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Consultant Offices Selection using the Analytic Hierarchy Process

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Abstract

Consulting offices selection is an important step in the success of a construction project. Selecting consultant offices in the Libya is often done by the criterion of lowest price. This leads to a lack of innovation and a loss of quality in the construction industry.

In this paper, the multi-criteria decision-making (MCDM) is suggests to be utilized for consultant offices selection. The analytic hierarchy process (AHP) has been used as a tool for MCDM. Here, the used criteria are those previously concluded from a former study. These criteria are human capabilities, office experience, previous performance level, assurance and quality control, office equipment, administrative system, training and development.

In the current study, two questionnaires have been designed. The first questionnaire is designed to determine the weights of relative importance of each criteria (main and sub-criteria). The answers to the questionnaire are analyzed using the Expert Choice program. The second questionnaire is designed to calculate the average rate of certain criteria. The weights of relative importance for each main and sub-criteria are used to assess a consulting office for both of design and supervision stages. Finally, an administrative buildings project is assumed and it is required to select an office out of four offices (A, B, C, and D) using the proposed methodology.

Keywords

Consulting offices, Selection Criteria, Multi Criteria Decision Making, and Analytical Hierarchy Process (AHP)

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Nomenclature

AHP	Analytical Hierarchy Process
A/E	Architectural Engaging
CCSM	Consultant Conceptual Selection Model
MCDM	Multi-Criteria Decision-Making
ANP	Analytic Network Process
CR	Consistency Ratio
W	Relative weights for the main criteria
GSMC	Geological Survey and Mining Company
G	General weight for the criterion
L	Local weight for the criterion

1. Introduction

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making approach and was developed by Thomas [1]. The AHP has attracted the interest of many researchers mainly due to the useful mathematical properties of the method and the fact that the required input data are rather easy to obtain. The AHP facilitates the decision process by considering the decision in the context of a hierarchy, with the goal at the top, criteria at the second level, sub-criteria at various lower levels, and alternatives at the bottom of the hierarchy. The decision-maker makes pair-wise comparisons of elements at each level of the hierarchy. Each entity at a particular hierarchy level is compared with each other entity at that level, in order to determine which is preferred to, or more important than, the other. Each pair-wise comparison (that is, comparisons of the various criteria, comparisons of the various sub-criteria, and comparisons of the various alternatives) is based on a nine-item verbal/numerical judgment scale. These comparisons are using to obtain the weights of importance of the decision criteria. The values of the pair-wise comparisons in the AHP are determined according to intensity of importance. Mubarak and Al-Besher, [2] discussed factors participating in making A/E selection process for the public sector engaging consultants (A/E) for professional services. Thirty public organizations and thirty consultants were surveyed to identify the major selection criteria of A/E based on the AHP theory concept and a software program Expert Choice. The Authors focuses on personal experiences, qualifications and previous activities of individual engineers. Cheng, *et. al* [3] studied the best selection of architectural consultant in Hong Kong by conducting a questionnaire survey. This research identified the common criteria for selection the relative importance using AHP. Survey data from projects with similar characteristics was used to compute the criteria weights. Multi-criteria models for 7 out of 27 categories of project were built with reference to the computed weights derived from survey. Other authors have been studied the best selection of contractor in different countries, among them, Meghalkumar [4] suggested AHP technique for contractor selection problem in Indian context. Based on multi criteria decision making process, the data collected are used to create a hierarchical model for contractor selection. Eddie and Heng [5] suggested the multi-criteria decision-making (MCDM) to be a viable method for contractor selection. The AHP has been used as a tool for MCDM. However, AHP can only be employed in hierarchical decision models. For complicated decision problems, the analytic network process (ANP) is highly recommended since ANP allows interdependent influences specified in the model. An example is demonstrated to illustrate how this method is conducted, including the formation of super matrix and the limit matrix. Jaskowski, *et. al* [6] suggested the application of fuzzy AHP method to the process of decision making for selection of contractors. The assessment based on criteria related with a bidder's technical and economic

in the prequalification stage in restricted tendering procedures. The results show that the proposed fuzzy AHP method is superior to the traditional AHP in terms of improved quality of criteria prioritization. It can be concluded that the wide use of AHP in different applications would imply its potential acceptability to practitioners as well as researchers. Furthermore, there is no research achieved for the selection of consulting offices.

