of supporting /facilitating infrastructure like approaches to project sites. A consulting firm may have to manage all those and it's a test of their ability to deliver the project on time regardless of so many hindrances.

v. Cost overrun in previous projects

Clients have been increasingly concerned with the overall profitability of projects and the accountability of projects generally. Cost overruns, in association with project delays, are frequently identified as one of the principal factors leading to the high cost of construction. In order to prevent the best interest client is always looking for someone with good record of minimum or no cost overrun.

3.5 Financial Stability: are judged through following two criteria's

i. Economic constrains or claims from previous projects:

This kind of problems arises when previous projects were not efficiently executed. The claims could be related to health and safety standards, pollution emission standards, fuel efficiency requirements, price controls and if there is any clients tries to stay away from these consultancies which may became a liability at later stage.

ii. Amount and duration of professional indemnity insurance:

Consulting Engineers carry Professional Indemnity insurance (sometimes known as Civil Liabilities insurance) which indemnifies an A/E professional in respect of liabilities arising from professional activities. These are liability, not material damage, insurances. They do not protect the client or the client's project, except indirectly and then only if it can be shown that the client's loss arises from an act or omission of A/E professional which the law holds to be negligent. In this event, the insurance will provide money, to the limit of the cover, for A/E professional to meet the costs agreed between the parties or awarded by the court.

3.6 Quality Assurance

They rely on two things mainly:

i. Quality of work: depends on professionalism, time management, teamwork judgment, knowledge and reputation. Hence it's a major role player in selection of A/E professional.

ii. Quality scheme: Additional scheme for particular job which no one offers may relate to safety or design can provide edge to that consultant during selection.

3.7 Innovation Capability

i. Methodology:

Consulting methodologies are methods or approaches used by A/E professional in tackling a particular challenge, problem or client engagement. A consulting methodology is nothing more than a proven approach through which a skilled consultant uses his specialist knowledge and expertise to the benefit of his clients. Investing time and effort in improving skills and gaining recognized qualifications in its discipline will payback tenfold. If the expertise matches clients criteria then consultant have better stands better chance of selection.

ii. Green approach:

Client generally owns the project for its life cycle and life cycle cost instead of high initial investment is always less than ordinary approach. A/E professional with best and appropriate green approach may have edge in getting selected.

iii. Pollution control:

Sometimes laws are very strict related to construction of any project especially in vicinity of schools or hospitals where pollution control like air, water and noise is very necessary and hence consultant with better approach toward pollution control during construction and after completion of project stands a better chance.

iv. Prize received:

It's a mark of quality and standard. If a firm has received prize for its innovative approach it stands biggest chance in getting selected because its reputation and standards are authenticated by bigger authority.

CHAPTER 4

4 MULTI CRITERIA ANALYSIS

4.1 Introduction

MCA technique is used when there is multiple options and complex information. It uses the relative weighting method to rank the option and differentiate between acceptable and unacceptable options.

This chapter provides an insight into MCA techniques.

4.2 MCA Uses:

- Consistency
- Soundness
- Transparency
- Ease of use

4.3 Why Better Than Informal Judgement?

• It is open and explicit

• Criteria's can be added or reduced in judgement process.

• Scores and weight are given in order to determine relative importance.

• After developing the model for selection, actual selection process can be sub-contracted.

4.4 Types of Multi-Criteria Analysis Method

- **Simple Weights and Scores Methods**: In this method certain score is given to each criterion and then these criteria are scored by respondent. Finally weight is multiplied by score to obtain the ranking for criteria. This method is very simple and practical.
- **Direct analysis of the performance matrix**: Though it doesn't much information but is used to determine domination of particular criteria over other because of which other criteria are overlooked and hence enable decision maker to have balanced tradeoff for comparing the criteria**.**
- **Multi-attribute utility theory**: All MCA analysis techniques receive some sort of critics but this method is widely accepted because it allows decision makers to break bigger problem into small ones. But this technique requires lot of expertise and is not easy to develop. It makes the use of utility curve, weight system and probabilistic measures.
- **Linear additive models:** This kind of model is used in certain circumstances by decision makers. In this model all the criteria are not treated independently but together as a model and weight & score of each criterion are added up to find the overall score for the model.
- **Outranking methods**: It's based on outranking concept. It shows degree of dominance of one criterion over other. It's also used sometimes when criteria are difficult to compare. It also makes utilization of incomplete information.

- **Fuzzy Sets Approach**: In this method each criteria is given a grade in fuzzy set. This grade represents compatibility of those criteria with fuzzy set. This method is difficult to use and requires extensive mathematical background.
- **The analytical hierarchy process**: The AHP process was developed by Saaty. It's based on the system of overall score or weights. In this method a questioner is answered by respondents who compare two criteria on the scale of 0 to 9 to determine their relative importance.

Comparing A with respect to B?

Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Overwhelmingly more important	9

These answers were put in software called Expert Choice to have detailed analysis of the desired objective as explained in the later part of the research.

4.5 Conclusion

This chapter reviews decision-making methods with these multi-criteria by suggesting simple weights and scores, multi-attribute utility, linear additive model, outranking method, fuzzy sets approach, and analytic hierarchy process.

In this research AHP model will be used. AHP process for the selection of A/E professionals is convenient because it allows decision makers to make judgement with consistency in complex situation. Decision maker can add or subtract criteria based on requirement because different sector companies may need to tailor the model to suite them while still maintaining the consistency and efficiency.

CHAPTER 5

5 RESEARCH METHODOLOGY

- Based on literature review several factors such as past experience, performance etc. has been identified. Along with interview with some professional from consultancies these factors will be consolidated.

- Based on the establish factors questioner will be made and survey will be conducted.

- In this survey owners will be asked to rate the factors as per their importance in selection of A/E professional. There are several models which are used for selection. Brief lists of most of the models are discussed in the literature review section. The framework to be used for this research is an Analytical Hierarchy Process (AHP). AHP model was developed by Satty in the year 1980. It is a theory of measurement which utilizes pair wise comparison among all attributes and relies on expert judgment. The qualitative scores are converted into crisp numbers.

- The input of qualitative scores is analyzed using mathematical analysis based on matrix evaluation and it yields results which are quantitative in nature. The factors are based on ranked based on their relative importance. Based on these factors, a particular consultant can be chosen considering all the contractors are weighted based on all the attributes described in the model.

Application of the model and Sample Questionnaire

- Questionnaires will be sent to Saudi Arabian and Indian owners. Initially, the survey participants are required to give a quantitative judgment (on a 1 to 9 scale) based on their qualitative reasoning and intuition for the relative importance of the seven broad categories of factors through pair wise comparison. The questionnaire is shown in Appendix.

- The data obtained from the survey will be used as the input for the Analytical Hierarchy Process. Expert Choice Software will be used in the analysis of the respondent's data. The resulting values obtained from the model will show the relative importance of each factor compared to each other.

- After evaluating the samples, EC software will be used to perform MCDM because it is widely used in selecting alternatives "what-if" forecasting.

- The detailed selection procedure based on AHP and EC software will be discussed in later sections.

CHAPTER 6

6 DATA ANALYSIS & RESULTS

6.1 Introduction

The proposed model was developed on the factors found in international literature. These factors included in the model will help to perform multi-criteria decision analysis for selection of A/E professional in KSA and India.

Seven main criteria's and 28 sub criteria's were found which will affect A/E selection process. All the factors used in development of model were assessed through a questioner survey.

6.2 Questionnaire Survey

A questionnaire survey (Appendix) was made and owners representative were contacted in order to assess the factors. It consists of two parts:

Part 1: Related to respondents experience.

Part 2: Assessment of factors through respondents.

6.3 Identification of Respondent's

This is model is developed for selecting appropriate A/E professional in KSA & India. The survey was conducted in public and private sectors in both the countries. Two owners representative from each of the organization in both the sectors for both the

countries were contacted to fill the survey. After the assessing the factors validation is done on actual projects the owner have in both public and private sector.

6.4 Pre Testing the Survey Questionnaire

The pre testing was done with the local consultants first because of the following reason:

- To determine adequacy of questions.
- To incorporate additional factors.
- To estimate the time to conduct the research.

Figure 6-1 Model (generated by EC)

6.5 Data Analysis

Country and sector wise results:

6.5.1 Saudi Public Sector

Comparing sub-criterias of firm background

Model Name: Saudi Public

Compare the relative importance with respect to: Firm BAckground (L: .279)

Circle one number per row below using the scale:
1 = Equal 3 = Moderate 5 = Strong 7 = Very strong 9 = Extreme

1	Reputation & Refrenc	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	Compliance with Req
2	Reputation & Refrenc	9	8	7	6	5	4	3	2	1	2	**3**	4	5	6	7	8	9	Service Fee
3	Reputation & Refrenc	9	8	7	6	**5**	4	3	2	1	2	3	4	5	6	7	8	9	Number & Location o
4	Reputation & Refrenc	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	Current Engagement
5	Compliance with Req	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	Service Fee
6	Compliance with Req	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	Number & Location o
7	Compliance with Req	9	8	7	6	5	4	3	2	1	**2**	3	4	5	6	7	8	9	Current Engagement
8	Service Fee	**9**	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number & Location o
9	Service Fee	9	8	7	**6**	5	4	3	2	1	2	3	4	5	6	7	8	9	Current Engagement
10	Number & Location o	9	8	7	6	5	4	3	2	1	2	3	**4**	5	6	7	8	9	Current Engagement

Figure 6-2 Sub criteria's evaluation in firm background

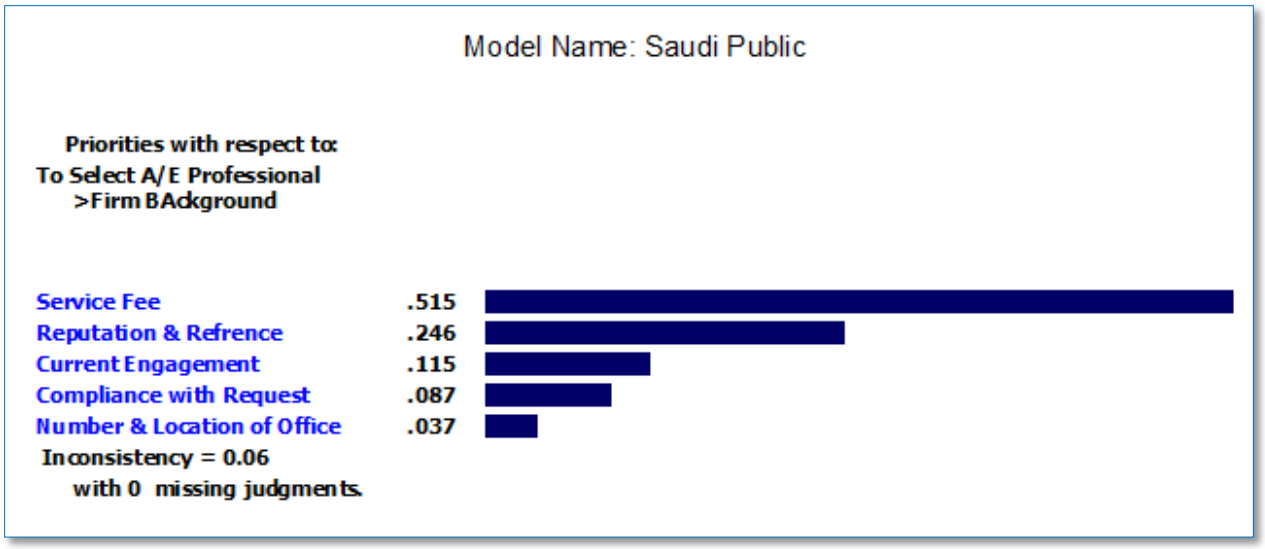


Figure 6-3 Importance of factors in firm background

Comparing sub-criterias of past experience:

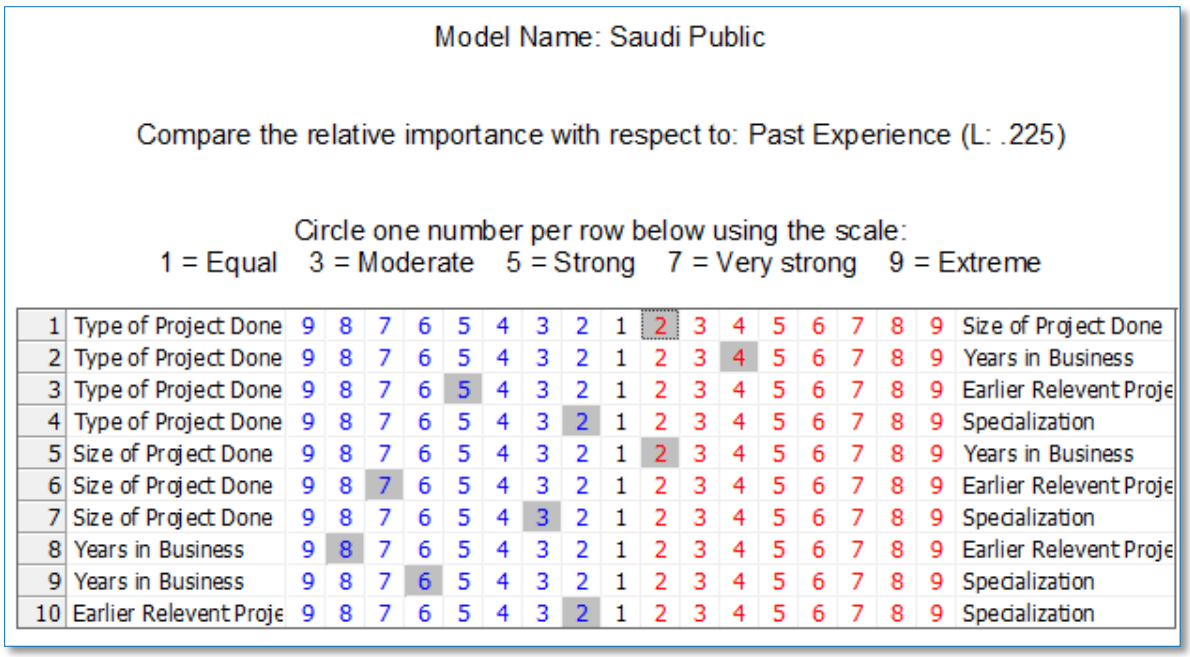


Figure 6-4 Sub criteria's evaluation in past experience

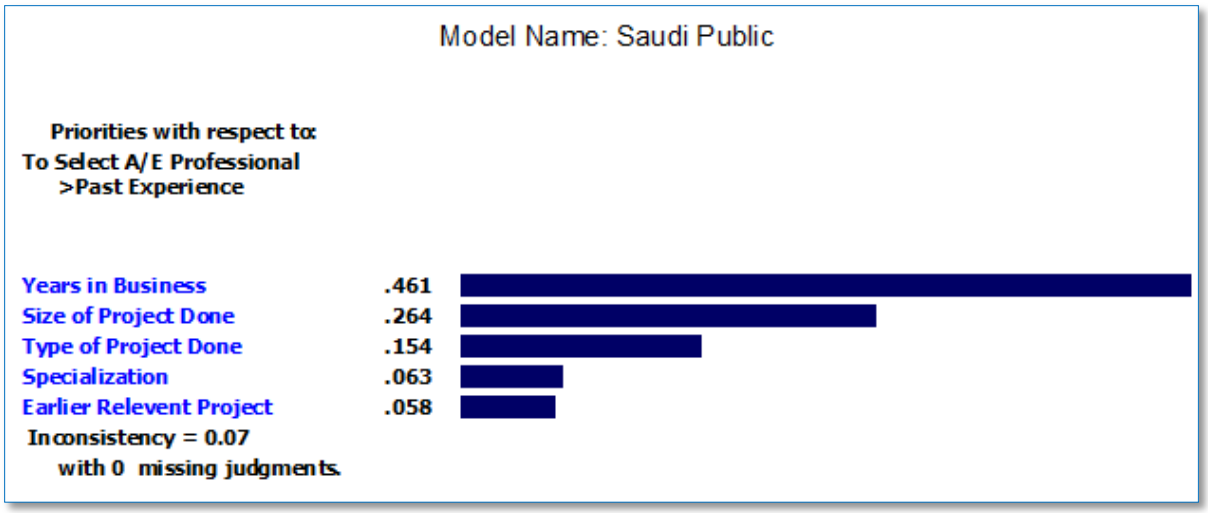
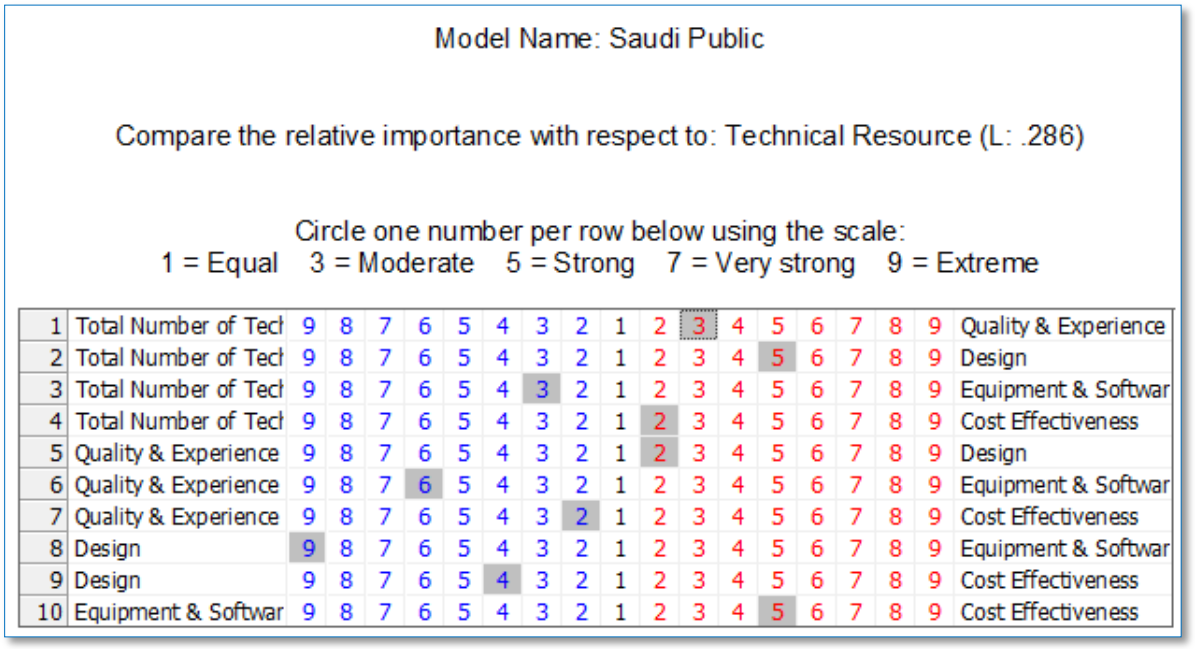


Figure 6-5 Importance of factors in past experience

Comparing sub-criterias of technical resources:



1	Total Number of Tech	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality & Experience
2	Total Number of Tech	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Design
3	Total Number of Tech	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equipment & Softwar
4	Total Number of Tech	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost Effectiveness
5	Quality & Experience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Design
6	Quality & Experience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equipment & Softwar
7	Quality & Experience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost Effectiveness
8	Design	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equipment & Softwar
9	Design	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost Effectiveness
10	Equipment & Softwar	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost Effectiveness

