

A STRATEGY FOR COLLECTING AND EVALUATING INFORMATION ON ENGINEERING CONSULTANT OFFICES USING NEURAL NETWORKS: A CASE STUDY

Mansour N. Jadid¹ and Mohammad M. Idrees²

ABSTRACT

This paper presents a strategy for collecting and evaluating information on engineering consultant offices using information technology (IT) and a neural network approach. This strategy is effective in selecting the most appropriate engineering consultant offices and their services. The overall process consists of four main stages: data collection, data evaluation, interface design, and information transformation to a neural network model.

The emergence of IT has been the natural result of the development and spread of the computer, and its applications in many fields, which have played a major role in overcoming many obstacles. This has resulted in the creation of new environments, and has facilitated new routine tasks. Programmers have competed to create programs that are easy to use, and many now offer complete packages, including software applications that enable engineers to conduct their work faster and more efficiently.

The use of neural networks in general has significantly increased during the past few years, and successful applications in many areas are expected to lead to further interest and confidence in the field of civil engineering. It has been demonstrated that neural networks can outperform conventional modeling in solving various complex engineering problems; however, reports of their practical application in evaluating engineering consultant offices are limited in the literature.

The use of Active Server Pages (ASP) and the Internet Information Server (IIS) is proposed in the design of a novel system for data collection and generating standardization processing information. Finally, the results are transferred to a neural network model for evaluation.

The proposed site has three user modes: free, public, and administrator. The public users are encouraged to visit this portal to access services, such as finding consultant offices local to new consultation services. Consultants are required to register as premium members to publish their profile for public viewing. Administrators are responsible for managing, updating, and administrating the contents of the website. Five steps are required to construct

¹ Associate Professor, Dept. of Building Science & Technology, P. O. Box 30973, Al-Khobar 31952, King Faisal University, Saudi Arabia, Phone 009663/857-4179, FAX 009663/857-8883, mnjadid@yahoo.com

² IT Engineer, Dept. of the New University Campus Projects, P. O. Box 1982, Dammam 31451, King Faisal University, Saudi Arabia, Phone 009663/857-4179, FAX 9663/857-7000/2130, mobin_pk@yahoo.com

the application: linking to the website, applying for a user account, filling in a registration form, creating a profile, and, finally, upgrading the membership.

This work is part of a funded research program aiming to demonstrate the essential functions and processes of a database-integrated system for the services of engineering consultant offices. Gathering and organizing information on engineering consultancy services is the core function of this research. The finalized database can be used to automate the selection of engineering consultant offices for designing for small or large scale projects. Therefore, it is reasonable to classify this approach as a B2B (business to business) and B2C (business to customer) engineering gateway.

KEY WORDS

consultant, information technology, gateway, neural networks, interface, active server page, internet information service, design, supervision.

INTRODUCTION

The selection of engineering consultant offices is one of the most important factors enabling clients to successfully complete a project. Usually, the selection of consultants is based on their commitment, experience, communications, and availability. The services provided by consultants include, but are not limited to, three main types: administrative, financial, and technical services. Generally, a design project passes through six major stages:

- Geotechnical investigation (that is, a soil report provided by independent geotechnical consultant)
- Approval of space program stage
- Schematic design stage
- Preliminary stage
- Final stage
- Tender documents

The essential functions and process of designing the database presented in this paper are based on information technology (IT) and a plan to implement a neural network methodology for selecting engineering consultant offices in Saudi Arabia, to provide design or supervision services to clients.

Saudi Arabia is about 2,250,000 square kilometers (868,730 square miles) in area, and is divided into 13 provinces, with a total population of about 16 million. There are estimated to be about 1,400 engineering consultant offices (Shaheen 2004) throughout the country, which are mainly concentrated in the large cities. This number is huge when compared with those in other countries — for example, Canada has about 600 engineering consultant offices for a population of 32 million (The World Fact Book 2005). In order to carry out the current research, a procedure was developed to collect information by utilizing the IT technology of the Internet.

The feasibility study described in this paper covers the whole of Saudi Arabia. Figure 1 represents the logical workflow scheme of the project. The application server resides in the city of Dammam, while users from all around the country can access the server for publishing and searching the database via the Internet. The use of Active Server Pages (ASP) and the Internet Information Server (IIS) is proposed for the novel system; a brief introduction to these tools is given below.