The current paper presents the application steps of the AHP for the consultant offices selection. Questionnaire number (1) is designed according to the AHP at which bilateral comparisons between the main and sub-criteria are presented. The questionnaire is then spreaded over (30) expert engineers. The collected information are then analyzed and the arithmetic means are calculated. The questionnaire results are also used to determine weights of the relative importance of each criterion using Expert Choice program. Questionnaire number (2) is designed to calculate the average rate of certain criteria. The questionnaire is spreaded over (10) engineers with experience in the selection of consulting offices. The weights of relative importance for each main and sub-criteria are used to assess a consulting office for both of design and supervision stages. Finally, an administrative buildings project is assumed and the best office out of four offices (A, B, C, and D) is determined.

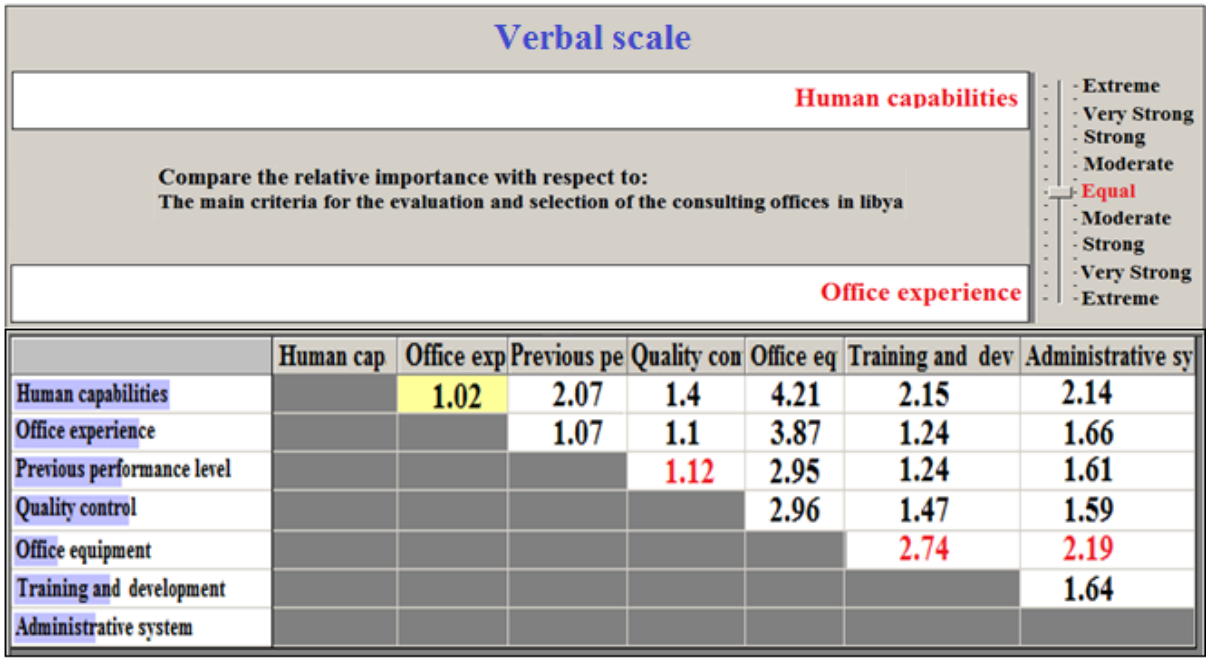
2. Determination of the weights of relative importance

AHP uses hierarchic or network structures to represent a decision problem and then develops priorities for the alternatives based on the decision-makers judgments throughout the system. The end product of the process is a prioritized ranking of the alternatives available to the decision-makers. The decision-makers must make judgments about the relative importance of each objective in paired comparison with each of the other objectives. They also must judge the relative merits of the alternatives with respect to each of the objectives. This is called relative measurement as opposed to absolute measurement, such as arbitrarily assigning a priority to each of the objectives, or stating that an alternative is high, moderate, or low and then arbitrarily assigning priorities to high, moderate, and low. The weights of relative importance to the criteria are determined using Expert Choice. The relative importance of each main criteria and sub-criteria shall be determined. Also, the relative preference of each alternative to each criterion is calculated using a process of pair-wise comparisons [7].