Figure 6-6 Sub criteria's evaluation in technical resource

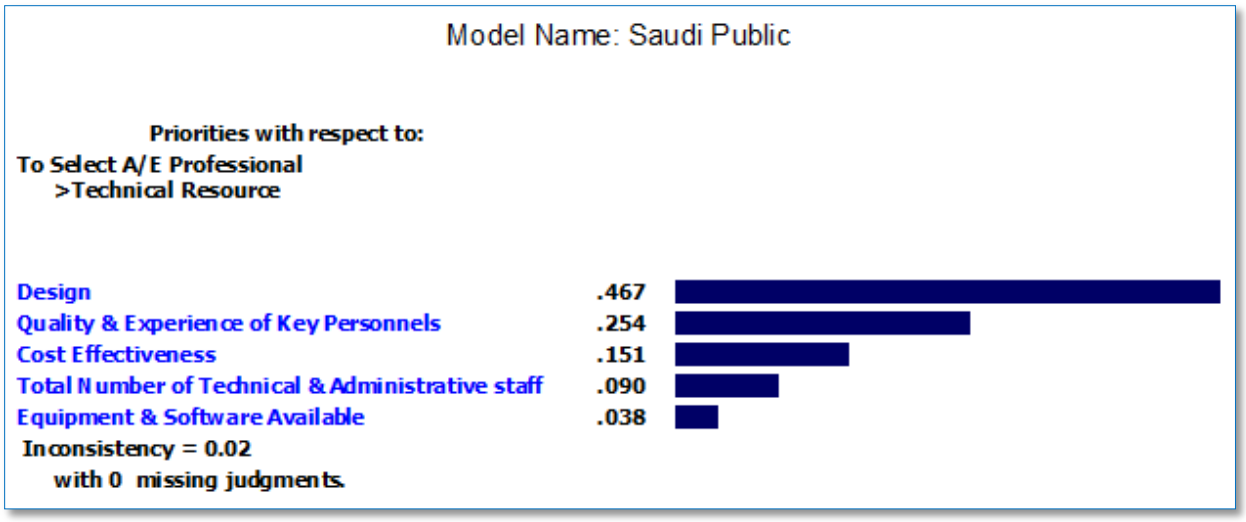


Figure 6-7 Importance of factors in technical resource

Comparing sub-criterias of management capabilities:

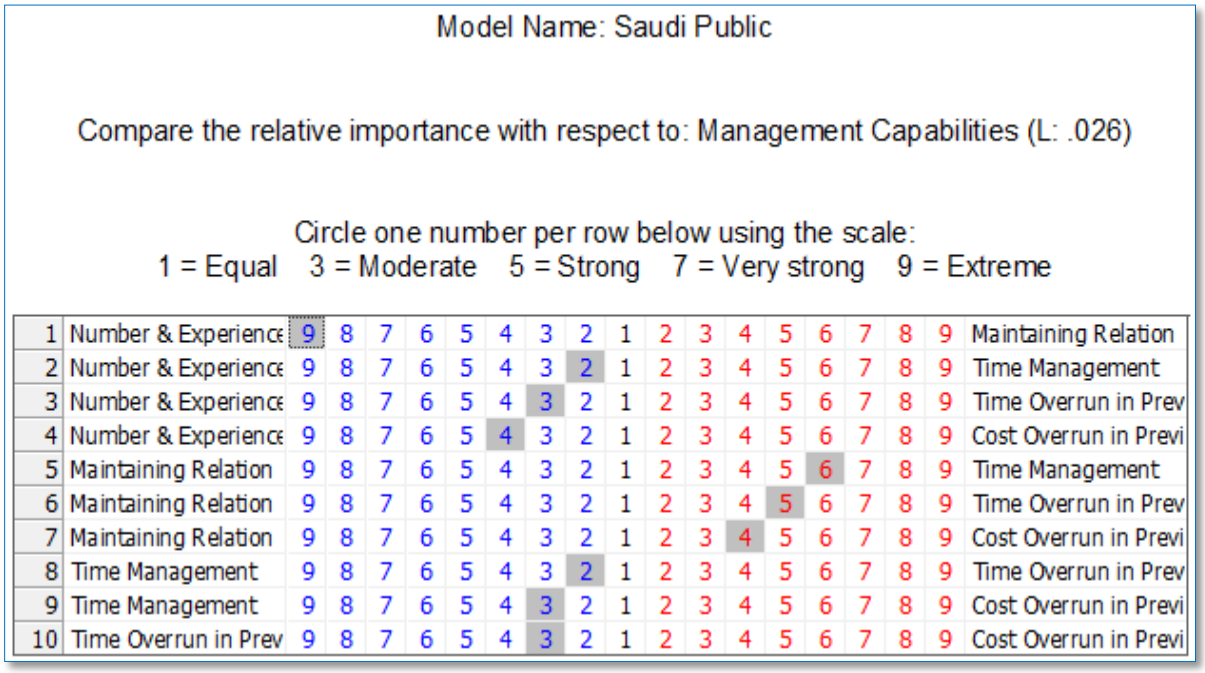


Figure 6-8 Sub criteria's evaluation in management capabilities

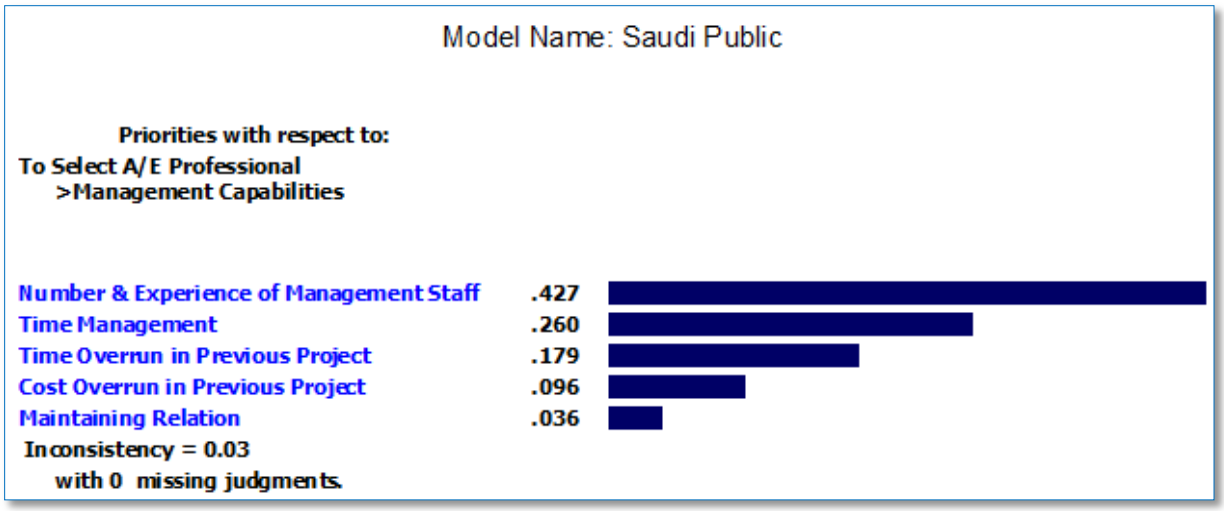


Figure 6-9importance of factors in management capabilities

Comparing sub-criterias of financial stablity:

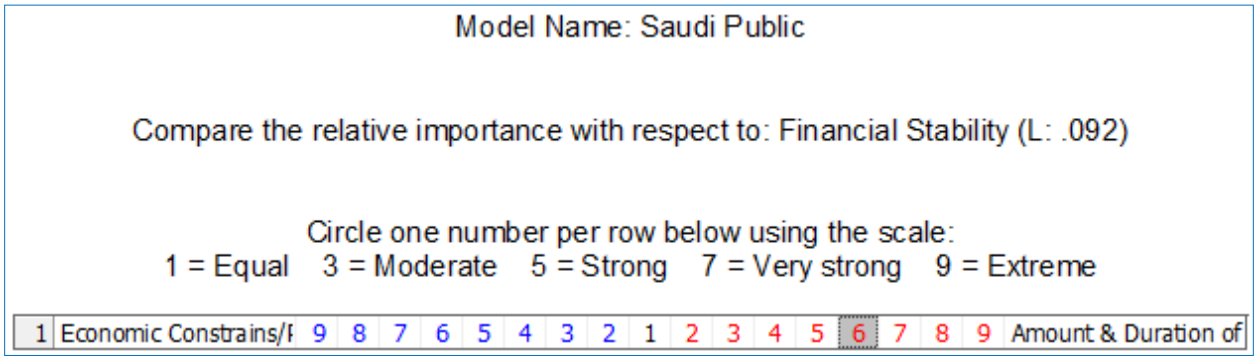


Figure 6-10 Sub criteria's evaluation in financial stability

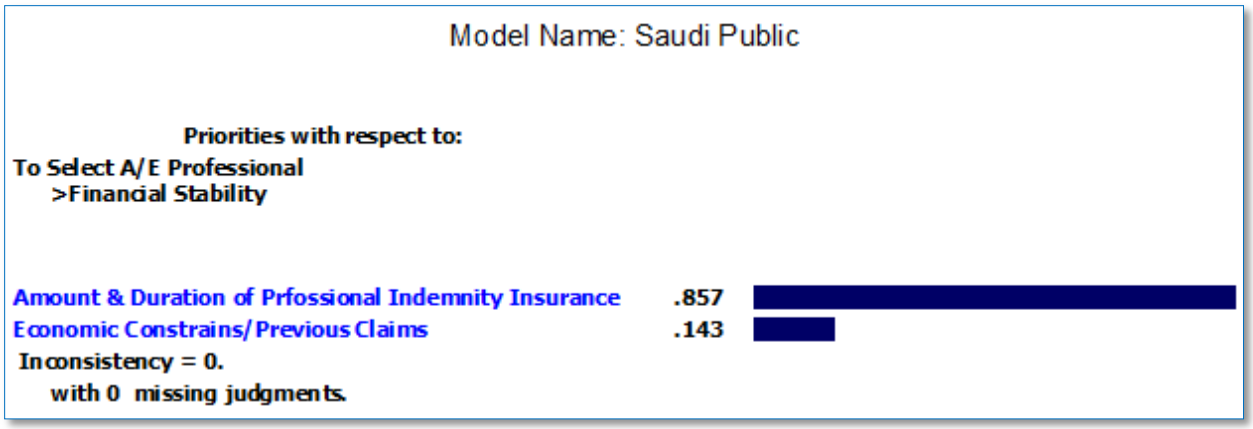


Figure 6-11 importance of factor in financial stability

Comparing sub-criterias of quality assurance:

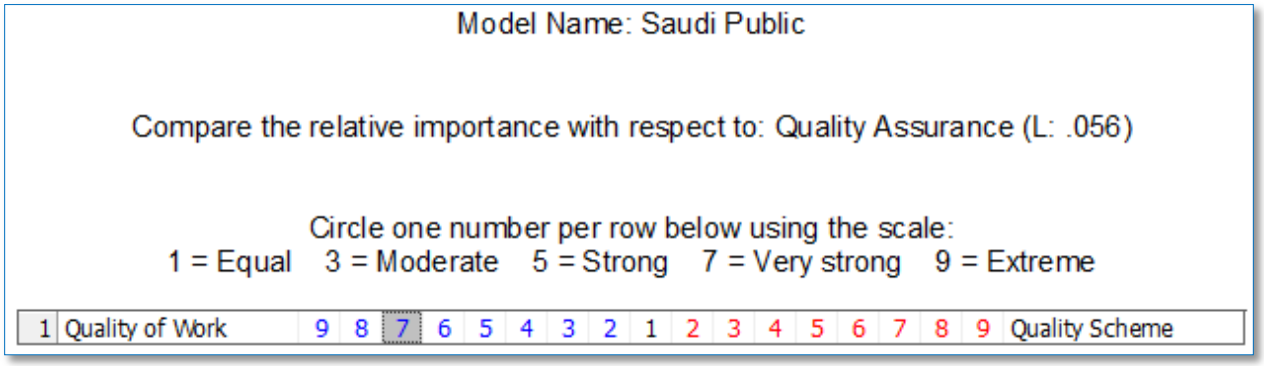


Figure 6-12 Sub criteria's evaluation in quality assurance

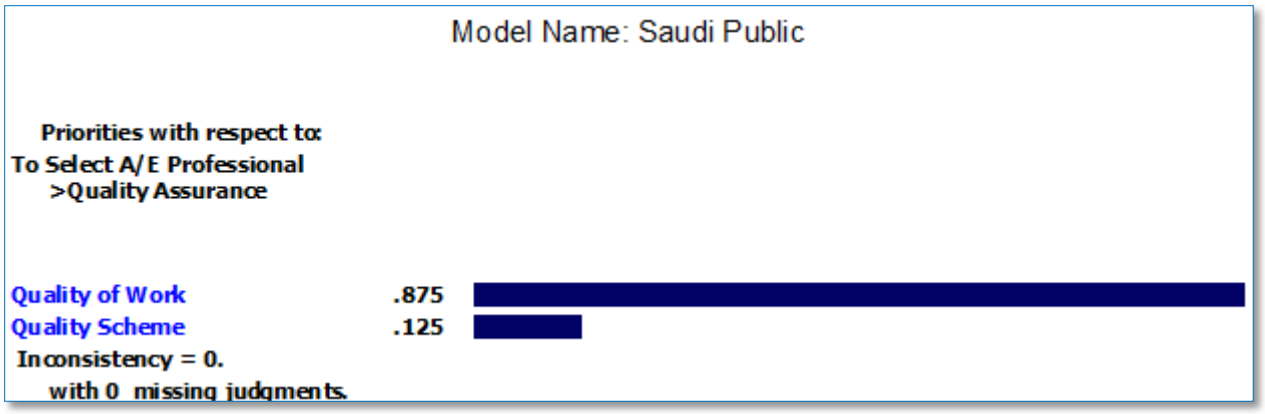


Figure 6-13 Importance of factor in quality assurance

Comparing sub-criterias of innovation capability:

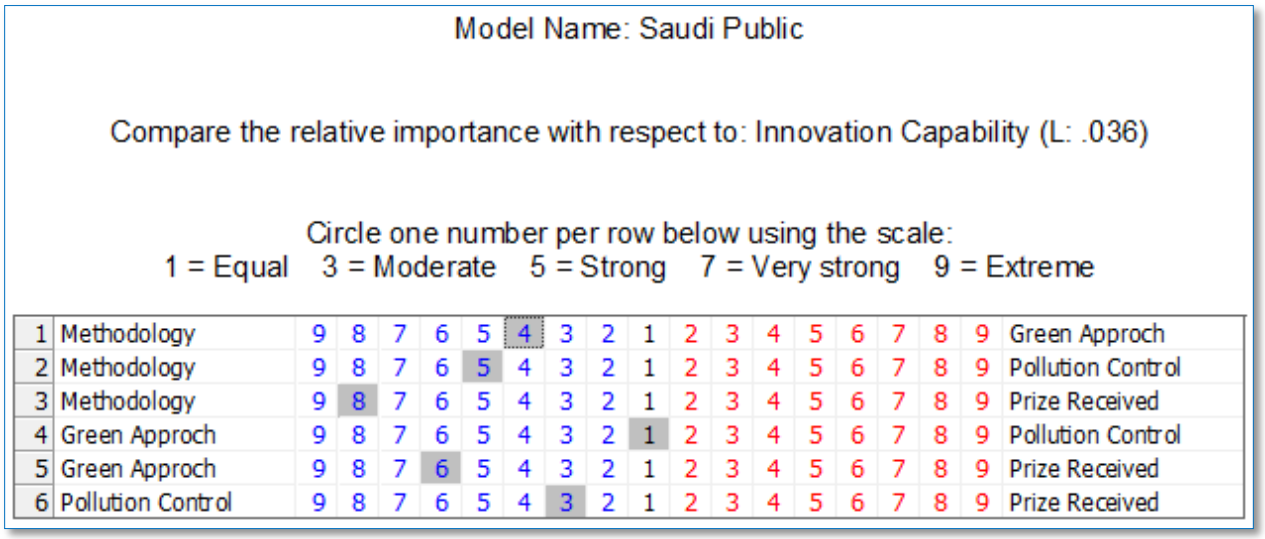


Figure 6-14 Sub criteria's evaluation in innovation capability

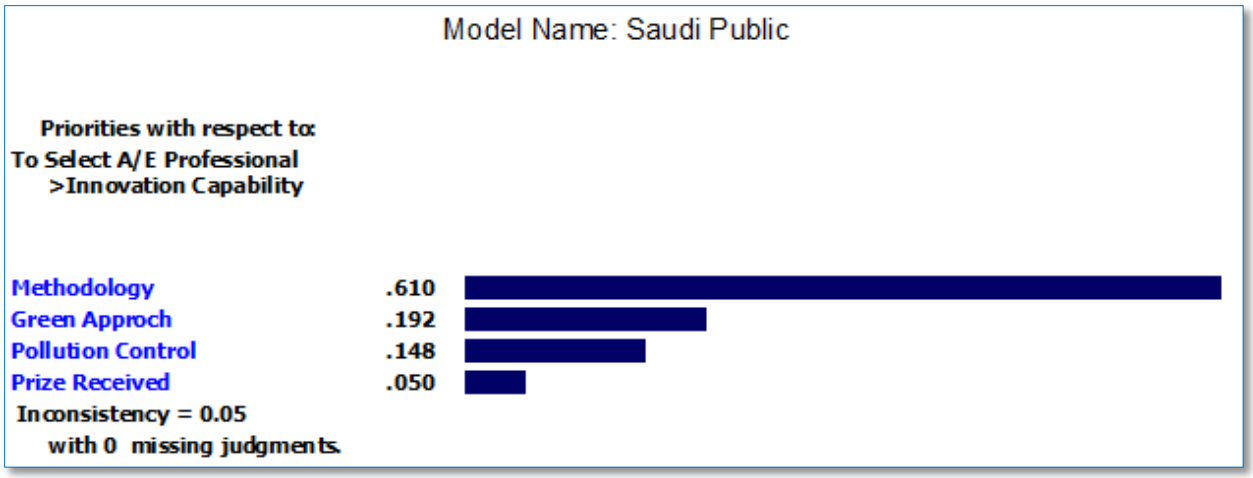


Figure 6-15 importance of factor in innovation capability

Comparing main criterias of Saudi public sector:

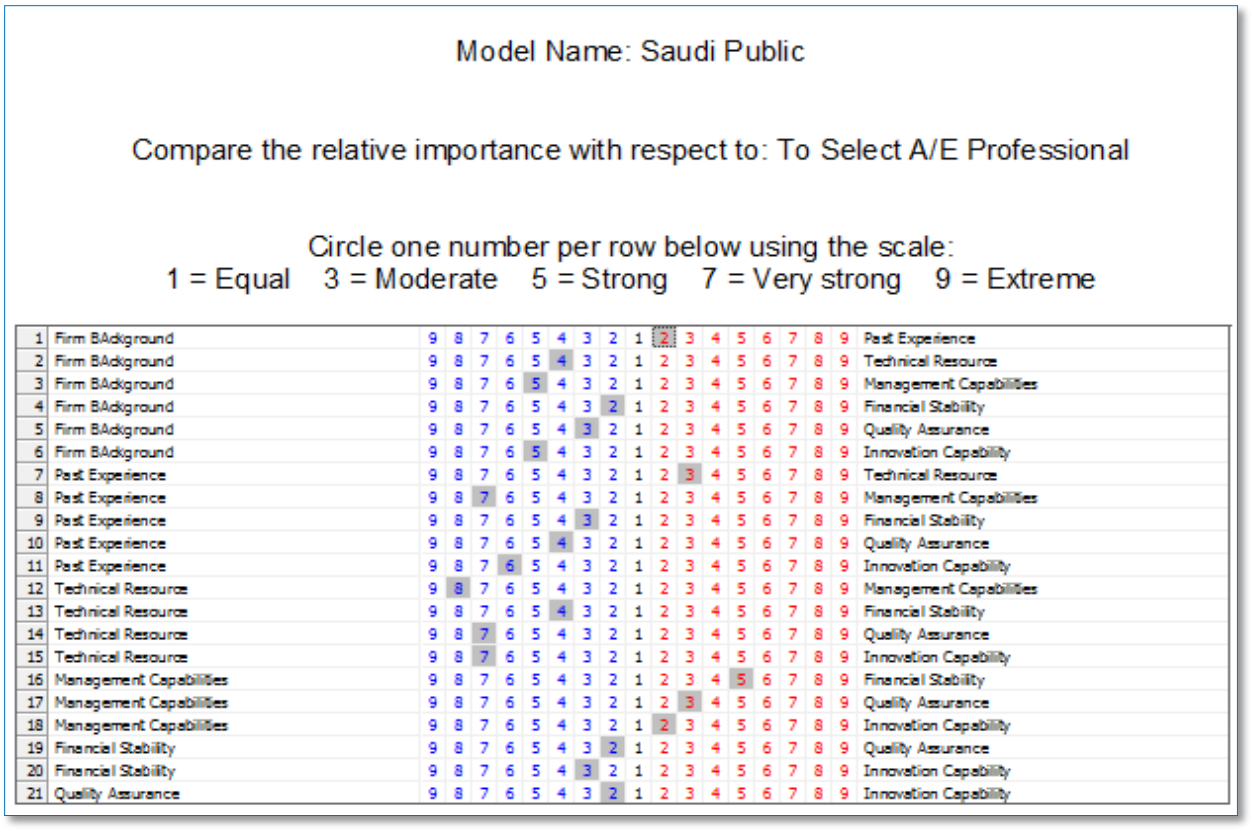


Figure 6-16 Evaluation of major criteria in Saudi public sector

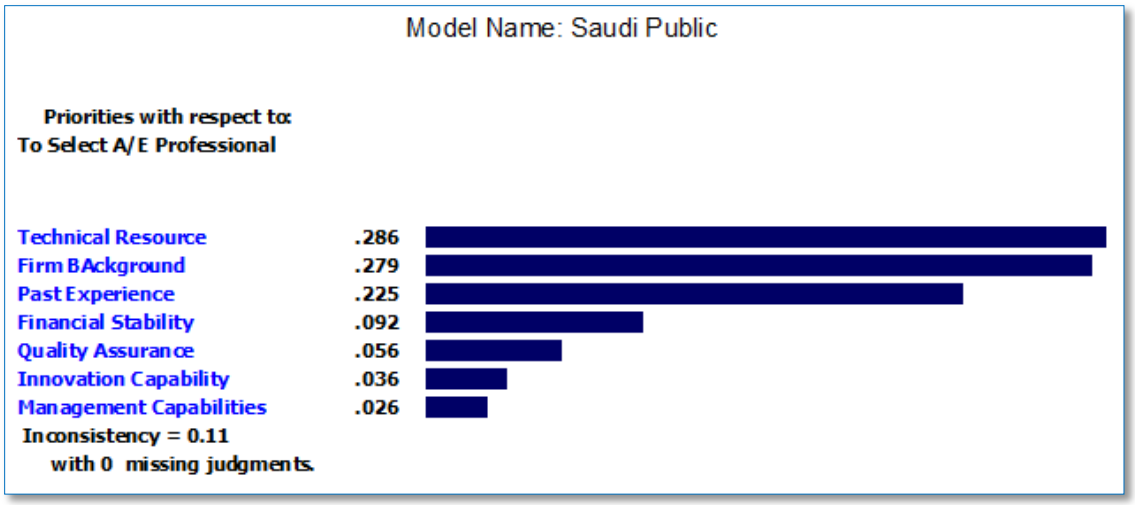


Figure 6-17 Ranking of major criteria's in Saudi public sector

Compairing consultants for a particular sub-criteria:

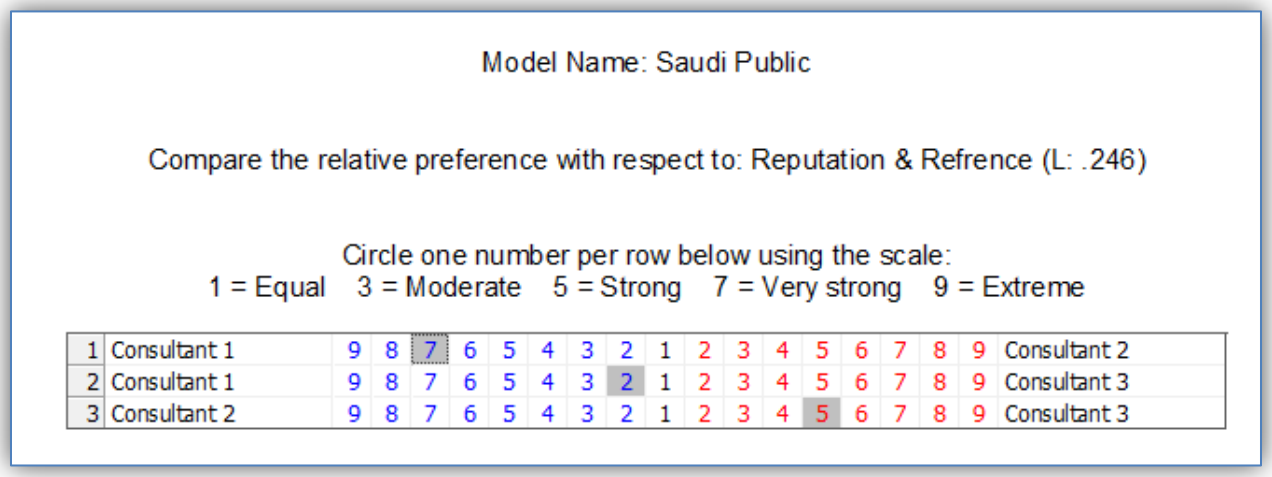


Figure 6-18 Giving scores to consultants

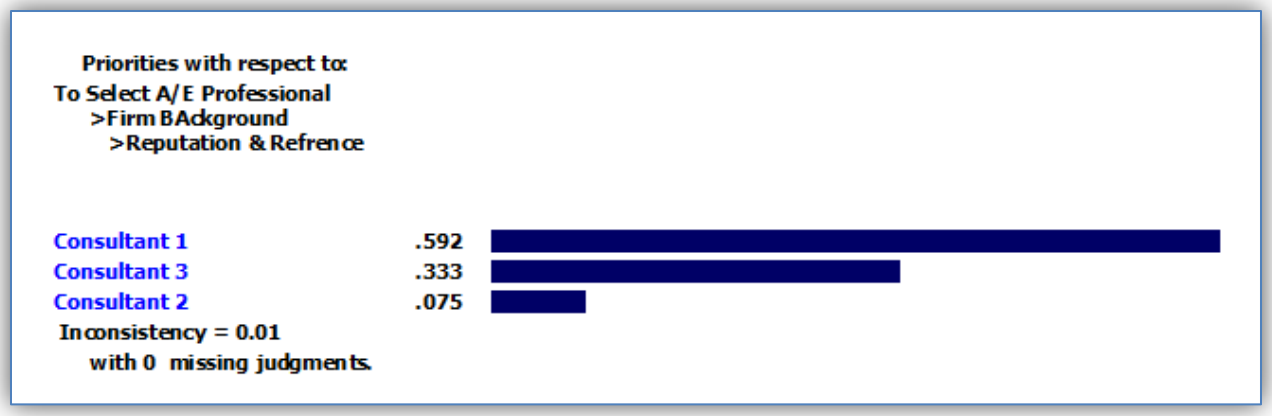


Figure 6-19 Score of consultant for selection

In the same way every consultant will be evaluated for each and every sub-criteria.

Prioroty for each criteria & sub-criteia and Consultant priority:

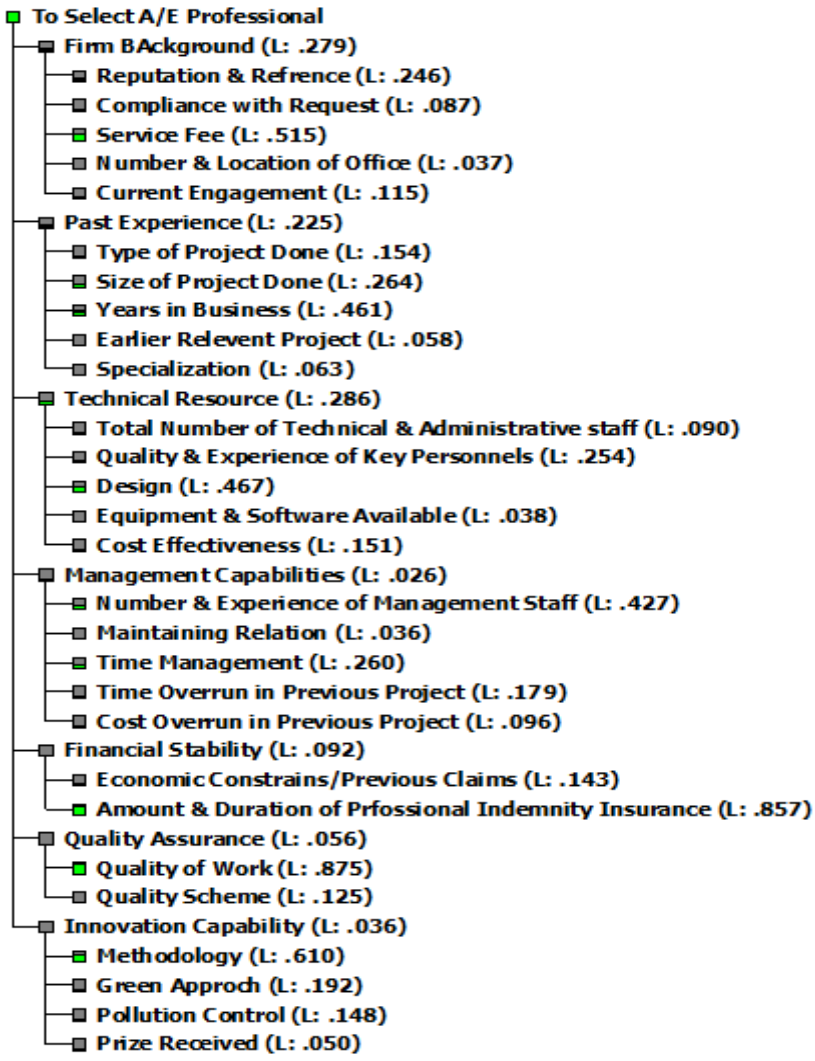


Figure 6-20 Overall priority for Saudi Public Model

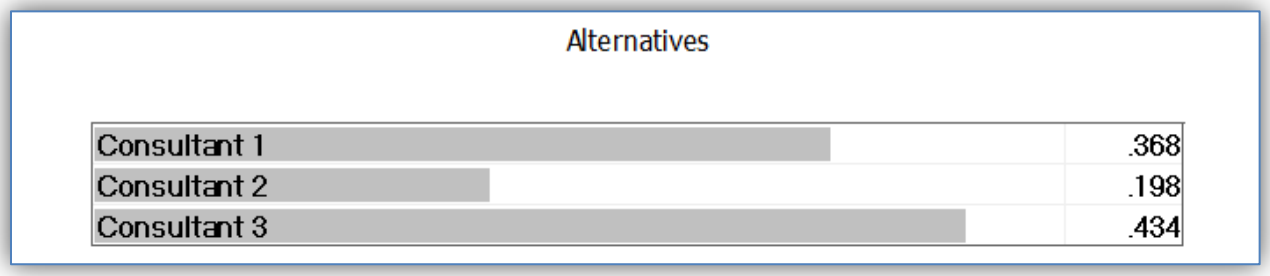


Figure 6-21 Consultant priority for Saudi Public Model

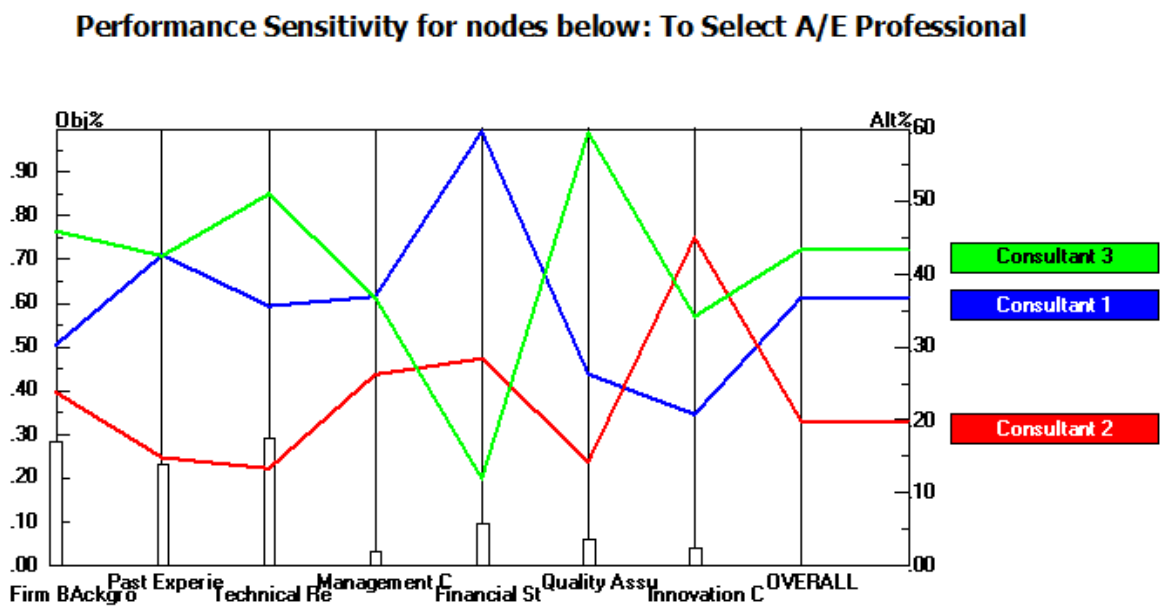


Figure 6-22 Performance sensitivity graph

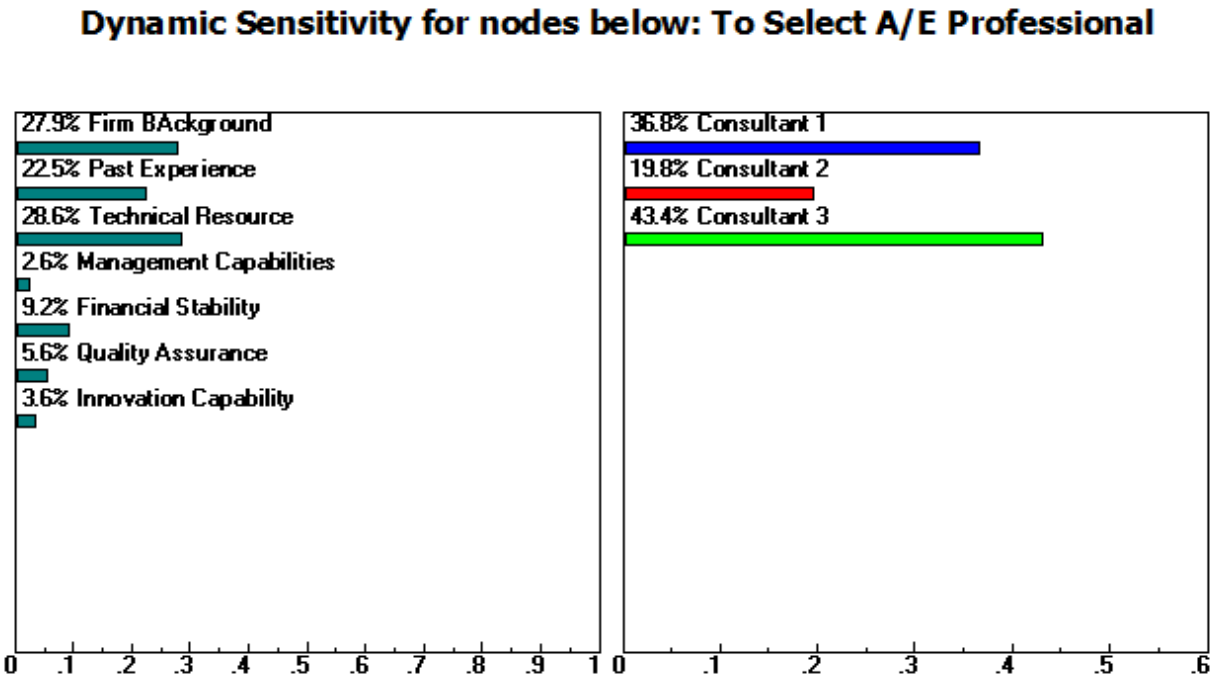


Figure 6-23 Dynamic sensitivity chart

Comparing consultants:

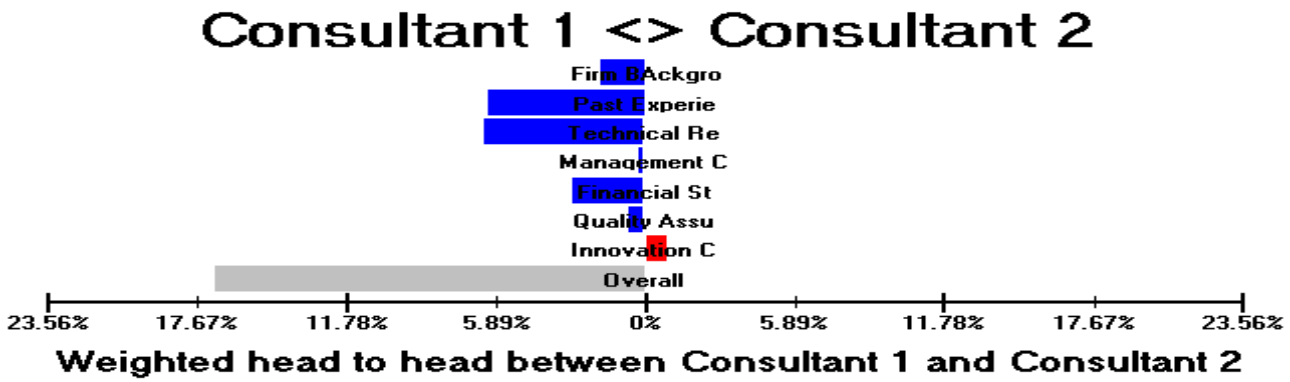


Figure 6-24 Comparing consultant 1 & 2

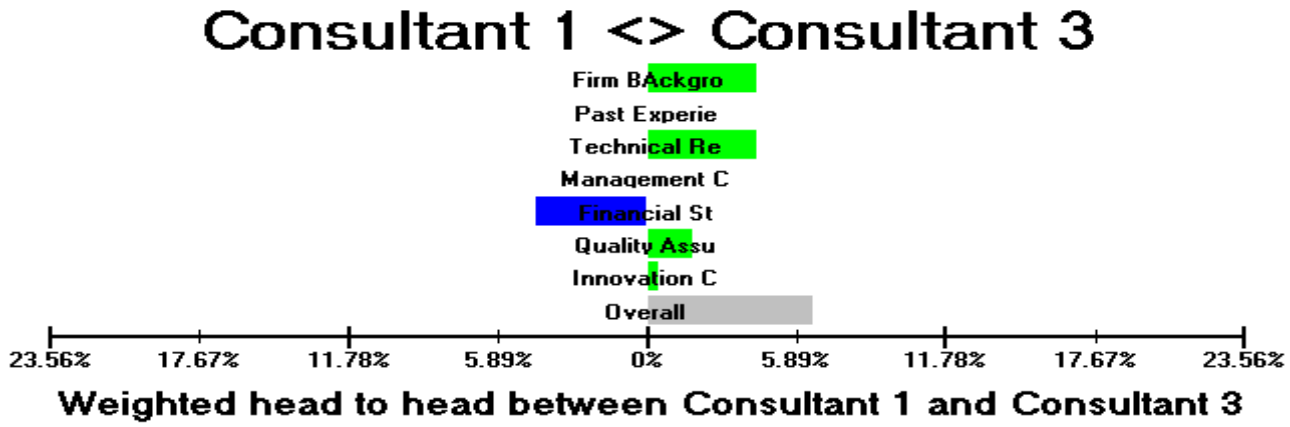


Figure 6-25 Comparing consultant 1 & 3

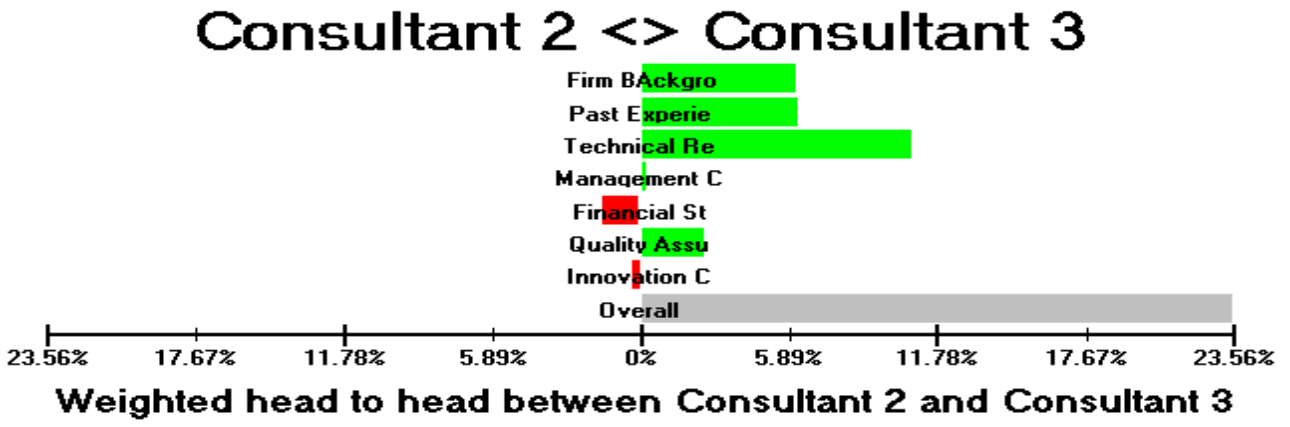


Figure 6-26 Comparing consultant 2 & 3

6.5.2 Saudi Private Sector

Overall priority for criteria, sub-criteria and consultants:

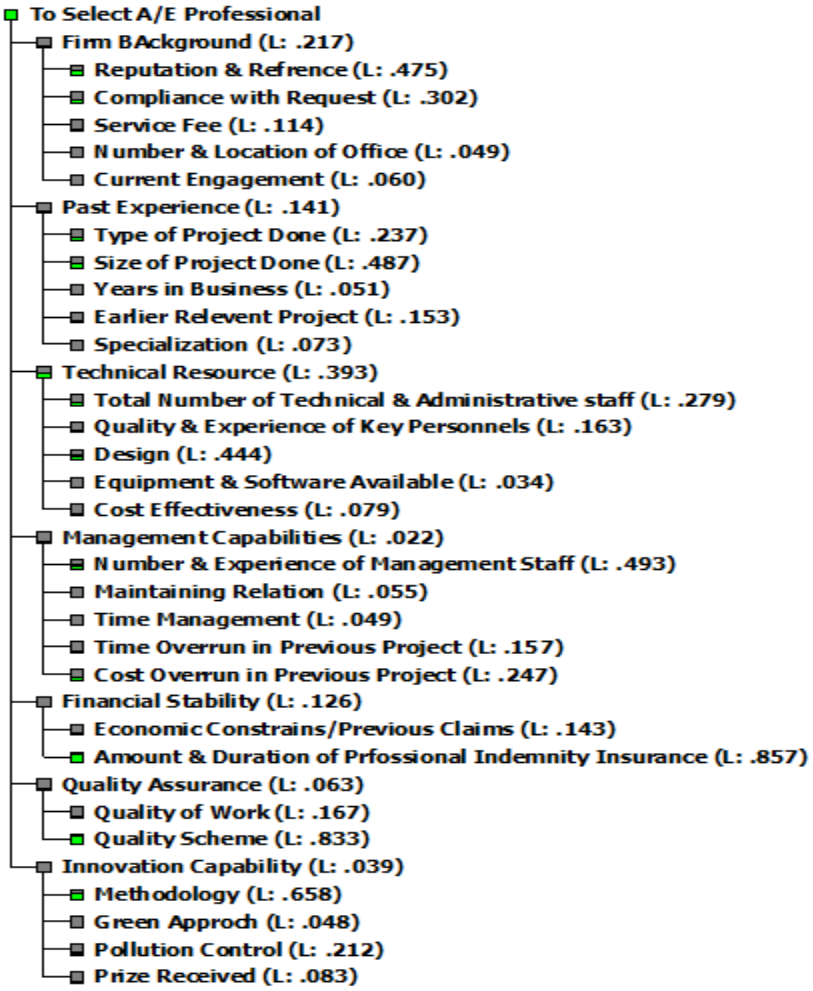


Figure 6-27 Overall priority for Saudi Private Model

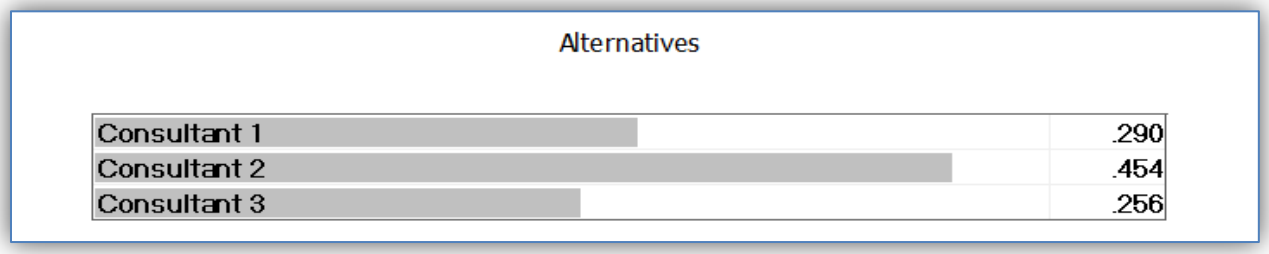


Figure 6-28 Priority of consultant for Saudi Private Model

Breakdown of relative importance of criteria and sub-criteria:

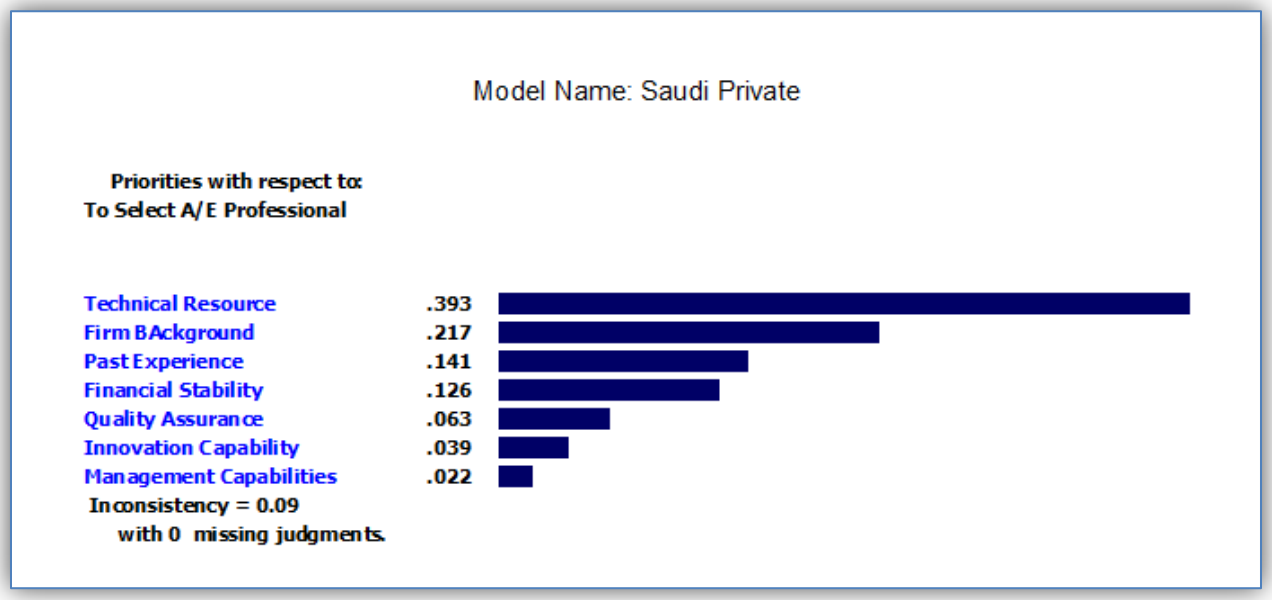


Figure 6-29 Importance of major criteria's in Saudi Private sector

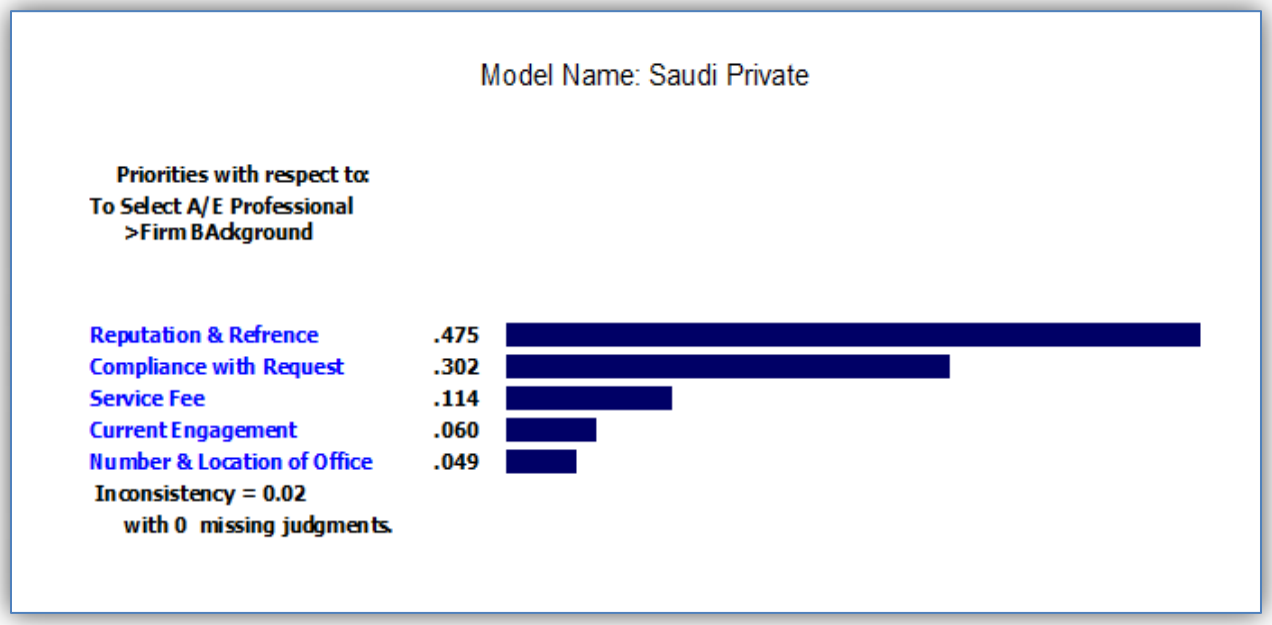


Figure 6-30 Importance of factors in firm background

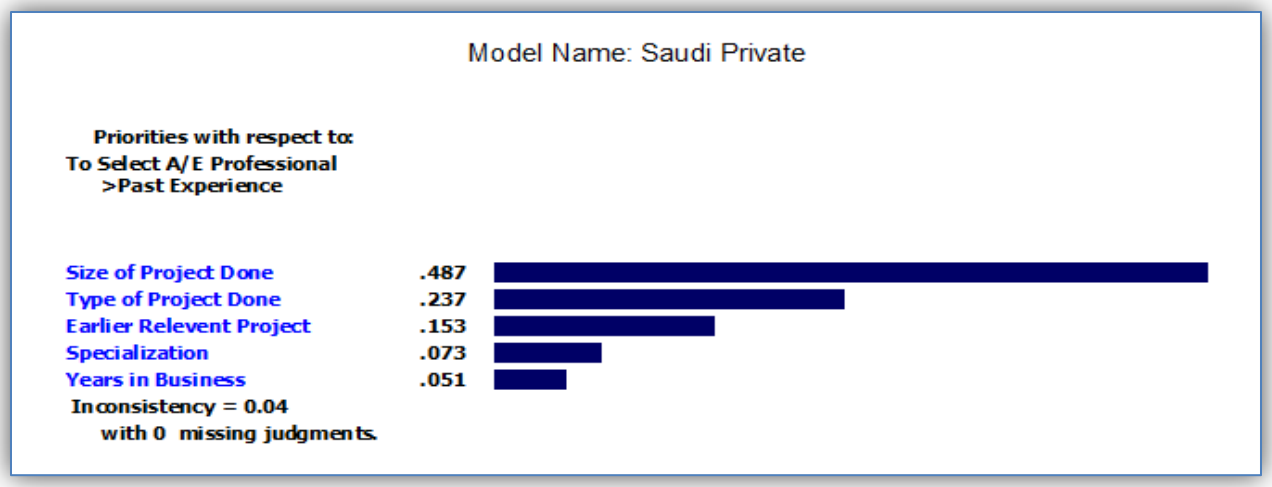


Figure 6-31 Importance of factors in past experience

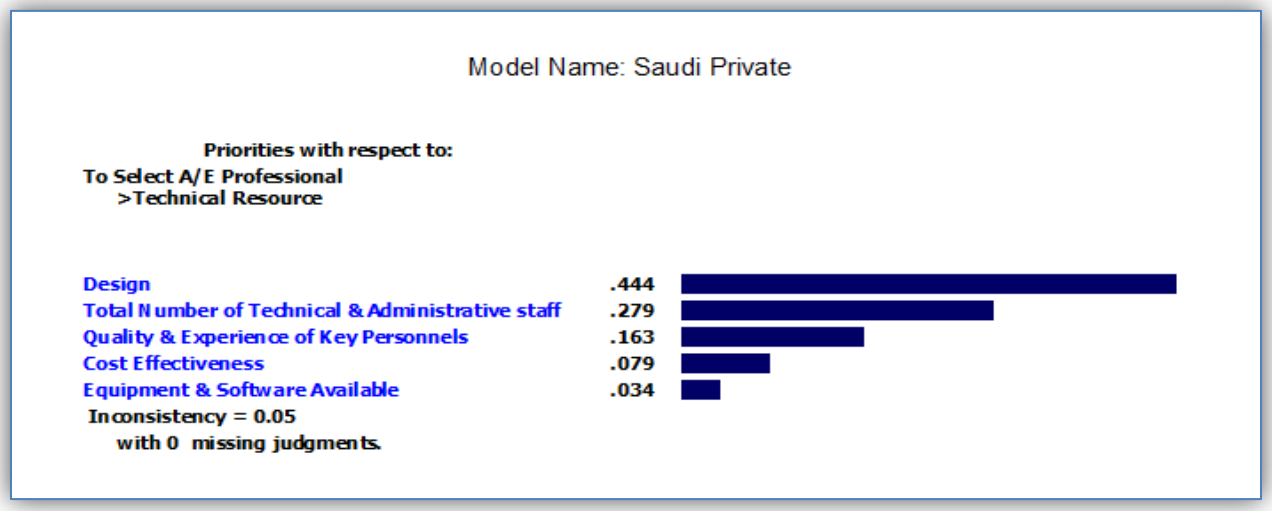


Figure 6-32 Importance of factors in technical resource

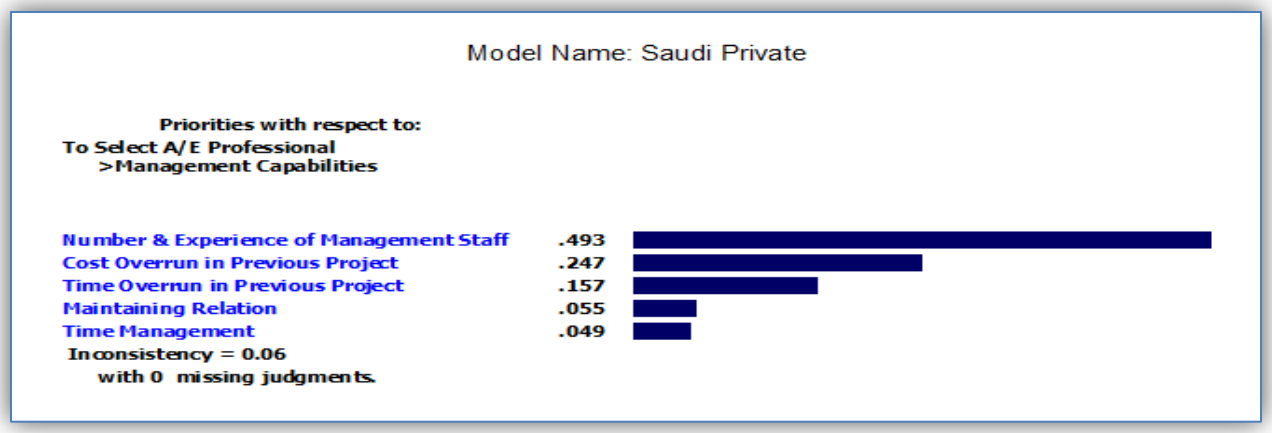


Figure 6-33 Importance of factors in management capabilities

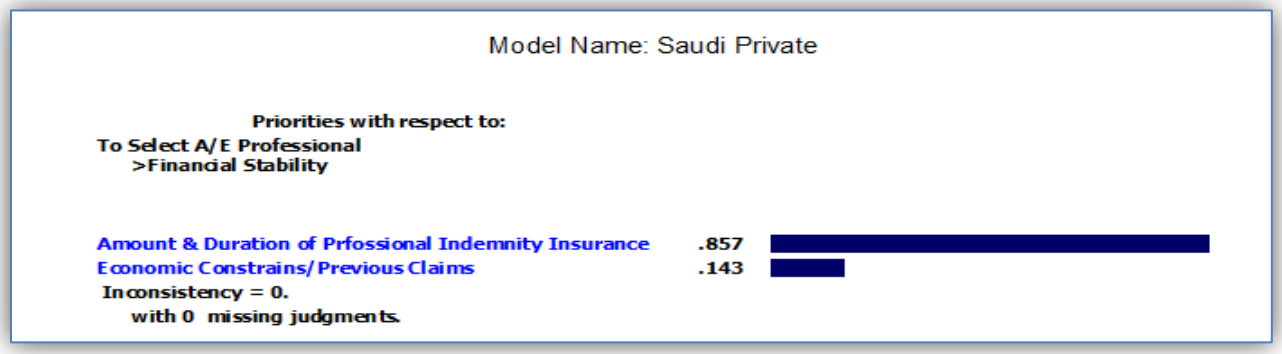


Figure 6-34 Importance of factors in financial stability

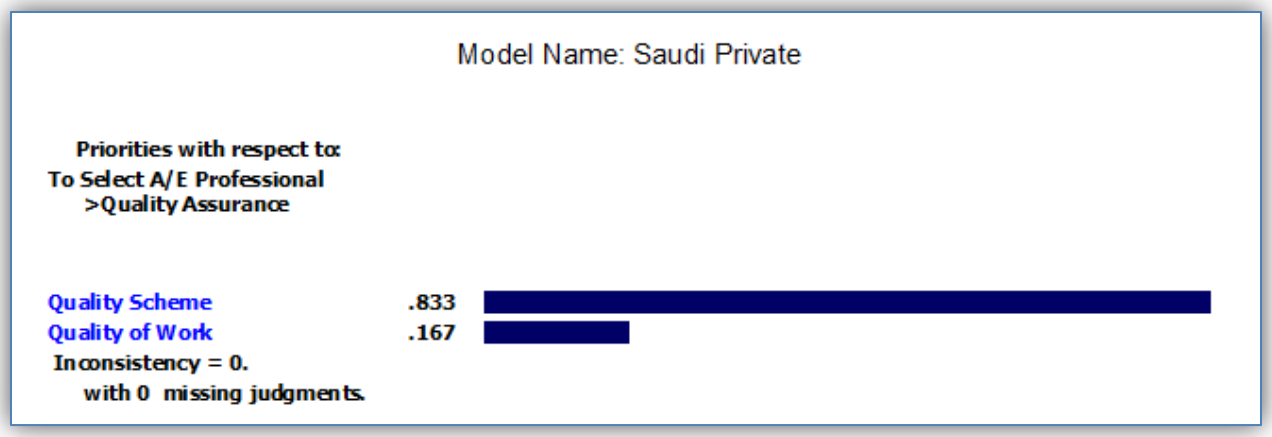


Figure 6-35 Importance of factors in quality assurance

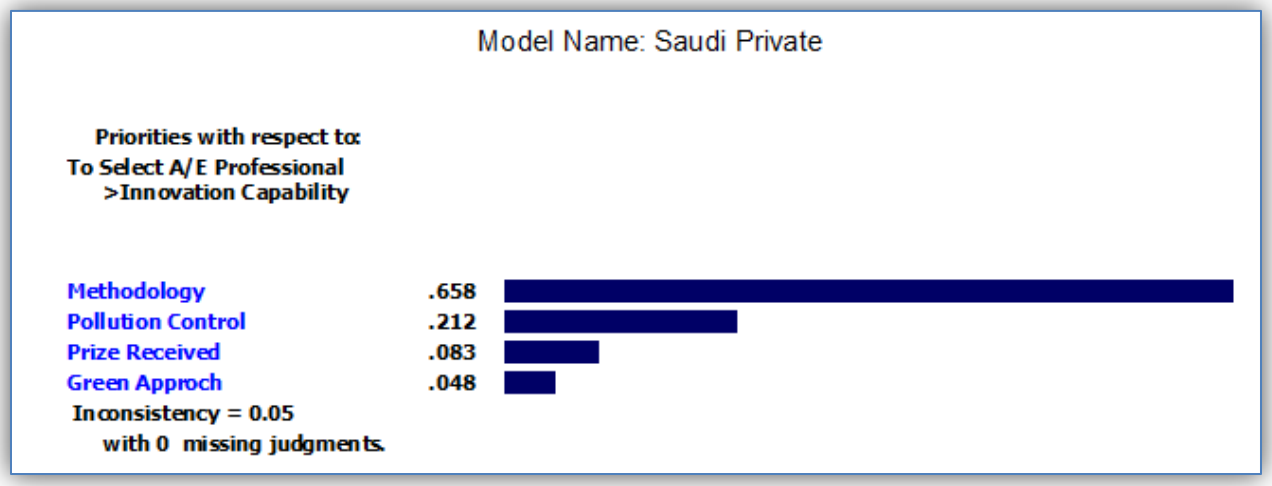


Figure 6-36 Importance of factors in innovation capability

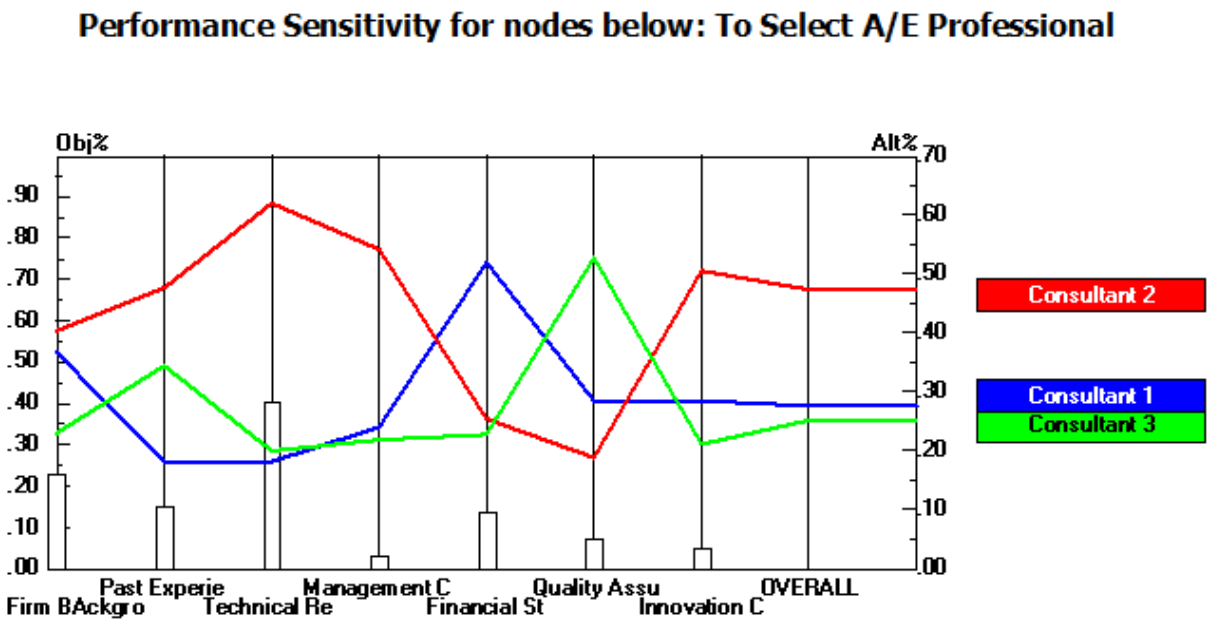


Figure 6-37 Performance sensitivity graph

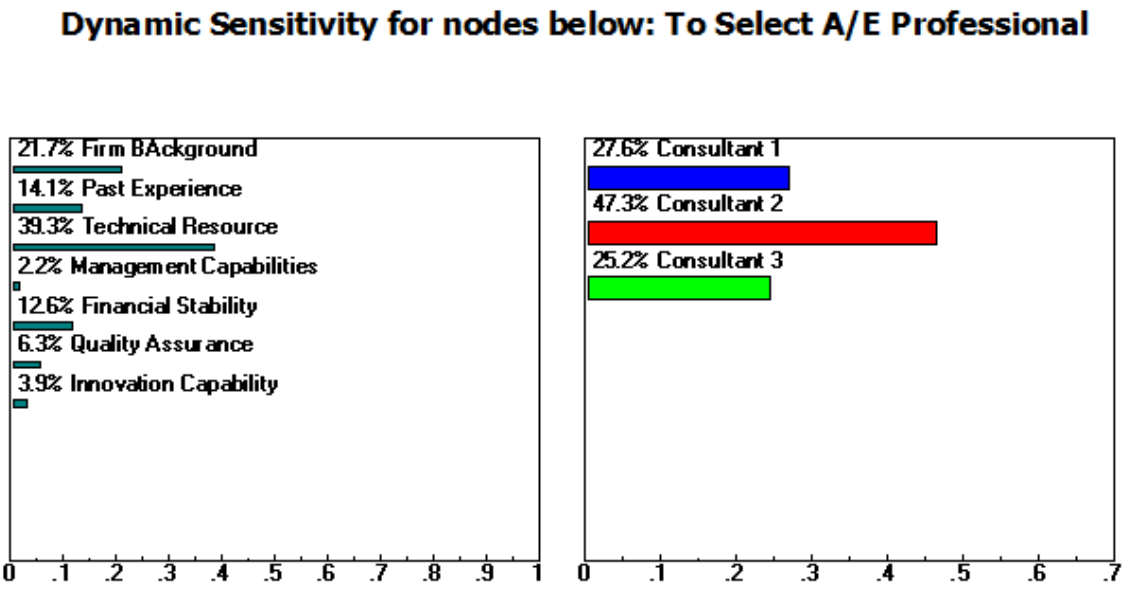


Figure 6-38 Dynamic sensitivity graph

Comparing consultants:

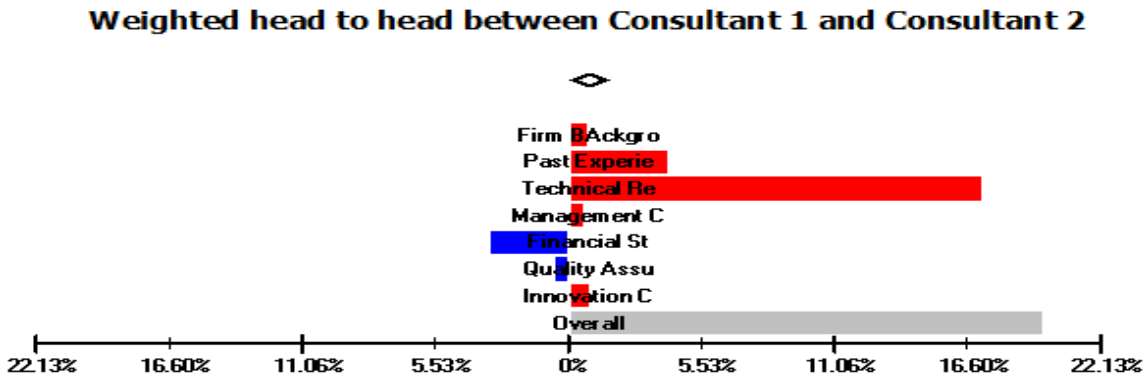


Figure 6-39 Comparing consultant 1 & 2

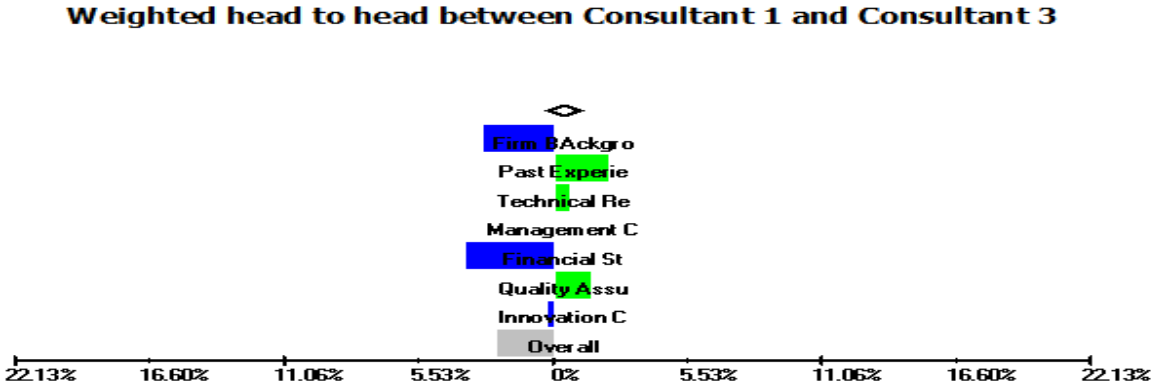


Figure 6-40 Comparing consultant 1 & 3

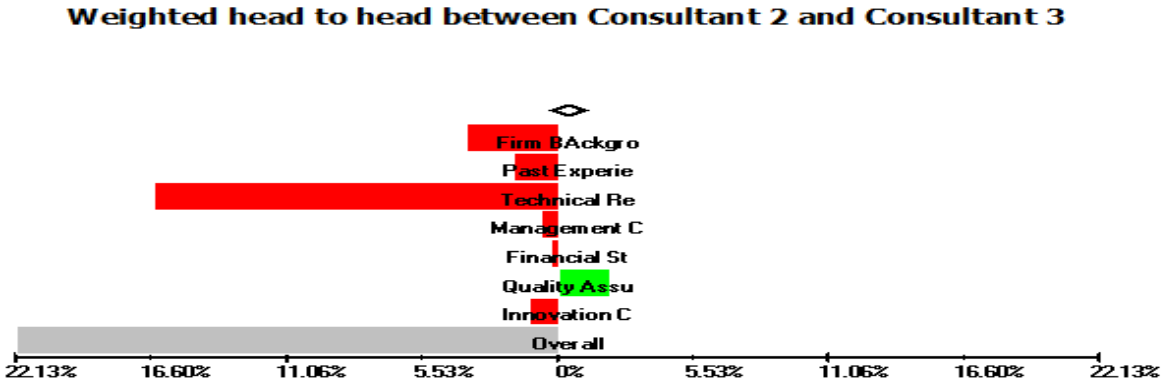


Figure 6-41 Comparing consultant 2 & 3

6.5.3 India Public

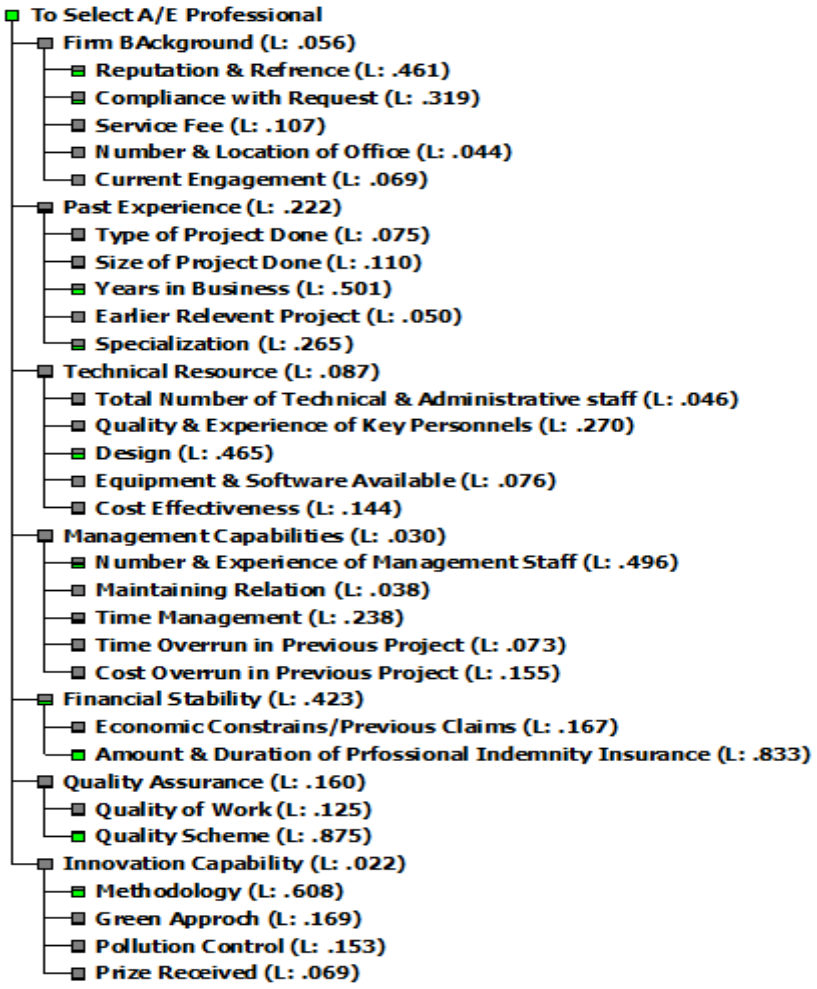


Figure 6-42 Overall priority for India Public Model

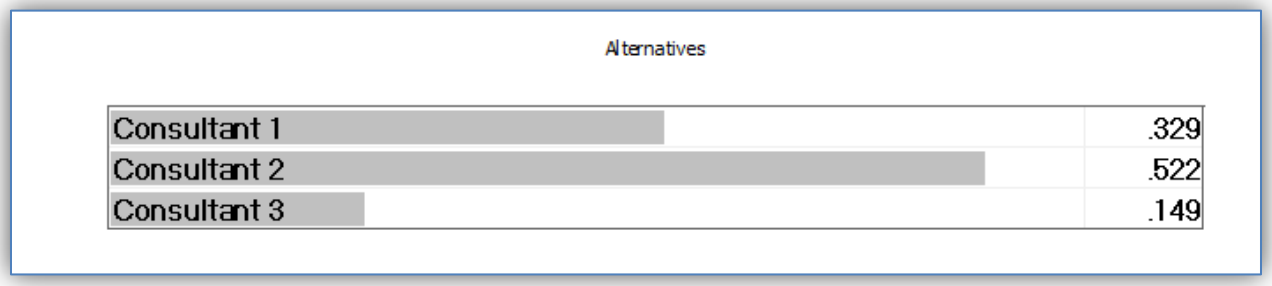


Figure 6-43 Consultant priority for India Public Model

Breakdown of relative importance of criteria and sub-criteria:

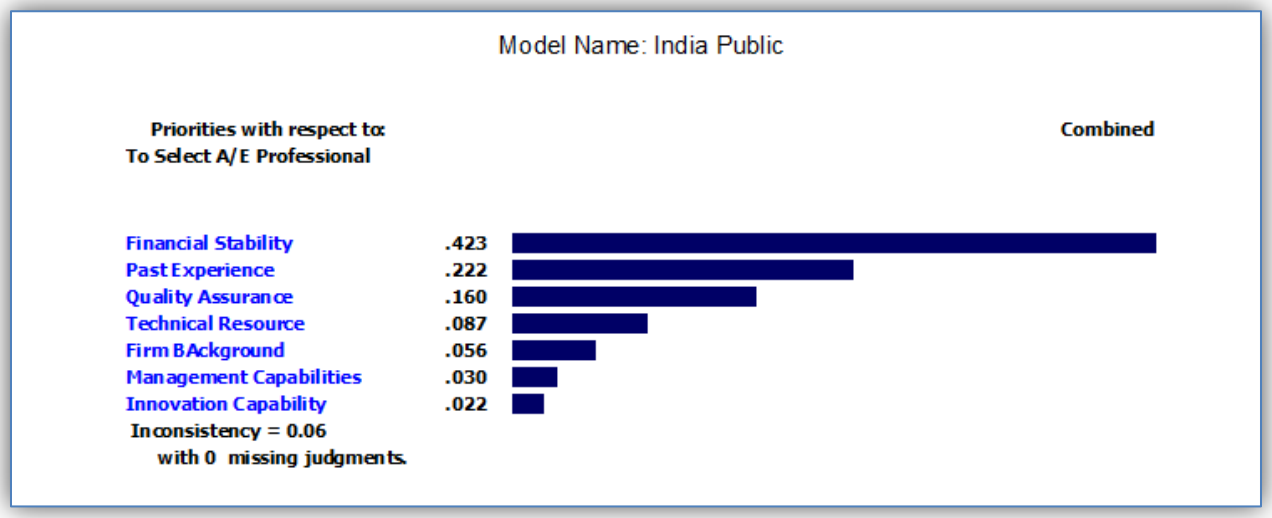


Figure 6-44 Importance of major criteria's in Indian public sector model

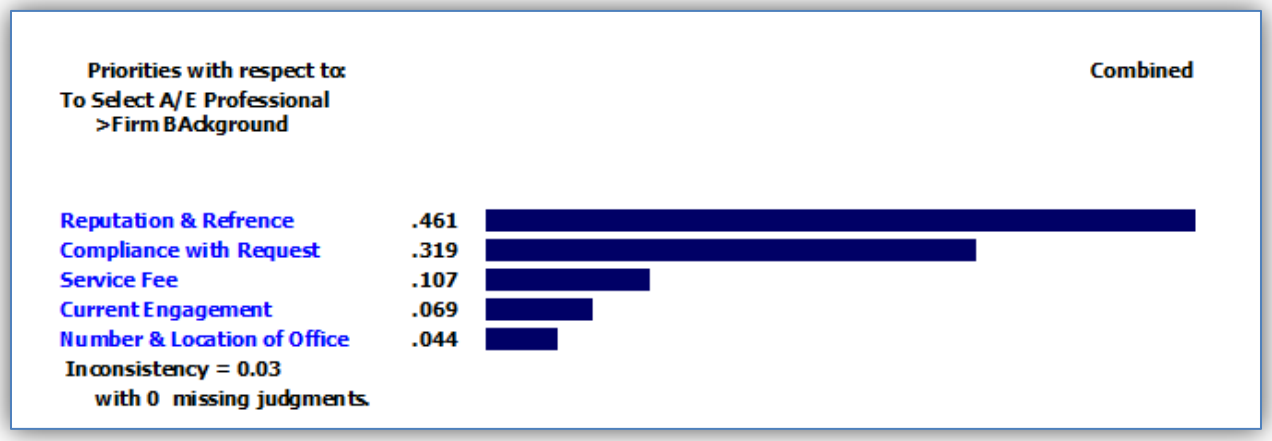


Figure 6-45 Importance of factors in firm background

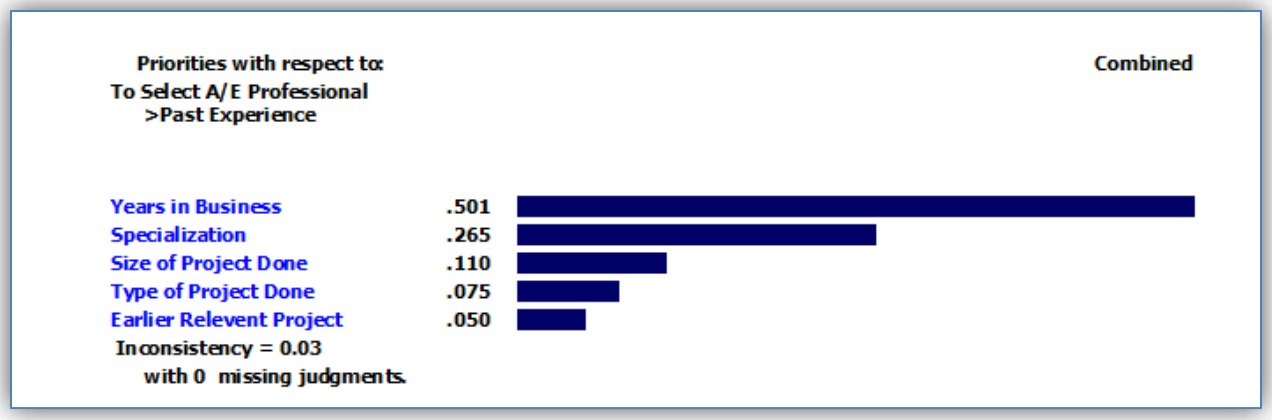


Figure 6-46 Importance of factors in past experience

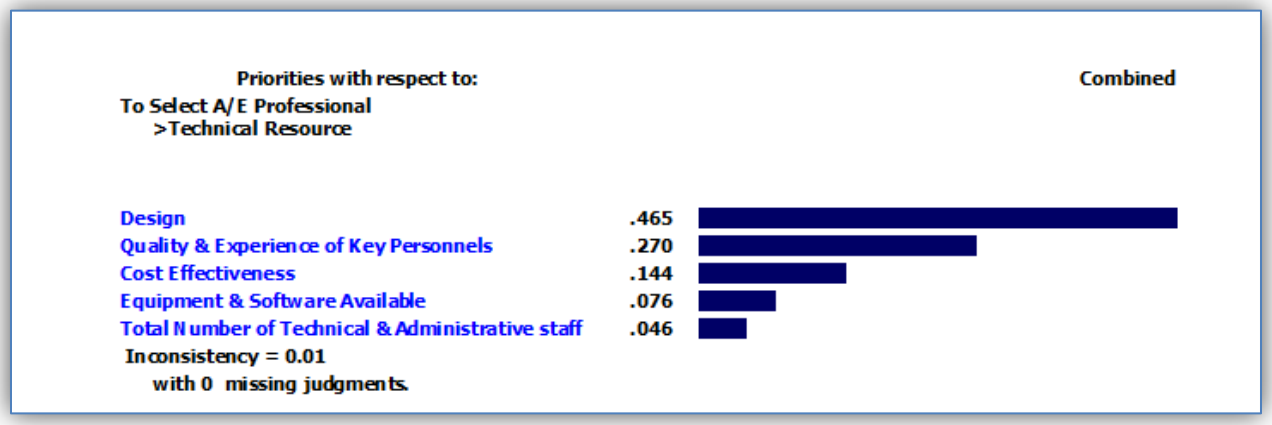


Figure 6-47 Importance of factors in technical resource

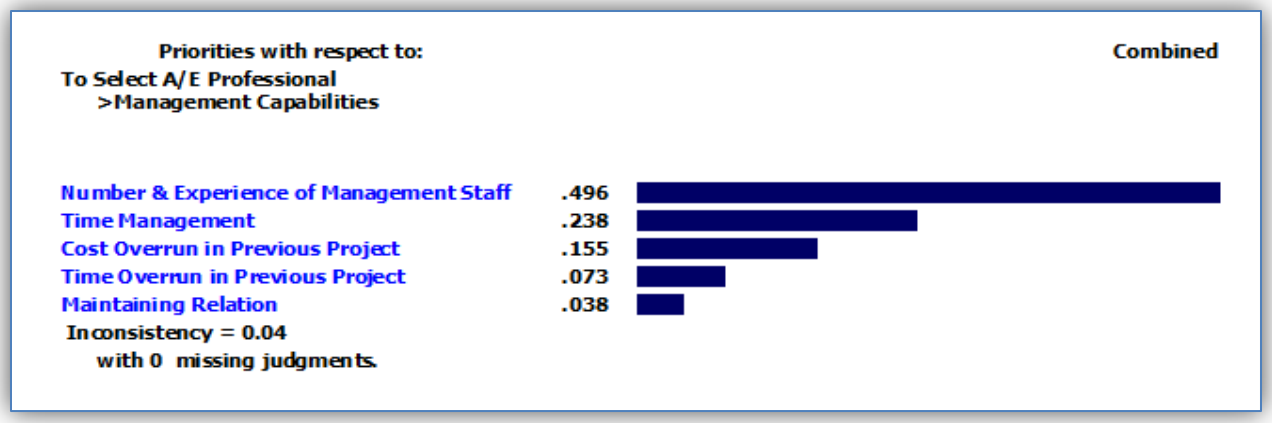


Figure 6-48 Importance of factors in management capabilities

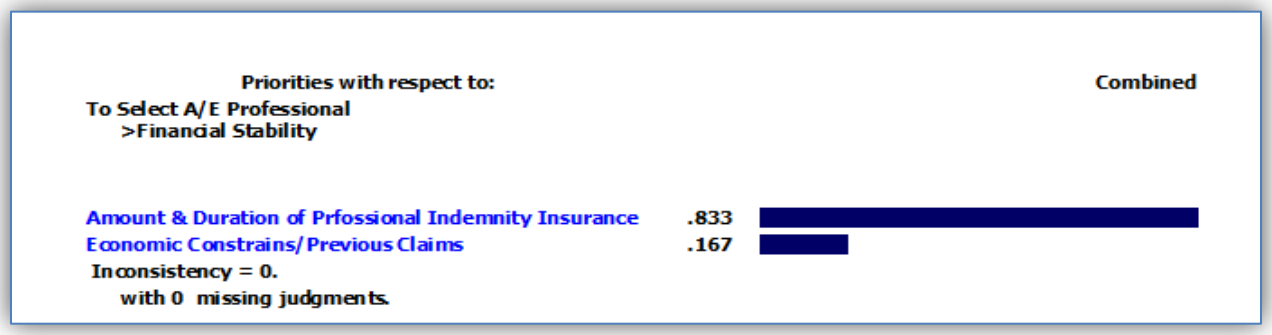


Figure 6-49 Importance of factors in financial stability

Figure 6-50 Importance of factors in quality assurance

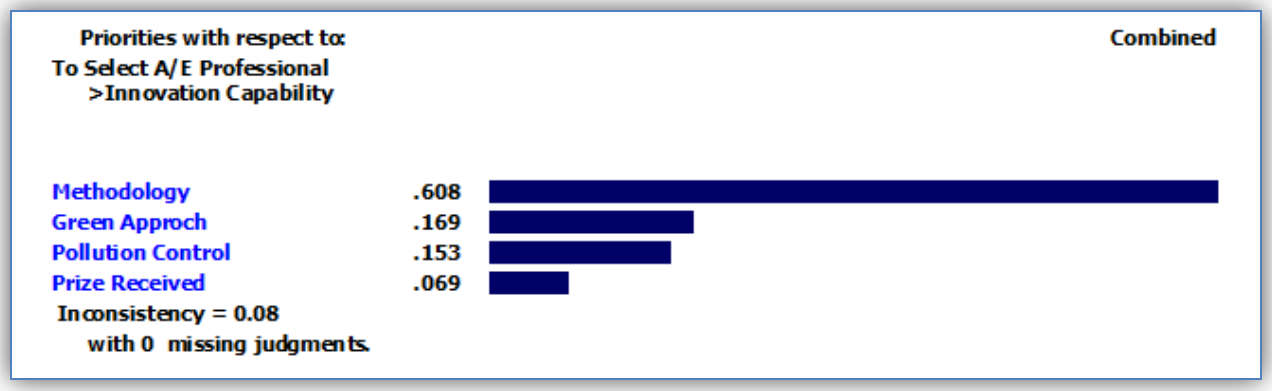


Figure 6-51 Importance of factors in innovation capability

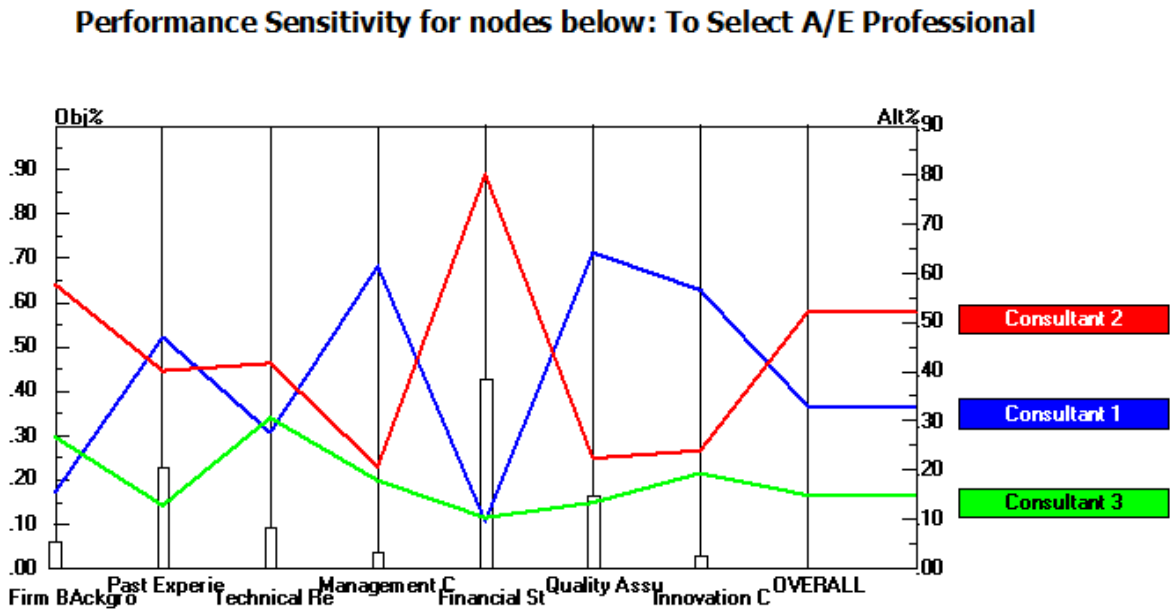


Figure 6-52 Performance sensitivity graph

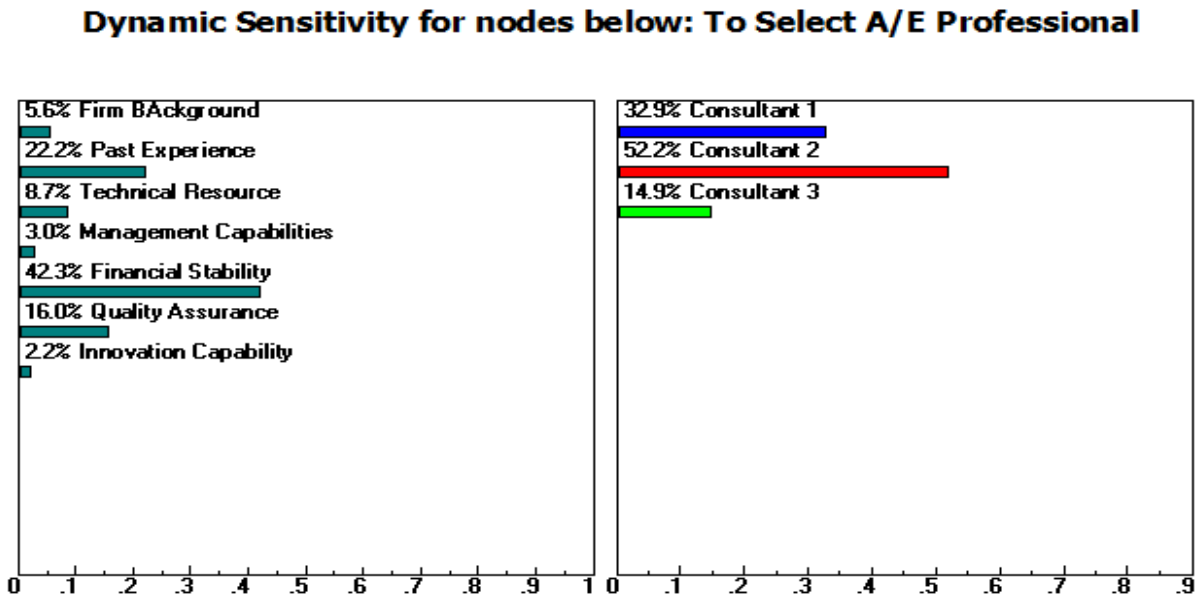


Figure 6-53 Dynamic sensitivity graph

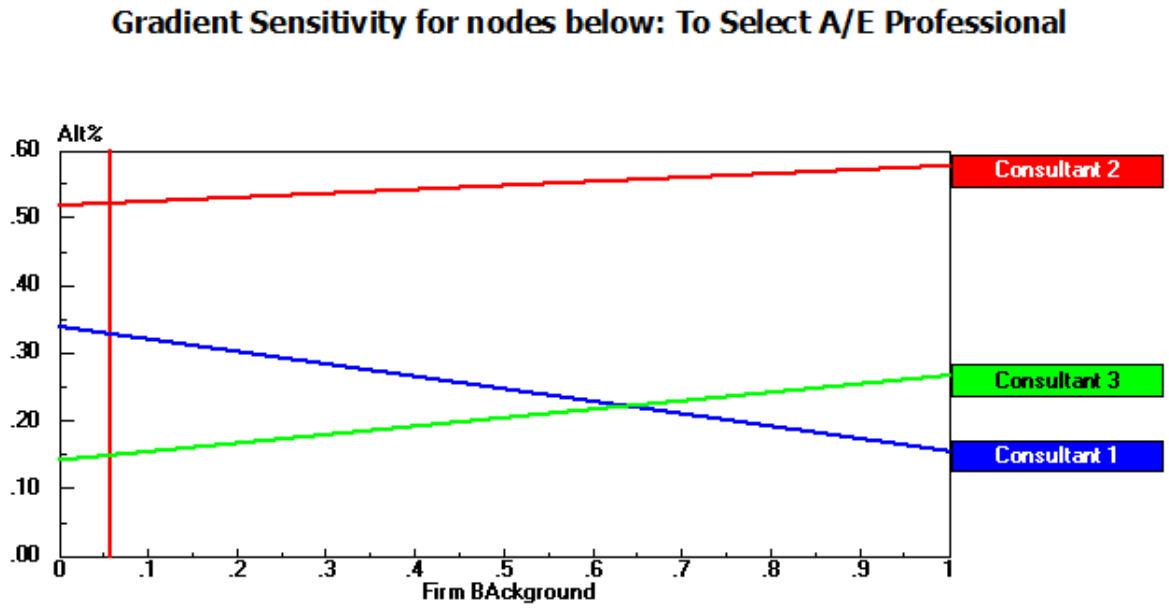


Figure 6-54 Gradient sensitivity

Comparing consultants:

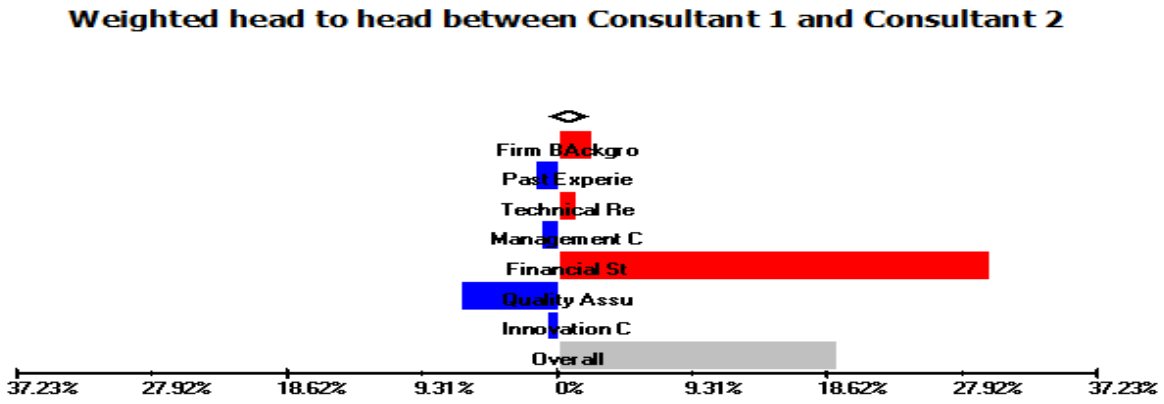


Figure 6-55 Comparing consultant 1 & 2

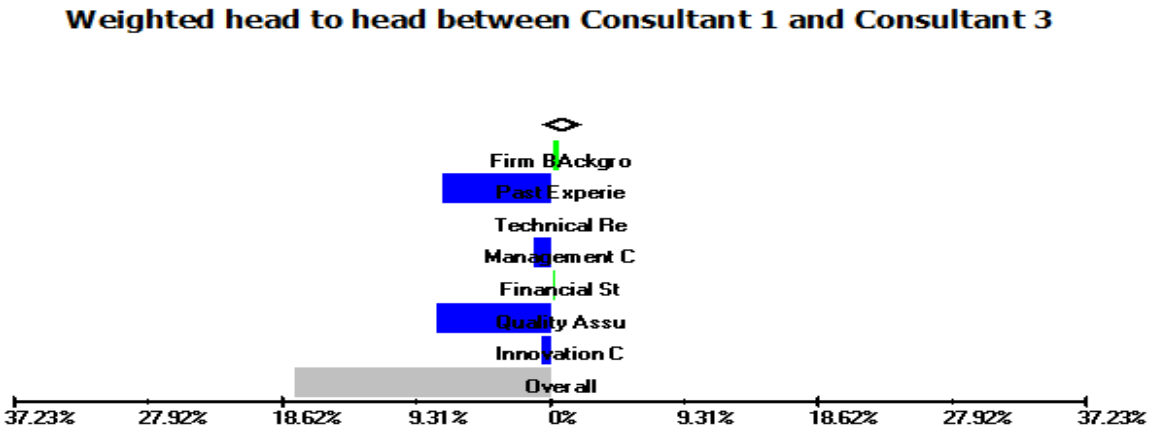


Figure 6-56 Comparing consultant 1 & 3

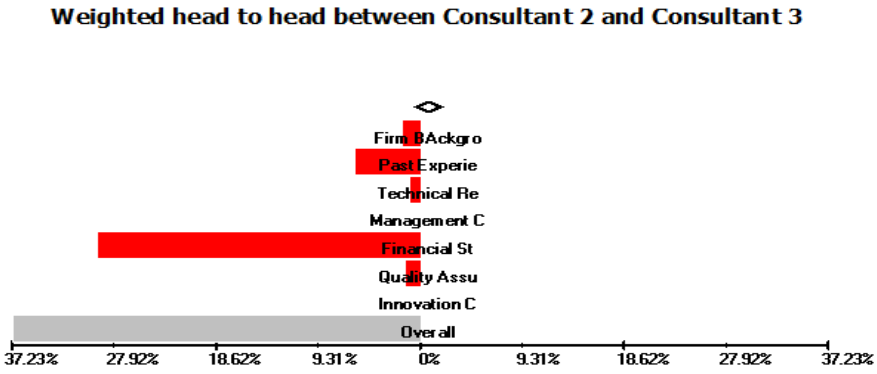


Figure 6-57 Comparing consultant 2 & 3

6.5.4 India Private

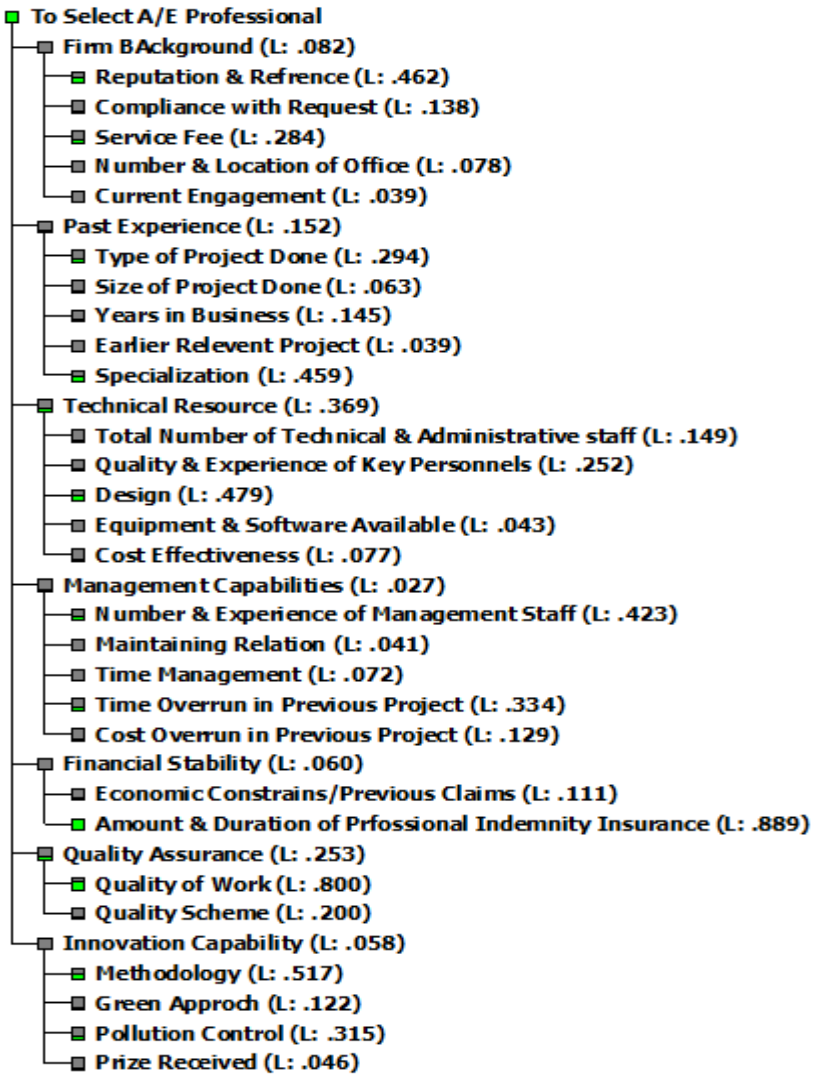


Figure 6-58 Overall priority for India Private Model

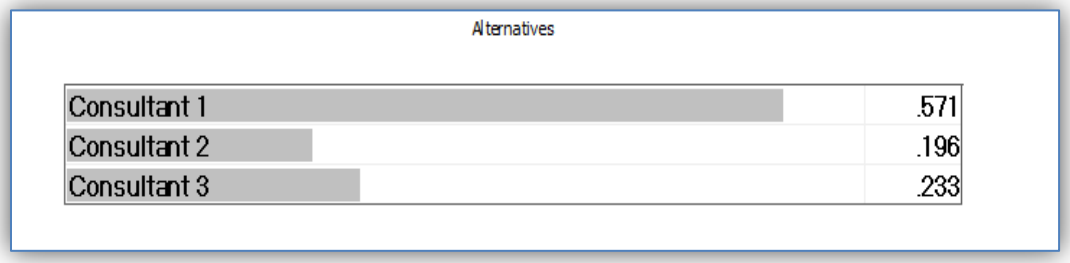


Figure 6-59 Consultant priority for India Private Model

Breakdown of relative importance of criteria and sub-criteria:

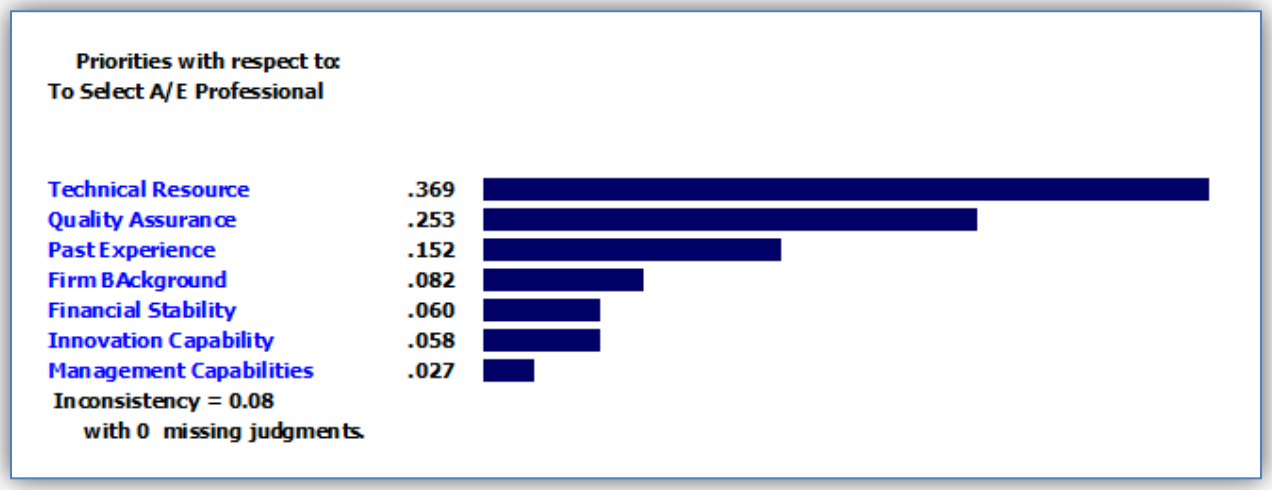


Figure 6-60 Importance of major factor for India private sector model

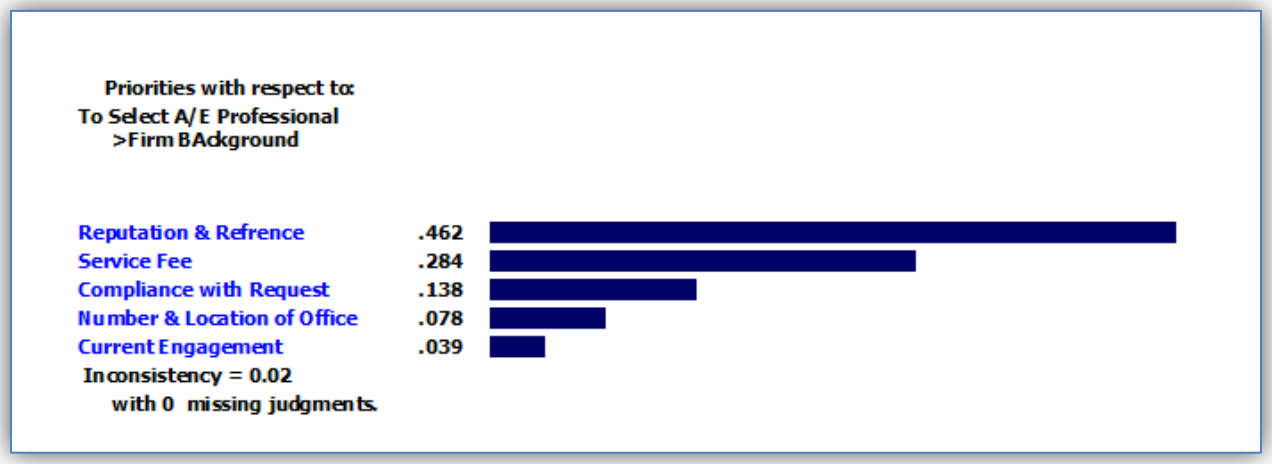


Figure 6-61 Importance of factors in firm background

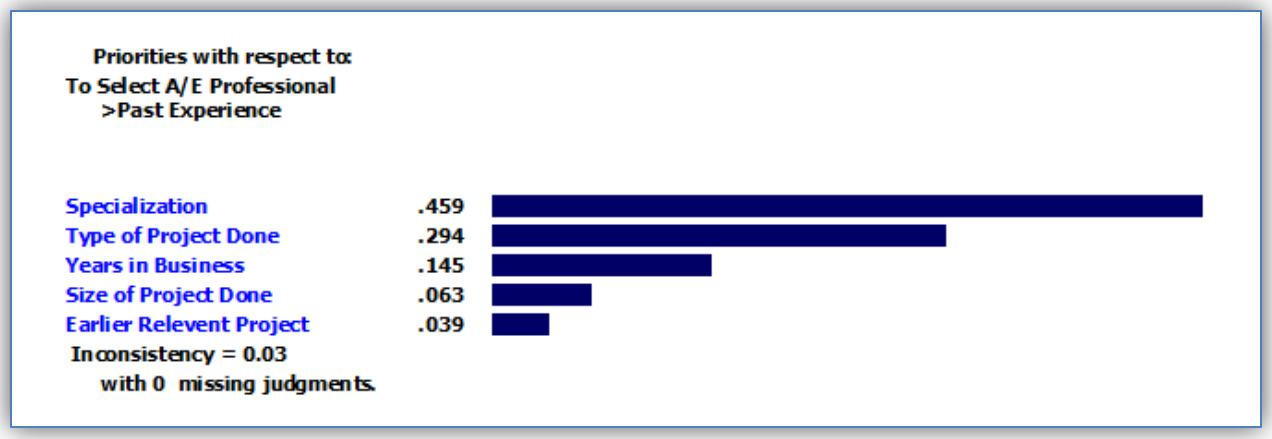


Figure 6-62 Importance of factors in past experience

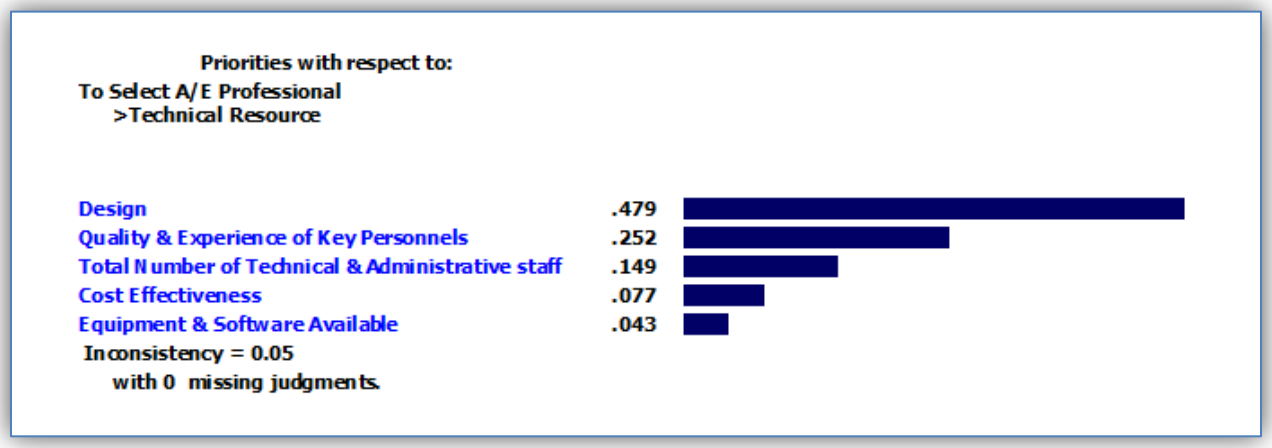


Figure 6-63 Importance of factors in technical resource

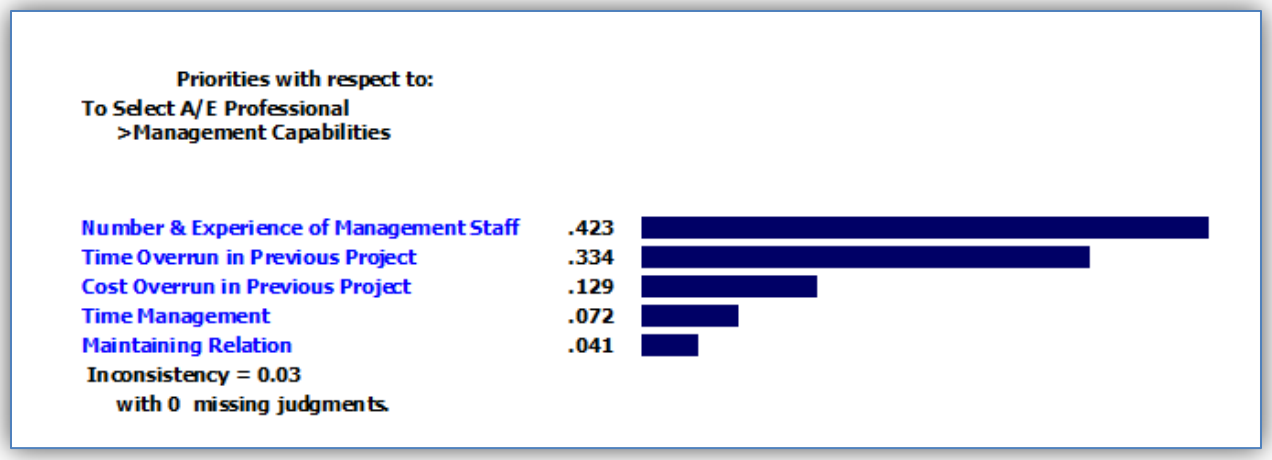


Figure 6-64 Importance of factors in management capabilities

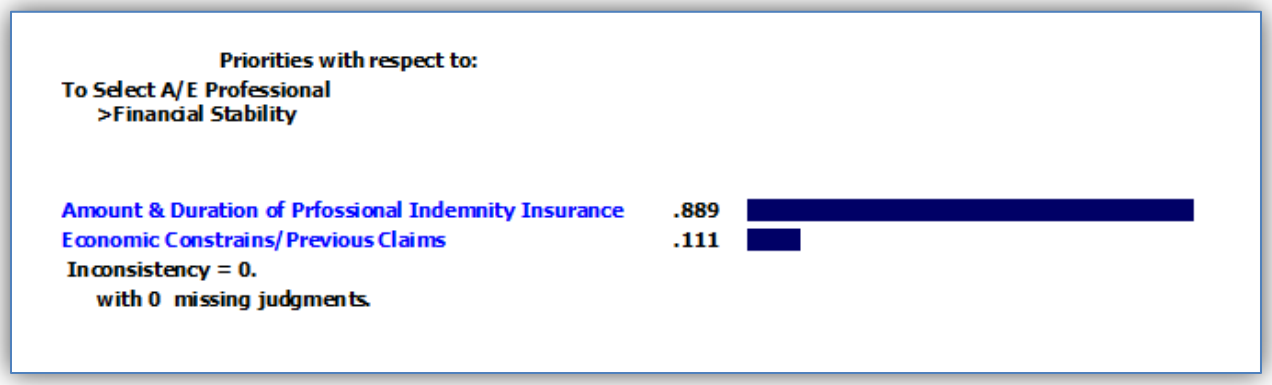


Figure 6-65 Importance of factors in financial stability

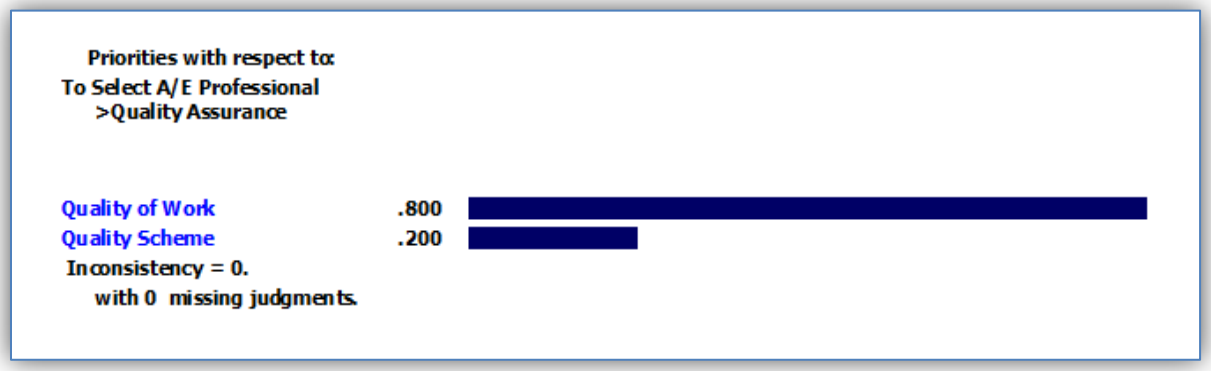


Figure 6-66 Importance of factors in quality assurance

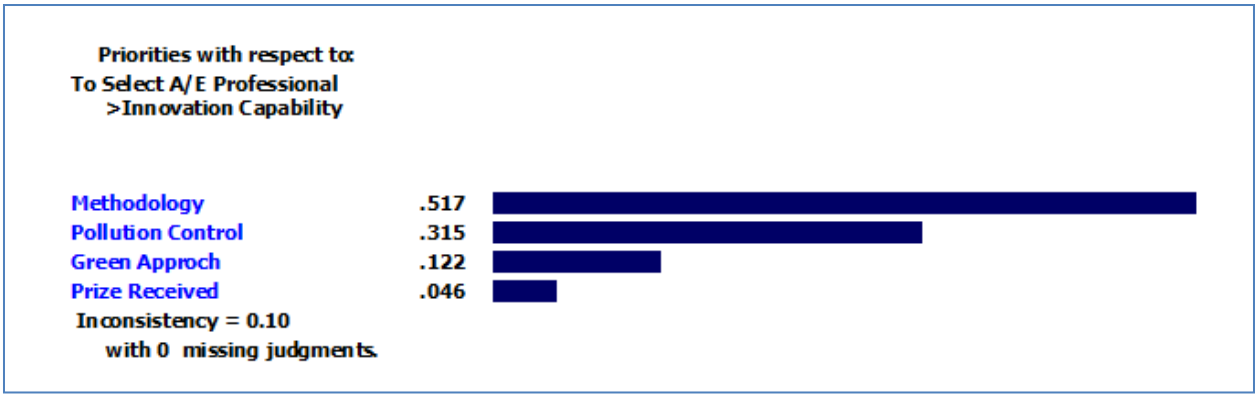


Figure 6-67 Importance of factors in innovation capability

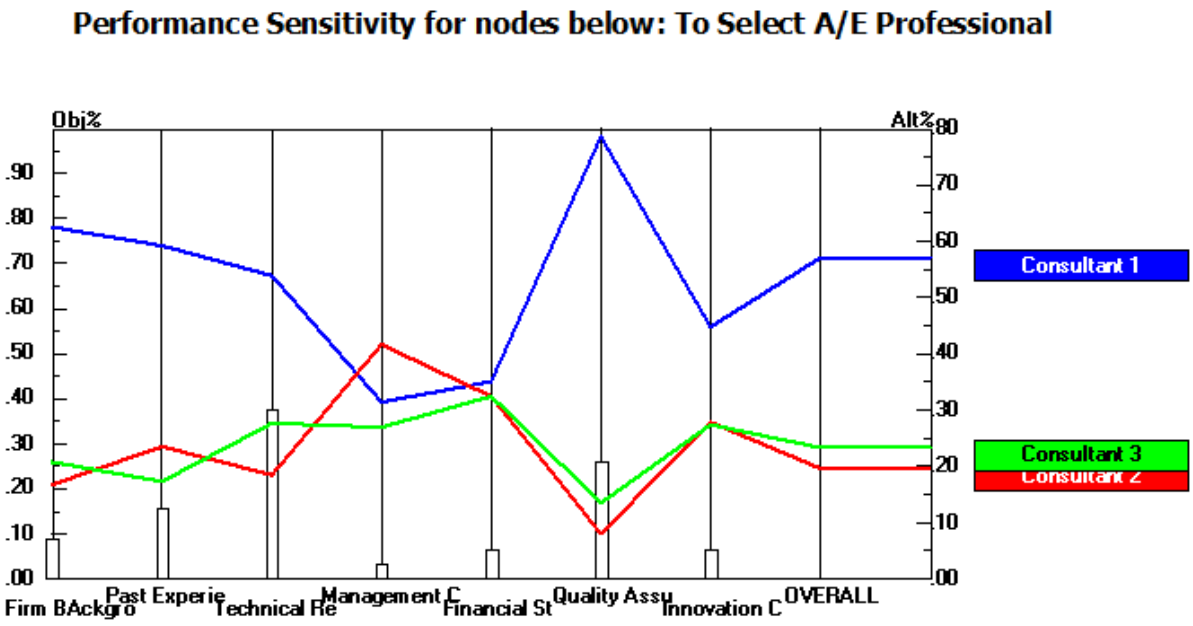


Figure 6-68 Performance sensitivity graph

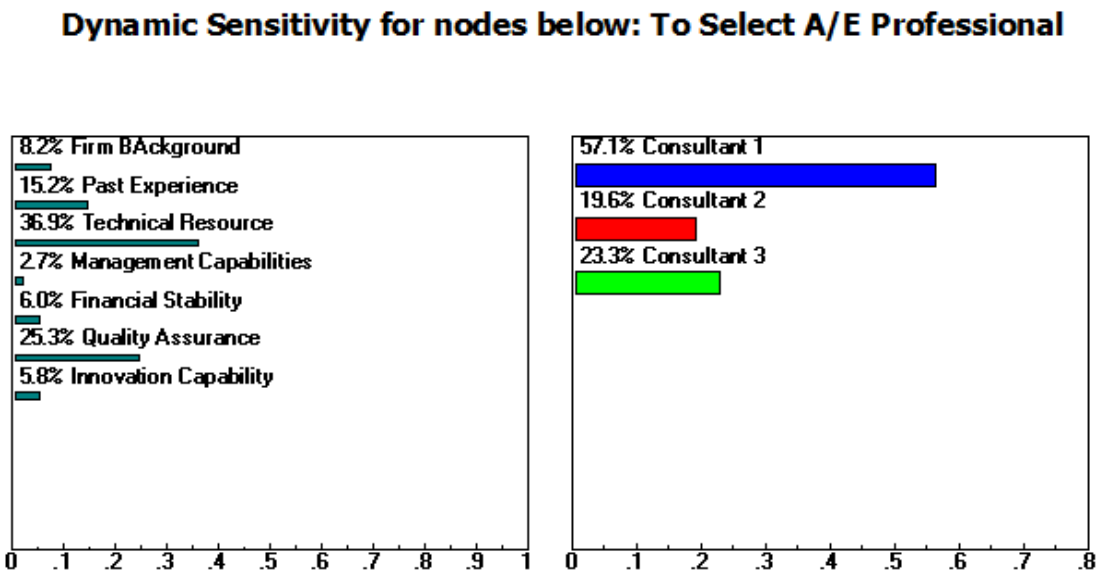


Figure 6-69 Dynamic sensitivity graph

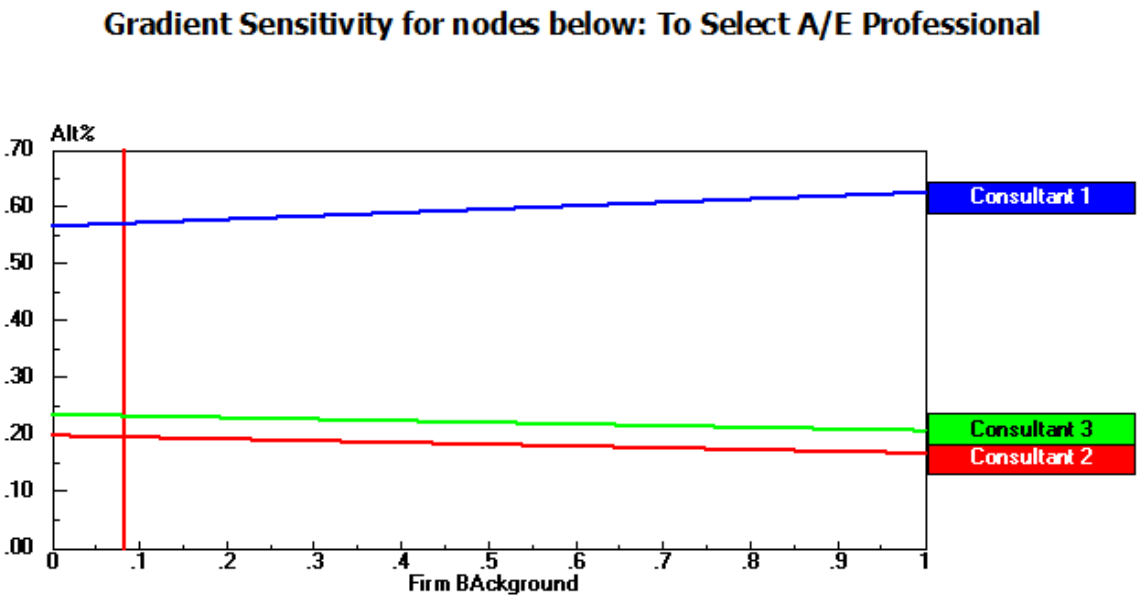


Figure 6-70 Gradient sensitivity

Comparing consultants:

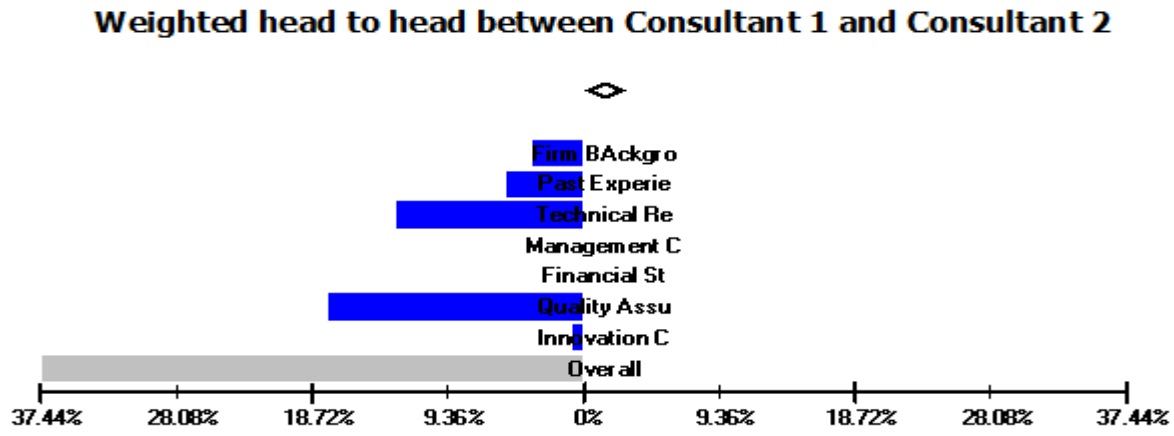


Figure 6-71 Comparing consultant 1 & 2

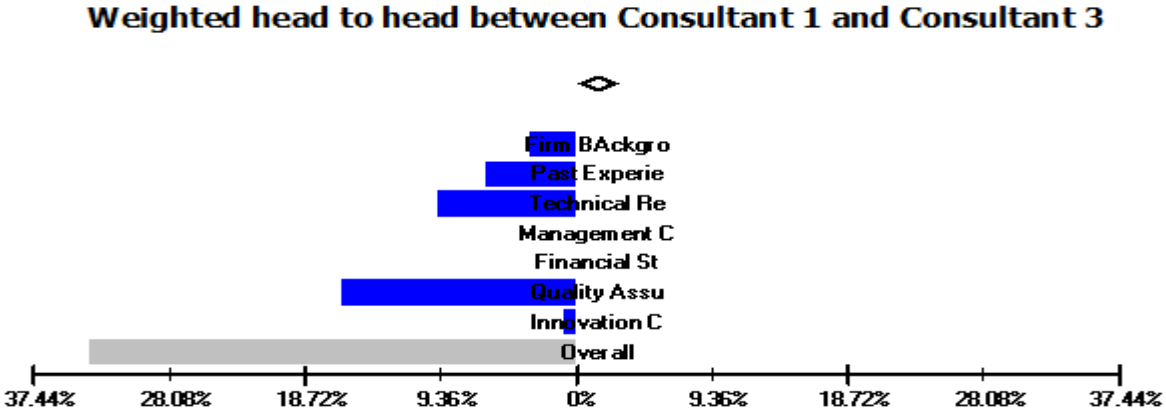


Figure 6-72 Comparing consultant 2 & 3

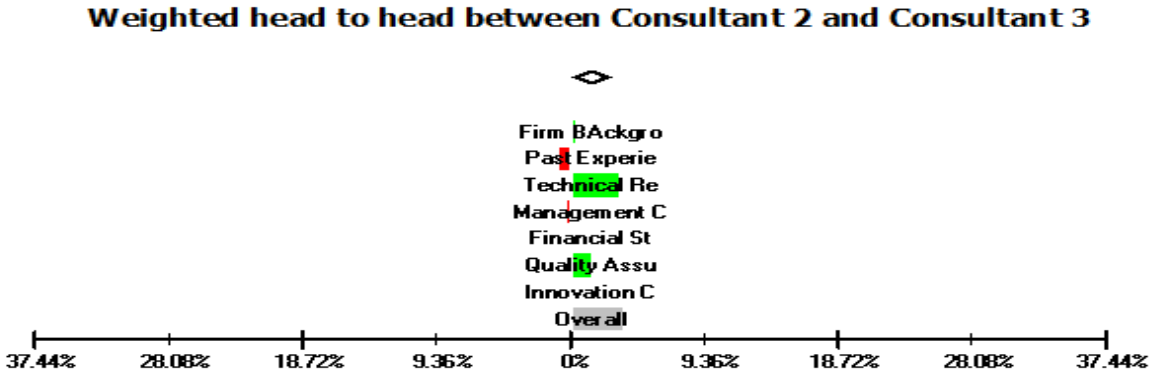


Figure 6-73 Comparing consultant 2 & 3

CHAPTER 7

7 CONCLUSION

A/E professionals are heart and soul of the project. They brings with them tremendous skills and expertise for any given project. Infrastructure is at its peak in KSA and India. Most of the owners don't have in-house expertise for all the projects, so they do hire consultants for different kind of work at different stages in project. A/E professionals are one of the most consultants they hire and their selection is very critical.

In this research effort has been made to ease the process of selection for owners so that they can hire best A/E professional for their projects.

In order to be thorough lot of criteria's has been considered through international journal and then are classified under 7 major categories as explained earlier. Then use of software expert choice is made in order to efficiently rate them and rate consultants based on their expertise on each criteria.

The result is summarized as:

- Ranking of criteria's for Saudi public sector:
    i. Technical resource – 28.6%
    ii. Firm background – 27.9%
    iii. Past experience – 22.5%
    iv. Financial stability – 9.2%
    v. Quality assurance – 5.6%

vi. Innovation capability – 3.6%

vii. Management capabilities – 2.6%

- Ranking of criteria's for Saudi private sector:

i. Technical resource – 39.3%

ii. Firm background – 21.7%

iii. Past experience – 14.1%

iv. Financial stability – 12.6%

v. Quality assurance – 6.3%

vi. Innovation capability – 3.9%

vii. Management capabilities – 2.2%

Because of similar work conditions it is clear that criteria's priorities in both the sectors are same though their magnitude of importance varies. Also while validating the model it was found that consultant selected through this model was in accordance with the actual selection which shows the efficiency of the model.

- Ranking of criteria's for India public sector:

i. Financial stability – 42.3%

ii. Past experience – 22.2%

iii. Quality assurance – 16.0%

iv. Technical resource – 8.7%

v. Firm background – 5.6%

vi. Management capabilities – 3.0%

vii. Innovation capability – 2.2%

- Ranking of criteria's for India private sector:
    i. Technical resource – 36.9%
    ii. Quality assurance – 25.3%
    iii. Past experience – 15.2%
    iv. Firm background – 8.2%
    v. Financial stability – 6.0%
    vi. Innovation capability – 5.8%
    vii. Management capabilities – 2.7%

Unlike Saudi Arabia, ranking of factor varies in public and private sector along with the magnitude of their importance as shown above. Consultant selection for Indian public sector was in accordance with actual selection process but for Indian private sector it was not found in accordance with actual selection process. The reason could be respondent's mistake or it could be illogical approach toward selection process but if they would have used a similar model or process they could be consistent in the selection process.

Following can be concluded from the research:

- It will aid the present construction industry in selection of consultants.
- It shows importance of A/E professional and also the importance of their selection process.
- Important criteria's for their selection have been evaluated.
- By using this process incompetent A/E's can be eliminated from selection process.
- It will also show shortcoming of present hiring system.

CHAPTER 8

8 RECOMMENDATIONS

- ✓ The research could help in proper selection of A/E consultants as it uses wide range of criteria to determine their worthiness.
- ✓ The model can be used as tool not just to hire A/E professional but other consultants too.
- ✓ This model can be used in professional organizations in India & KSA.
- ✓ This model could be tailored to fit in scope of different projects.
- ✓ This research is done on limited number of industries; therefore it is recommended to explore this models effectiveness in different industries or could be in different nations.

REFERENCES

1. Grima, F. and G. Trépo, Internal consultants: Why do clients use them and for what benefits? European Management Journal, 2011. **29**(2): p. 144-154.
2. Creplet, F., et al., Consultants and experts in management consulting firms. Research Policy, 2001. **30**(9): p. 1517-1535.
3. Al-Besher, M.F.S., A Conceptual Model for Consultant Selection in Saudi Arabia. THESIS KFUPM, 1998.
4. Assaf, S. and M.O. Jannadi, A multi-criterion decision-making model for contractor prequalification selection -- New pre-qualification method for Saudi Arabia presented utilizing all pre-qualification factors important to building owner. Building Research & Information, 1994. **22**(6): p. 332 - 335.
5. Al-Reshaid, K. and N. Kartam, Design-build pre-qualification and tendering approach for public projects. International Journal of Project Management, 2005. **23**(4): p. 309-320.
6. Al-Musallami, A.I., Owners satisfaction with consultancy practices in Saudi Arabia. Unpublished Masters thesis in construction engineering and management, at the College of Environmental Design, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, 1992.
7. Assaf, S.A., et al., A CONCEPTUAL MODEL FOR A/E CONSULTANT SELECTION (CCSM) IN SAUDI ARABIA.

8. Chow, L.K. and S.T. Ng, Expectation of performance levels pertinent to consultant performance evaluation. International Journal of Project Management, 2007. **25**(1): p. 90-103.

9. Latham, M., Constructing the team. 1994, HMSO, London.

10. Al-Shammari, M., AHP MODEL FOR ENGINEERING CONSULTANT SELECTION IN SAUDI ARABIA. MS REPORT, 2010.

11. Ng, S.T. and L.K. Chow, Framework for evaluating the performance of engineering consultants. Journal of professional issues in engineering education and practice, 2004. **130**: p. 280.

12. Cheung, F.K.T., J.L.F. Kuen, and M. Skitmore, Multi-criteria evaluation model for the selection of architectural consultants. Construction management and economics, 2002. **20**(7): p. 569-580.

13. Ng, S.T. and L.K. Chow, Evaluating engineering consultants' general capabilities during the pre-selection process–a Hong Kong study. Engineering, Construction and Architectural Management, 2004. **11**(3): p. 150-158.

14. Tufte, E.A., Effective Use of Consulting Engineers. Journal of Professional Issues in Engineering, 1988. **114**(2): p. 162-166.

15. Aje, J.O., *The* process of hiring and managing a technical consultant. Engineering Management International, 1988. **5**(2): p. 101-105.

16. Basham, A.P., *Consultant selection: The two envelope system of bidding.* Industrial Marketing Management, 1983. **12**(4): p. 271-279.

17. Potter, K.J. and V. Sanvido, Design/build prequalification system. Journal of Management in Engineering, 1994. **10**(2): p. 48-56.

18. Ng, S.T. and W.Y. Wan, Appraisal of subcontractor performance—criteria and their importance. Proceedings of CIB2005—Advancing Facilities Management and Construction through Innovation, Finlandia Hall, Helsinki, Finland, 2005: p. 305–314.

19. Ling, Y.Y., Model for predicting performance of architects and engineers. Journal of construction engineering and management, 2002. **128**: p. 446.

20. Topcu, Y.I., A decision model proposal for construction contractor selection in Turkey. Building and Environment, 2004. **39**(4): p. 469-481.

21. Zavadskas, E.K. and T. Vilutiene, A multiple criteria evaluation of multi-family apartment block's maintenance contractors: I--Model for maintenance contractor evaluation and the determination of its selection criteria. Building and Environment, 2006. **41**(5): p. 621-632.

22. Jaskowski, P., S. Biruk, and R. Bucon, Assessing contractor selection criteria weights with fuzzy AHP method application in group decision environment. Automation in Construction, 2010. **19**(2): p. 120-126.