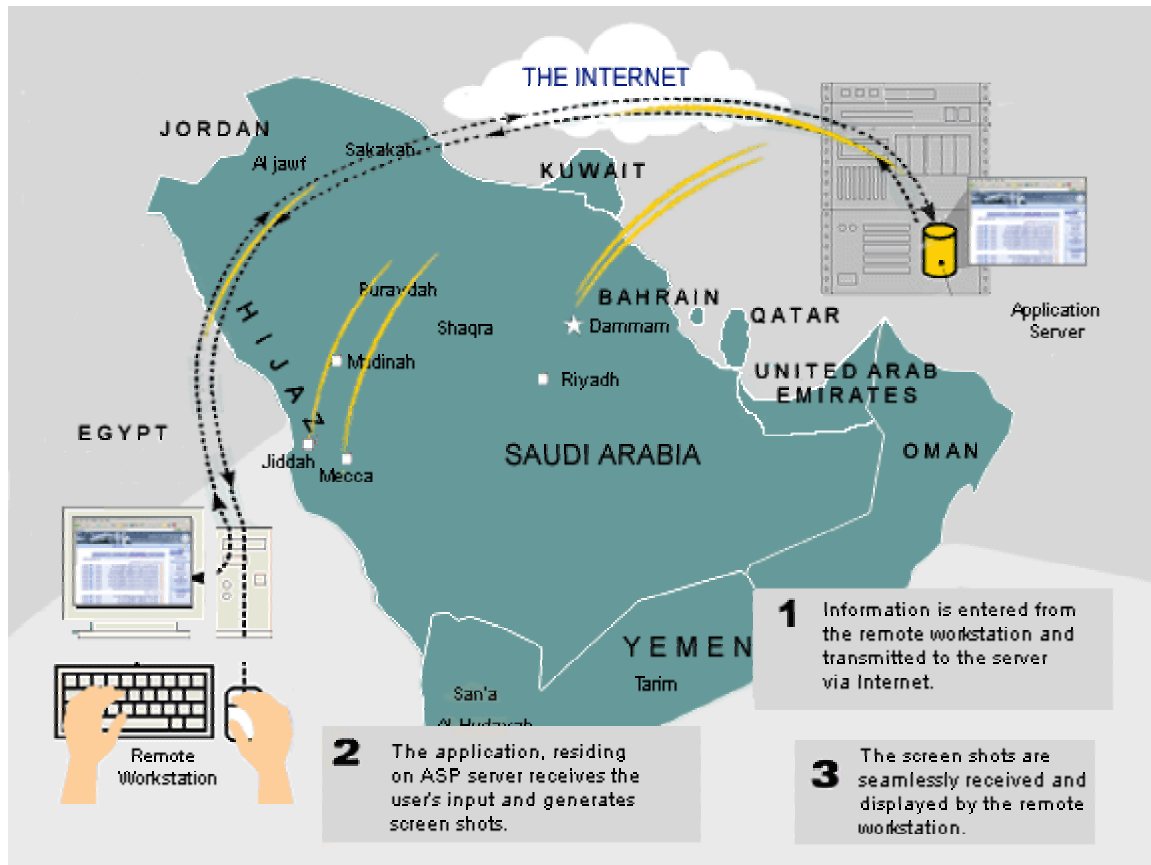


Figure 1: Logical scheme of Workflow of the Project

ACTIVE SERVER PAGES (ASP)

Microsoft® ASP (Microsoft Corporation) is a server-side scripting environment that can be used to create and run dynamic, interactive web server applications. With ASP, it is possible to combine HTML pages, script commands, and COM components to create interactive web pages and powerful web-based applications that are easy to develop and modify.

INTERNET INFORMATION SERVICES (IIS)

IIS provides integrated, reliable, scalable, secure, and manageable web server capabilities over an intranet, the Internet, or an extranet. IIS is a tool for creating a strong communications platform of dynamic network applications. IIS 6.0 is a powerful web server,

available in all versions of Microsoft® Windows Server™ 2003 (Microsoft Corporation), which provides a highly reliable, manageable, scalable, and secure web application infrastructure. IIS 6.0 enables organizations of all sizes to quickly and easily deploy websites, and provides a high-performance platform for applications built using Microsoft ASP.NET and the Microsoft .NET Framework. The Internet user brings up a web page, which has the extension .asp (Figure 2). When the browser requests the ASP file from the web server, instead of processing the page as a normal .html or .htm page, the ASP is processed on the server (Figure 3). ASP processes the requested file from top to bottom, executing any script commands contained within it, and produces pure 100% HTML code.