The bilateral comparisons between the criteria are represented numerically, according to Saaty's fundamental verbal scale [1].

In the current study, questionnaire, see Appendix (A), is designed to conduct bilateral comparisons between the criteria and to determine the relative important of each criterion in the selection of consulting offices. This questionnaire is spreaded over (30) expert engineers see Appendix (B). After that, the collected information are analyzed and the arithmetic mean for each criterion is calculated. Here, (170) comparisons, between two criteria, are achieved. The values of the comparisons in the AHP are determined according to the scale introduced by Saaty [1]. According to this scale, the available values for the pair-wise comparisons are members of the set: {9, 8, 7, 6, 5, 4, 3, 2, and 1}, are as follows: (9) means extreme importance, (7) implies very strong importance, (5) mean strong importance, (3) equals moderate importance, (1) means equal importance. The values (2), (4), (6) and (8) are used when compromise is needed. The arithmetic means are then used as input data to the expert choice program to calculate the weight of relative importance of each criterion, see Appendix (C).

Figure (1) shows a pair-wise verbal judgment expressing, that human capabilities equal importance with office experience. The marked numbers indicate that the criterion in the cell row is more important than the criterion in the cell column. Figure (2) shows the descending order of main criteria priorities. The Expert Choice program can also be used to calculate the Consistency Ratio (CR), (i.e. inconsistency index) in the data entered to make sure that it will not exceed (10%) according to the analytic hierarchy process. The inconsistency index is not relevant if it is larger than 10%, in which case the judgments should be reviewed. Reasons for a high inconsistency ratio may include lack of information, lack of concentration and real world inconsistencies.



	Human cap	Office exp	Previous pe	Quality con	Office eq	Training and dev	Administrative sy
Human capabilities		1.02	2.07	1.4	4.21	2.15	2.14
Office experience			1.07	1.1	3.87	1.24	1.66
Previous performance level				1.12	2.95	1.24	1.61
Quality control					2.96	1.47	1.59
Office equipment						2.74	2.19
Training and development							1.64
Administrative system							

Fig. (1) Assigning verbal judgement for comparisons

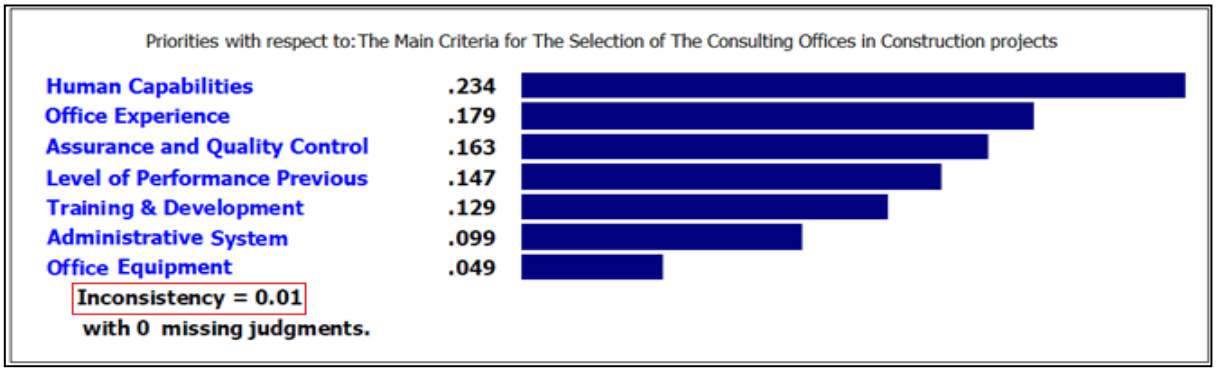


Fig. (2) Priorities resulting of the main criteria

3. Sensitivity Analysis

The last step of the decision process is the sensitivity analysis, where the input data are slightly modified in order to observe the impact on the overall results. If the ranking does not change, the results are said to be robust. Sensitivity analysis examines the sensitivity of the results to changes in the priorities of the criteria. Expert Choice allows different interaction graphical interface sensitivity analyses techniques. (1) Performance, (2) Dynamic, (3) Gradient, (4) two-dimensional plot, and (5) differences and each of them provide a different viewpoint to sensitivity analysis. Here, the user can easily manipulate criterion priorities and

immediately see the impact of the change over the result [8], [9]. For the current study the application of the dynamic sensitivity for the criteria Figure (3), shows the arrangement of all criteria according the relative importance in the design stage and supervision stage.