APPENDIX

All detailed information of respondents will be kept confidential and be used for only the analysis of this research.

Respondent's personal information

Name:

Company Name:

Position:

Work experience:

Email:

Phone:

Q1. Have you ever been involved in selection of A/E professional?

- Yes
- No

Q2. If you have answered yes, how much experience do you have in terms of number of years and projects done?

Ans.

- **Questionnaire 1** What could have greater importance in selection of A/E professional, Criteria A or Criteria B and to what extent in level 2.

Criteria A	ABSLT		DMNSTR		STRNG		Weak		Equal		Weak		STRNG		DMNSTR		ABSLT	Criteria B
Firm background	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Past experience
Firm background	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technical resource
Firm background	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Management capabilities
Firm background	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Financial stability
Firm background	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality assurance
Firm background	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovation capability
Past experience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technical resource
Past experience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Management capabilities
Past experience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Financial stability
Past experience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality assurance
Past experience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovation capability
Technical resource	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Management capabilities
Technical resource	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Financial stability
Technical resource	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality assurance
Technical resource	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovation capability
Management capabilities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Financial stability
Management capabilities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality assurance
Management capabilities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovation capability
Financial stability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality assurance
Financial stability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovation capability
Quality assurance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovation capability

Questionnaire 2 What could have greater importance in selection of A/E professional, Criteria A or Criteria B and to what extent in level 3.

- FIRM BACKGROUND

Criteria A	Absolute		Demonstrated		Strong		Weak		Equal		Weak		Strong		Demonstrated		Absolute	Criteria B
Reputation & reference	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Compliance with request
Reputation & reference	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Service fee
Reputation & reference	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number or location of office
Reputation & reference	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Current engagement
Compliance with request	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Service fee
Compliance with request	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number or location of office
Compliance with request	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Current engagement
Service fee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number or location of office
Service fee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Current engagement
Number or location of office	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Current engagement

- PAST EXPERIENCE

Criteria A	Absolute		Demonstrated		Strong		Weak		Equal		Weak		Strong		Demonstrated		Absolute	Criteria B
Type of project done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Size of project done
Type of project done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Years in business
Type of project done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Earlier relevant project
Type of project done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Special ization
Size of project done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Years in business
Size of project done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Earlier relevant project
Size of project done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Special ization
Years in business	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Earlier relevant project
Years in business	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Special ization
Earlier relevant project	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Special ization

- TECHNICAL RESOURCES

Criteria A	Absolute		Demonstrated		Strong		Weak		Equal		Weak		Strong		Demonstrated		Absolute		Criteria B
Num. of tech & admn staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Quality of key personnel
Num. of tech & admn staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Experience of key personnel
Num. of tech & admn staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Equipment available
Num. of tech & admn staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Software available
Quality of key personnel	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Experience of key personnel
Quality of key personnel	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Equipment available
Quality of key personnel	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Software available
Experience of key personnel	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Equipment available
Experience of key personnel	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Software available
Equipment available	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		Software available

- MANAGEMENT CAPABILITIES

Criteria A	Absolute		Demonstrated		Strong		Weak		Equal		Weak		Strong		Demonstrated		Absolute	Criteria B
No. of mangt. Staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Exp. Of mngt. Staff
No. of mangt. Staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Time mangt.
No. of mangt. Staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Time overrun in previous projects
No. of mangt. Staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost overrun in previous projects
Exp. Of mngt. Staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Time mangt.
Exp. Of mngt. Staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Time overrun in previous projects
Exp. Of mngt. Staff	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost overrun in previous projects
Time mangt.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Time overrun in previous projects
Time mangt.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost overrun in previous projects
Time overrun in previous projects	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost overrun in previous projects

- FINANCIAL STABILITY

Criteria A	Absolute		Demonstrated		Strong		Weak		Equal		Weak		Strong		Demonstrated		Absolute	Criteria B
Economic constrain or amount of claim from previous projects	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Amount and duration of professional indemnity insurance

- QUALITY ASSURANCE

Criteria A	Absolute		Demonstrated		Strong		Weak		Equal		Weak		Strong		Demonstrated		Absolute	Criteria B
Quality of work	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality scheme

- INNOVATION CAPABILITY

Criteria A	Absolute		Demonstrated		Strong		Weak		Equal		Weak		Strong		Demonstrated		Absolute	Criteria B
Methodology	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Green approach
Methodology	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Pollution control
Methodology	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Prize received
Green approach	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Pollution control
Green approach	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Prize received
Pollution control	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Prize received

VITAE

Name	:	Azfar Amaan
Address	:	A-16/1 Shahin Bagh, AFE 2, Jamia Nagar Okhla, New Delhi- 110025, India
Telephone	:	+966-531564496
Date of Birth	:	06-02-1987
Nationality	:	Indian
Languages	:	English, Urdu, Hindi and Arabic (Basic)
Contact Address	:	King Fahd University of Petroleum and Minerals P.O.BOX-8650, Dhahran-31261, Kingdom of Saudi Arabia
Email	:	amaanambide@gmail.com, azfaramaan@gmail.com
Education	:	Master of Science (M.S.) May 2012 Department of Construction Engineering & Management King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia Bachelor of Technology May 2009 Civil Engineering Department Jamia Millia Islamia, New Delhi-110025, India.