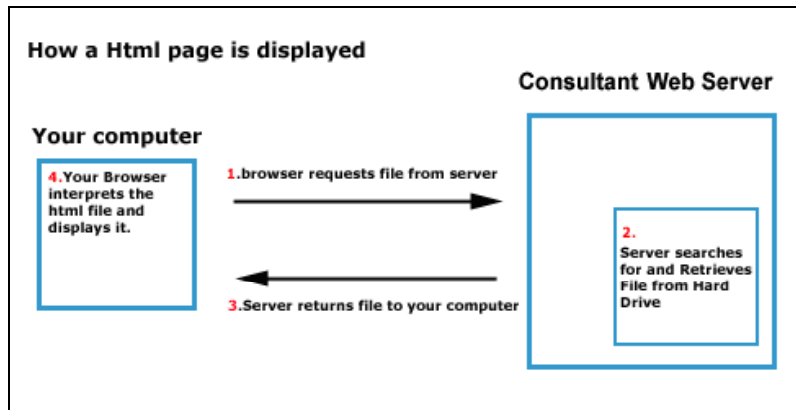


Figure 2: HTML Page

The resultant HTML is then sent back to the browser for the user to view. Because the required script runs on the server, the web server carries out the processing, and standard HTML pages can be generated and sent back to the browser.

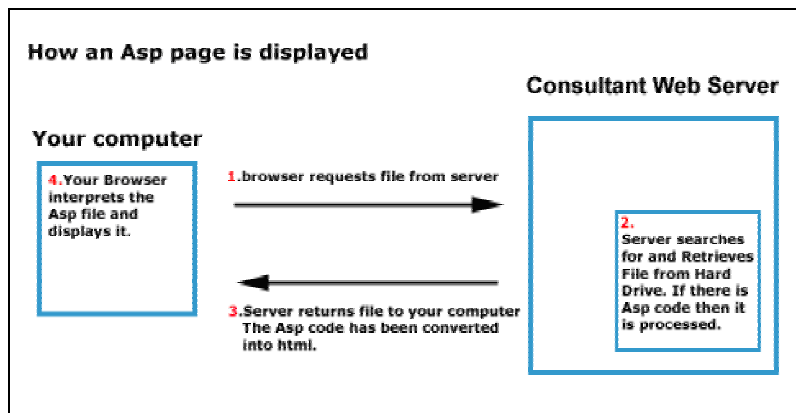


Figure 3: ASP Page

ASP pages are browser independent, so a web page with the .asp extension can be viewed by all browsers. Server-based computing means deploying existing software applications, managing them, and supporting them, all using a server located in a data center site. Users at

our corporate client sites employ “thin clients” or “dumb terminals” to connect to their files, while enjoying problem-free computing, available 24 hours a day and 7 days a week. The benefits include lower costs for their IT infrastructure and management, easy-to-use computing services, fast and reliable performance, and high levels of security for client data. Delivering these features is the priority of our management and professional staff.

IIS USER COOKIE AUTHENTICATION

Cookie authentication makes use of functionality at the scripting level to provide user authentication. This does not require a specific IIS server configuration, but rather ASP script configuration.

The following code would need to be placed at the top of each page that the user wanted to protect:

```
<% If session("login") = FALSE Then  
Response.Redirect "LoginPage.asp"  
Else  
Response.Write "You are logged in"  
End If %>
```

The following code is an example of the login form:

```
<% if request.form("password") = "yourpass" then  
session("login") = TRUE  
end if %>  
<form method="POST" action="login.asp"  
<input type="text" name="password" size="20"><input type="submit"  
value="login" name="login"></p>
```

This code could be expanded to tie into a database and track usernames as well as passwords, but the concept is the same as in this hard-coded sample with a password of “user pass”.