Fig. (3) Dynamic sensitivity: goal: selection of the consulting offices in (Design stage and supervision stage)

4. The average rate of certain criteria

To calculate the average rate of certain criteria, the type of project is determined (i.e. administrative buildings in the government institutions). Also, the task for the consulting office is determined (design stage and supervision stage) and the weights of relative importance for criteria (main and sub-criteria) are determined. A questionnaire number (2) is designed to calculate the average rate of certain criteria, see Appendix (D). The questionnaire is spreaded over engineers with experience in the selection of consulting offices. Table (1) shows the results of the average rate of certain criteria.

Table (1) Average rate of certain criteria

No.	The criteria	Unit	Average
1.	Number of Engineers and architects.	number	31
2.	Average years the experience to engineers and architects.	year	13
3.	Average number of months training for the engineers in the office	month	10.5
4.	Ratio of the certificate holders (master) from engineers	%	80.3
5.	Ratio of the certificate holder (bachelor) from engineers	%	69.3
6.	Percentage of registered engineers in professional organizations.	%	45
7.	Number of assistants technicians	number	34
8.	Average years of experience technician's assistants	year	13.7
9.	Average number of months training for technicians in the office	month	13.7
10.	Rate of the certificate holders (diploma) from technician's	%	62.9
11.	Percentage of registered technicians in professional organizations	%	34.7
12.	Number of years' experience for the office	year	15
13.	Number the previous projects in the same field and the task	number	25
14.	The average value of previous projects in the same field and the same task	LY D	353,725
15.	Number the previous projects in the other fields and the tasks	number	4
16.	The average value of previous projects in the other fields and the tasks	LY D	280,225
17.	The no. of previous owners of projects who have been dealing with them	number	13
18.	Percentage of client repetition who have been dealing with them	%	40
19.	Number of previous projects in the same field and the task	number	65
20.	Number of previous projects in the fields and other	number	75
21.	Average of office area	m^2	380
22.	Average of number consultant office the branches	number	3.2
23.	Average number of months the training provided for staff	month	1.4
24.	Number posts in scientific conferences and seminars	number	6

5. Evaluation methodology

The weights of relative importance for each main and sub-criteria are used to assess a consulting office using the following equations for both of design and supervision stages.

$$E_{HC}{}^{d} = \sum_{i=1}^{6} E_i^d W_i + \sum_{j=1}^{6} E_j^d W_j \quad (1)$$

$$E_{HC}{}^{s} = \sum_{i=1}^{6} E_i^s W_i + \sum_{j=1}^{6} E_j^s W_j \quad (2)$$

$$E_{OE} = \sum_{oe=1}^{4} E_{oe} W_{oe} \quad (3)$$

$$E_{PP} = \sum_{pp=1}^{3} E_{pp} W_{PP} \quad (4)$$

$$E_{QC} = \sum_{qc=1}^{2} E_{qc} W_{qc} \quad (5)$$

$$E_{OQ}{}^{d} = \sum_{oq=1}^{3} E_{oq}^d W_{oq} \quad (6)$$

$$E_{OQ}{}^{s} = \sum_{oq=1}^{3} E_{oq}^{s} W_{oq} \quad (7)$$

$$E_{TD} = \sum_{td=1}^{3} E_{td} W_{td} \quad (8)$$

$$E_{AS} = \sum_{as=1}^{4} E_{as} W_{as} \quad (9)$$

$$\mathrm{FED} = E_{HC}{}^{d}\mathrm{W_{HC}} + E_{OE}\mathrm{W_{OE}} + E_{PP}\mathrm{W_{PP}} + E_{QC}\mathrm{W_{QC}} + E_{OQ}{}^{d}W_{OQ} + E_{TD}W_{TD} + E_{AS}W_{AS} \quad (10)$$

$$\mathrm{FES} = E_{HC}{}^{s}\mathrm{W_{HC}} + E_{OE}\mathrm{W_{OE}} + E_{PP}\mathrm{W_{PP}} + E_{QC}\mathrm{W_{QC}} + E_{OQ}{}^{s}W_{OQ} + E_{TD}W_{TD} + E_{AS}W_{AS} \quad (11)$$

Where:

$E_{HC}{}^{d}$	The human capabilities criterion evaluation in design stage
E_{i}^{d}	Evaluation of the sub-criteria (engineers criterion) in design stage
E_{j}^{d}	Evaluation of the sub-criteria (technicians criterion) in design stage
E_{i}^{s}	Evaluation of the sub-criteria (engineers criterion) in supervision stage
E_{j}^{s}	Evaluation of the sub-criteria (technicians criterion) in supervision stage
$E_{HC}{}^{s}$	The human capabilities criterion evaluation in supervision stage
W_{i}	Weight of the engineers criterion
W_{j}	Weight of the technicians criterion
E_{OE}	The office experience criterion evaluation
E_{oe}	Evaluation of the sub-criteria (office experience criterion)
W_{oe}	Weight of the sub-criteria (office experience criterion)
E_{PP}	The previous performance level criterion evaluation
E_{pp}	Evaluation of the sub-criteria (previous performance level criterion)
W_{pp}	Weight of the sub-criteria (previous performance level criterion)
E_{QC}	The quality control criterion evaluation
E_{qc}	Evaluation of the sub-criteria (quality control criterion)
W_{qc}	Weight of the sub-criteria (quality control criterion)
$E_{OQ}{}^{d}$	The office equipment criterion evaluation in design stage
E_{oq}^{d}	Evaluation of the sub-criteria (office equipment) in design stage
$E_{OQ}{}^{s}$	The office equipment criterion evaluation in supervision stage
E_{oq}^{s}	Evaluation of the sub-criteria (office equipment) in supervision stage
W_{oq}	Weight of the sub-criteria (office equipment criterion)
E_{TD}	The training and development criterion evaluation
E_{td}	Evaluation of the sub-criteria (training and development)
W_{td}	Weight of the sub-criteria (training and development criterion)
E_{AS}	The administrative system criterion evaluation
E_{as}	Evaluation of the sub-criteria (administrative system)
W_{as}	Weight of the sub-criteria (administrative system criterion)
$\mathrm{W_{HC}}$	Weight of the human capabilities criterion
$\mathrm{W_{OE}}$	Weight of the office experience criterion

W_{PP}	Weight of the previous performance level criterion
W_{QC}	Weight of the quality control criterion
W_{OQ}	Weight of the office equipment criterion
W_{TD}	Weight of the training and development criterion
W_{AS}	Weight of the administrative system criterion
FED	Final evaluation in design stage
FES	Final evaluation in supervision stage

Figure (4) illustrates the evaluation process for consultant office in design and supervision stages.