DATA ACCESS OBJECT (ADO)

The IIS provides ADO objects to access databases. The information about the connection can also be defined beforehand and stored on the server. These data definitions are specified in Open Database Connection (ODBC) settings (Figure 4). Each setting has a Data Source Name (DSN).

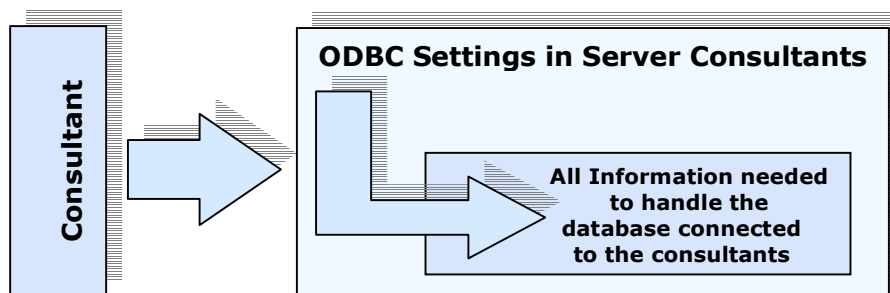


Figure 4: ODBC Settings in Consultant's Server

OVERVIEW OF PROJECT

Figure 5 shows the detailed steps required to register an account, the functionalities of this project, and an overview of the application. A flow chart of the actions that are coded in the ASP files is given below.