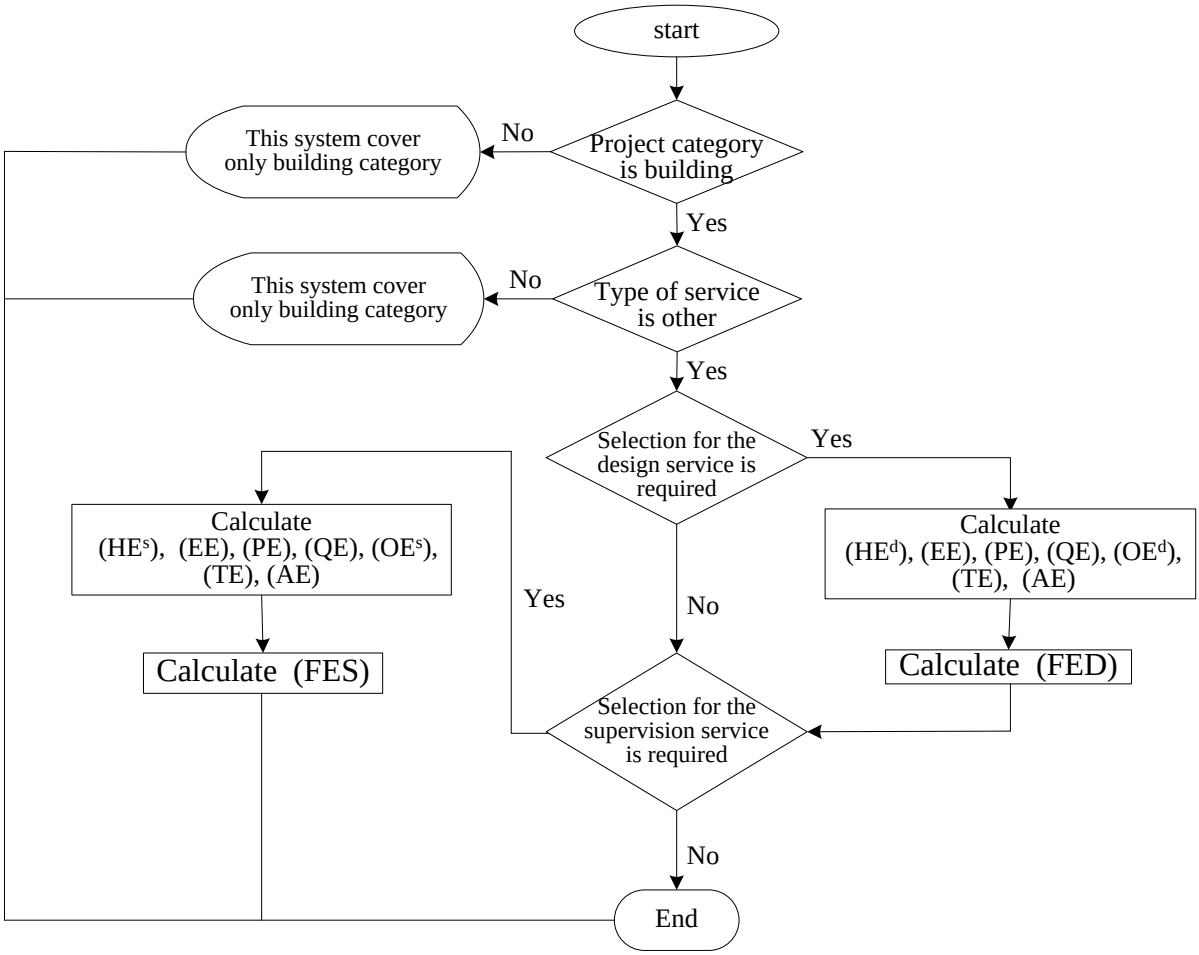


Fig. (4) The flowchart for the evaluation for consultant office

6. Application for selecting the best consultant office: case study

In this section, an administrative buildings project is assumed and it is required to select an office out of four offices (A, B, C, and D). Here, different information's about the four offices are gathered. These information are listed in Appendix (E). These information's are then analyzed using the techniques presented in the previous section. The final evaluation for each office is calculated and the results are shown in Table (2).

Table (2) Summary of the results

The criteria	The evaluation for the consultant office							
	office C		office A		office D		office B	
	Design	Supervision	Design	Supervision	Design	Supervision	Design	Supervision
Human capabilities	23.35	23.4	18.56	18.56	20.62	20.62	15.6	15.74
Office experience	18.79	18.79	17.67	17.67	17.88	17.88	19.68	19.68
Previous performance level	14.53	14.53	14.26	14.26	14.68	14.68	14.3	14.3
Quality control	16.4	16.4	15.3	15.3	12.6	12.6	14.88	14.88
Office equipment	4.66	4.32	4.73	4.73	5.21	4.31	5.21	4.31
Training and development	12.56	12.56	13.01	13.01	11.06	11.06	10.62	10.62
Administrative system	9.23	9.23	8.02	8.02	6.24	6.24	7.6	7.6
Final evaluation	**99.52**	**99.23**	**91.55**	**91.55**	**88.29%**	**87.39%**	**87.89%**	**87.13**

5. Conclusions

The main conclusions may be drawn from this paper as follows:
[1] Scientific methodology of the selection on consulting offices based on (AHP) can be successfully applied to calculate the weights of the selection criteria through bilateral comparison between criteria in Libya.
[2] For the governmental construction projects in Libya, the weights of the relative importance of the main criteria that should be used in classification and the selection of consulting offices are: human capabilities (23.4 %), office experience (17.9), assurance and quality control (16.3), performance previous level (14.7%), training and development (12.9%), administrative system (9.9%), office equipment (4.9%).
[3] Application of the classification criteria to consulting offices allows to choose the best office for the design and supervision stages. The application shows the potential of the developed criteria for the selection of the best consultant office.