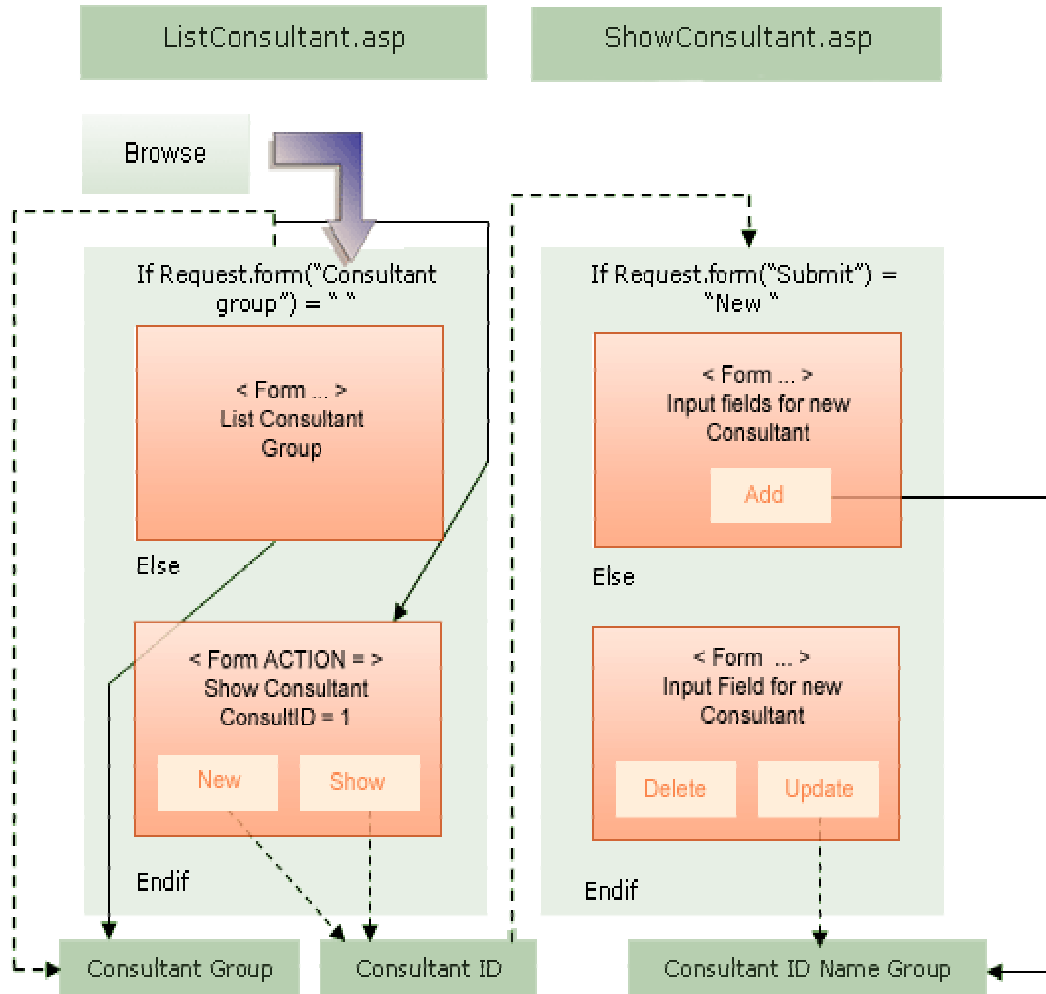


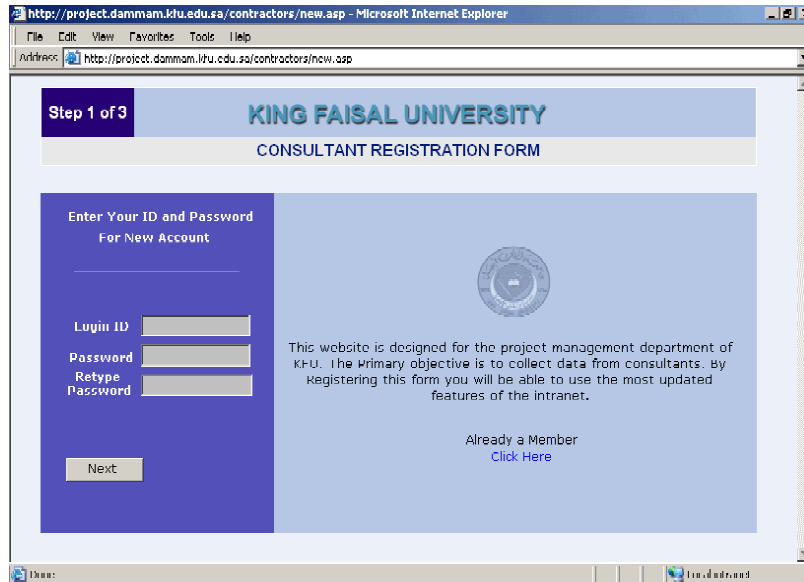
Figure 5: Flow Chart - Browse and Add new Consultant

APPLY A USER ACCOUNT

A login screen is available to enter the website. If the user is already registered, then they enter the login name and the user password, and press the enter button. If the user is not yet a member, then they click on the “get members” link. The following steps detail how to register an account.

FILL IN A REGISTRATION FORM AND CREATING PROFILE

New users have to create an account, which is unique for each consultant (Figure 6). If the consultant has already registered, then they proceed to the login page.



The screenshot shows a web browser window displaying the registration form. The browser's address bar shows the URL: <http://project.dammam.kfu.edu.sa/contractors/new.asp>. The page title is "KING FAISAL UNIVERSITY" and the subtitle is "CONSULTANT REGISTRATION FORM". The page is labeled "Step 1 of 3". The main heading is "Enter Your ID and Password For New Account". There are three input fields: "Login ID", "Password", and "Retype Password". A "Next" button is located below these fields. To the right, there is a circular logo of King Faisal University and a text block: "This website is designed for the project management department of KFU. The Primary objective is to collect data from consultants. By Registering this form you will be able to use the most updated features of the intranet." Below this text is a link: "Already a Member Click Here".

Figure 6. New Registration

During the registration process, each consultant has to create a profile by filling in the form (Figure 7), which is essential for the evaluation process when selecting a consultant.



The screenshot shows the second step of the registration form. The browser's address bar shows the URL: <http://project.dammam.kfu.edu.sa/contractors/new.asp>. The page title is "KING FAISAL UNIVERSITY" and the subtitle is "CONSULTANT REGISTRATION FORM". The page is labeled "Step 2 of 3". The main heading is "Please Fill this form to create your Profile in order to access complete feature of the service". There is a "Consult" label. The form contains several input fields: "Company Name" (ABC Consultant), "Phone" (865990), "Title / Category" (Consultant), "Extension" (2155), "City" (Dammam), "Email" (cons@yahoo.com), "Area Code" (757000), "Country" (Saudi Arabia), "P.O. Box" (85700), and "website" (www.consult.com). A "Next" button is located below the form. To the right, there is a photograph of a large, modern building.

Figure 7: Sample of Consultant's General Information

FOUR STEPS FOR COLLECTING INFORMATION FROM CONSULTANTS

Four steps are required to collect the following information: office information, previous history, organization chart, and standard system code (Figures 8, 9, 10, and 11, respectively).



Figure 8: Office General Information

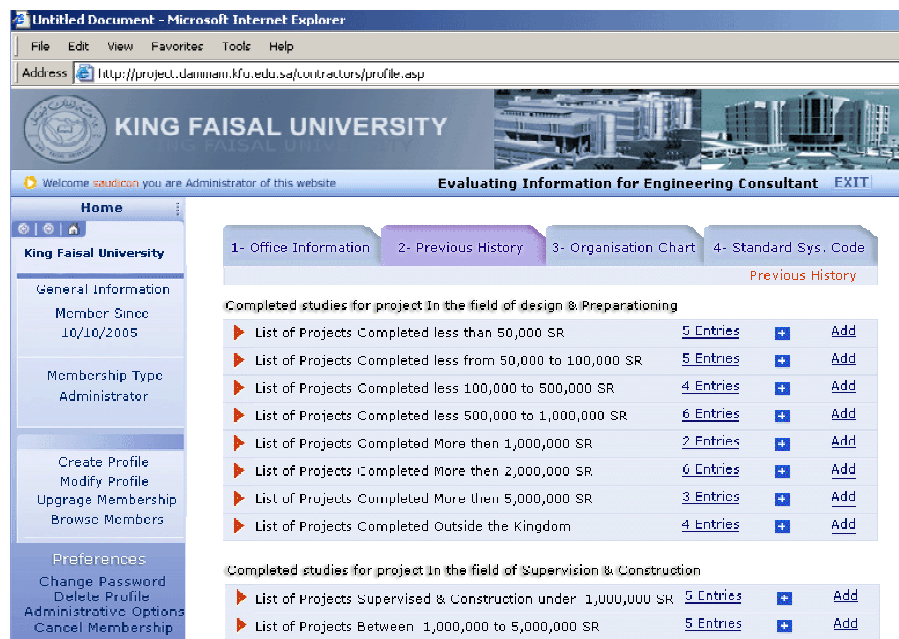


Figure 9 : Consultant's Previous History

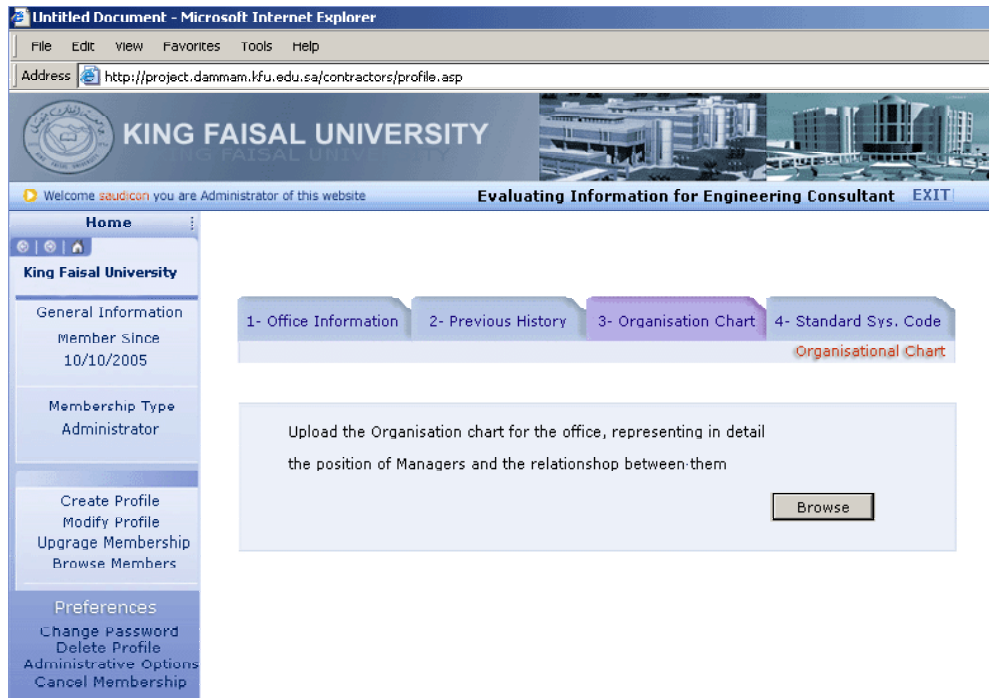


Figure 10 : Organization Chart

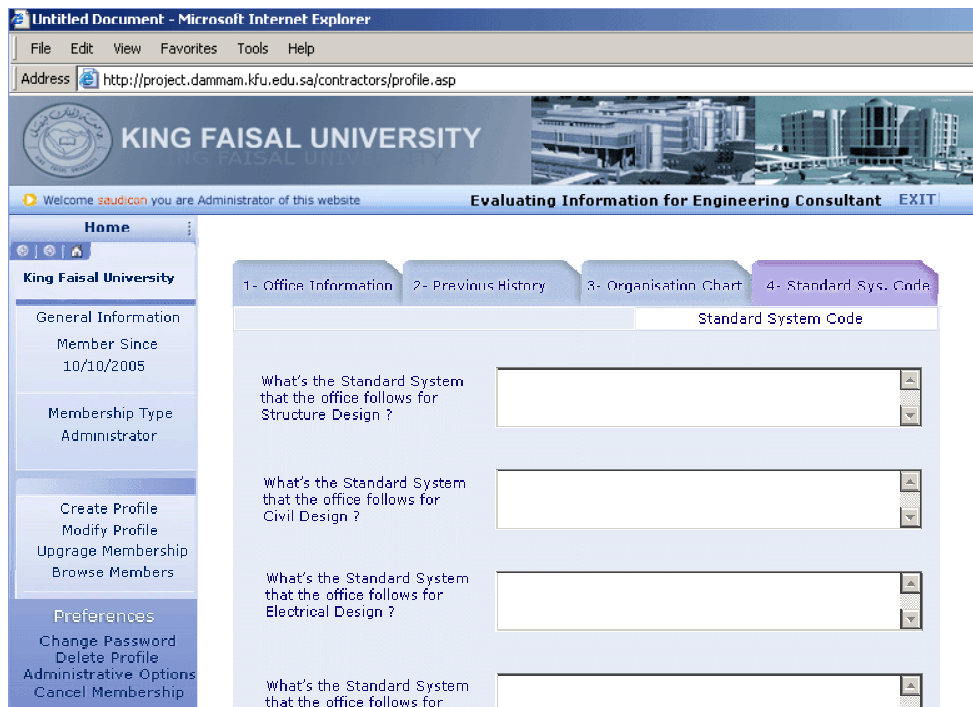


Figure 11 : Standard System Code.

BACKPROPAGATION NETWORKS

Neural networks were originally developed to simulate the function of a human neural system. They have powerful capabilities as universal approximations of nonlinear mapping functions with arbitrary complexity, which can be applied in many fields of science and engineering. The back-propagation paradigm used in the current research is one of the most popular training algorithms. The network always has an input layer, one or more hidden layers, and an output layer (Rumelhart et al. 1986). The back-propagation algorithm involves a forward-propagation start, when a set of input patterns is presented to the network. The process of forward and backward propagation continues until the error is reduced to an acceptable level (Jadid 1994). Figure 12 shows a typical back-propagation network with input, hidden, and output layers. The algorithm proposed in the present study used a supervised training mode with a known output layer through the hidden layers.

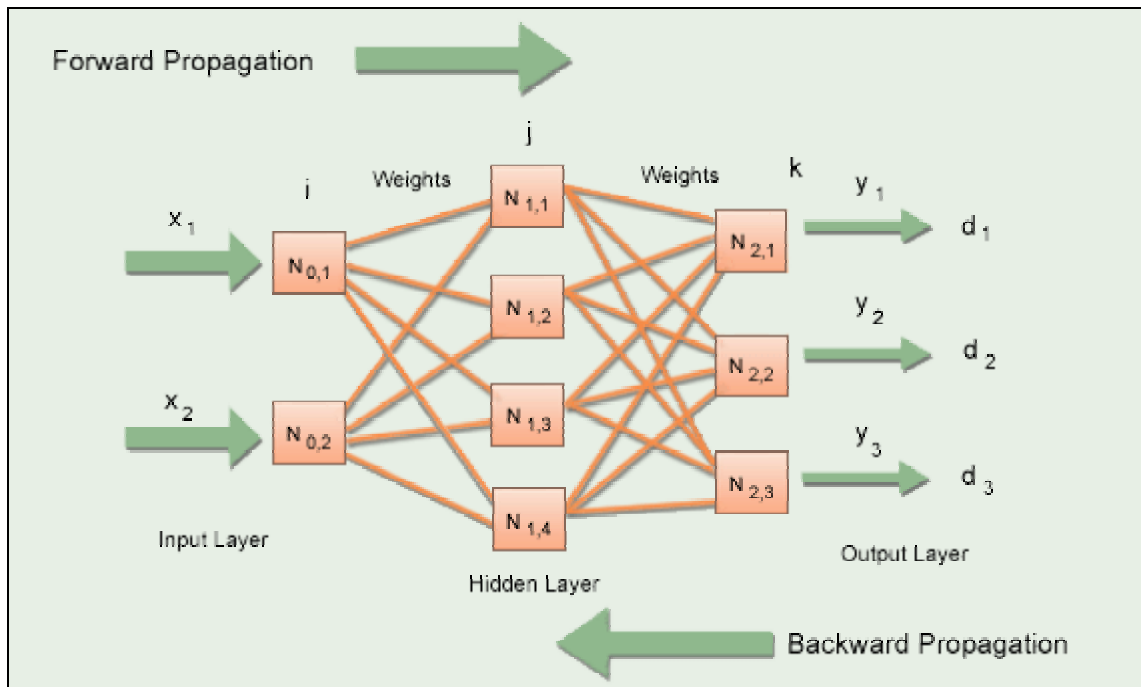


Figure 12: Back-Propagation Network Model

The number of neurons in the input layer depends on the number of possible inputs used, while the number of neurons in the output layer depends on the number of desired outputs. The number of hidden layers, and how many neurons appear in each hidden layer, cannot be defined accurately in advance, and can change according to the network configuration and type of data. In general, the addition of a hidden layer can allow the network to learn more complex patterns, but at the same time decreases its performance. The structure of the model consists of a number of input layers equal to the selection attributes of the consultant, one element in the output layer (either qualify or disqualify), and one hidden layer.

STRATEGY FOR SELECTING INPUT PARAMETERS

The process of allocating weightings to individual factors and quantifying the overall decision system is not a precise science, and is susceptible to subjective judgments (Farzad 1999). There have been many attempts to quantify the selection method by attaching weightings to subjective attributes (Hawwash 1991), using a probability-rating system (Gary et al. 1993) or the relative index-ranking method (Gary et al. 1994).

A number of engineering consultant offices (Shaheen 2004) were invited to participate in the evaluation process, in order to study their potential and services. The information required for the input data parameters was gathered through a website, where the consultants submitted detailed electronic questionnaires. The selection parameters were designed to focus on the specific needs of the project, including the design and supervision. The following preliminary criteria parameters were used for selecting a consultant.

- Design and supervision ability evaluated by examination of the functional, technical, economic, and aesthetic qualities of previous projects.
- Previous experience with special engineering requirements.
- Research potential defined as the capability to undertake appropriate research and to resolve design problems specific to the needs of the program or project under consideration.
- Production capability based on evidence of the ability to perform all the design phases of the work, coordination, and supervision.
- Project management during the construction phase of the project, proximity to the project location or willingness to establish a local office.
- Client relationships and recognition of the need to work harmoniously with administrators, engineers, and staff.
- Financial standing and the location of the firm.

CONCLUSION

This paper has proposed a strategy for selecting engineering consultant offices in Saudi Arabia, which benefits the clients, based on IT technology and using an artificial neural network methodology.

For any design or supervision project, the right choice of consultant is one of the most important decisions. Therefore, the development of an effective decision-support model for consultant selection will yield significant benefits to the clients. Non-linearity and uncertainty are the major characteristics of consultant selection, which result in the process being more of an art than a scientific evaluation. A full working model for building a neural network model aimed at improving the objectiveness of selecting consultant offices is currently underway. This will provide a mechanism for finding engineering consultant services with direct customer links for the construction business. Therefore, it will be reasonable to classify the project as B2B (business to business) as well as B2C (business to customer) once it is completed.

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