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Appendix A: Questionnaire Number (1)

Rate of the relative importance for each criteria

The values of the comparisons: (9) means extreme importance, (7) implies very strong importance, (5) mean strong importance, (3) equals moderate importance, (1) means equal importance. The values (2), (4), (6) and (8) are used when compromise is needed.

- **The relative importance for the main criteria**

The main criteria	Human capabilities	Office experience	Performance level	Quality control	Office equipment	Training and development	Administrative system
Human capabilities		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Office experience			[ ]	[ ]	[ ]	[ ]	[ ]
Performance level				[ ]	[ ]	[ ]	[ ]
Quality control					[ ]	[ ]	[ ]
Office resources						[ ]	[ ]
Training and development							[ ]
Administrative system							

- **The relative importance of the sub-criteria (engineers criterion)**

The criteria	Number	Training	Experience	Qualification	Registry in professional organizations	Provides disciplines
Number of Eng.		[ ]	[ ]	[ ]	[ ]	[ ]
Training of Eng.			[ ]	[ ]	[ ]	[ ]
Experience of Eng.				[ ]	[ ]	[ ]
Qualification of Eng.					[ ]	[ ]
Registry in professional organizations						[ ]
Provides disciplines						

- **The relative importance of the sub-criteria (disciplines criterion for design stage)**

The criteria	Architect	Structural	Plumbing	Mechanical	Electrical	Planning and scheduling	Preparation costs
Architect		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
structural			[ ]	[ ]	[ ]	[ ]	[ ]
Plumbing				[ ]	[ ]	[ ]	[ ]
Mechanical					[ ]	[ ]	[ ]
Electrical						[ ]	[ ]
Planning and scheduling							[ ]
Preparation costs							

- **The relative importance of the sub-criteria (disciplines criterion for supervision stage)**

The criteria	Architect	Structural	Plumbing	Mechanical	Electrical	Planning and scheduling	Preparation costs
Architect		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
structural			[ ]	[ ]	[ ]	[ ]	[ ]
Plumbing				[ ]	[ ]	[ ]	[ ]
Mechanical					[ ]	[ ]	[ ]
Electrical						[ ]	[ ]
Planning and scheduling							[ ]
Preparation costs							

- **The relative importance of the sub-criteria (technicians criterion)**

The criteria	Number	Training	Experience	Qualification	Registry in professional organizations	Provides disciplines
Number of Tech.		[ ]	[ ]	[ ]	[ ]	[ ]
Training of Tech.			[ ]	[ ]	[ ]	[ ]
Experience of Tech.				[ ]	[ ]	[ ]
Qualification of Tech.					[ ]	[ ]
Registry in professional organizations						[ ]
Provides disciplines						

Appendix A: (Continue) Questionnaire Number (1)

Rate of the relative importance for each criteria

The values of the comparisons: (9) means extreme importance, (7) implies very strong importance, (5) mean strong importance, (3) equals moderate importance, (1) means equal importance. The values (2), (4), (6) and (8) are used when compromise is needed.

- **The relative importance of the sub-criteria (disciplines criterion for design stage)**

The criteria	Starter specifications	Painter	Estimates specialist	Quantities specialist	Contracts specialist	Scheduling project specialist
Starter specifications		[ ]	[ ]	[ ]	[ ]	[ ]
Painter			[ ]	[ ]	[ ]	[ ]
Estimates specialist				[ ]	[ ]	[ ]
Quantities specialist					[ ]	[ ]
Contracts specialist						[ ]
Scheduling project specialist						

- **The relative importance of the sub-criteria (disciplines criterion for supervision stage)**

The criteria	Quantities specialist	Contracts specialist	Scheduling project specialist	Inspector	Safety specialist	Surveyor
Quantities specialist		[ ]	[ ]	[ ]	[ ]	[ ]
Contracts specialist			[ ]	[ ]	[ ]	[ ]
Scheduling specialist				[ ]	[ ]	[ ]
Inspector					[ ]	[ ]
Safety specialist						[ ]
Surveyor						

- **The relative importance of the sub-criteria (office experience criterion)**

The criteria	Experience years	Previous projects in the same field and task	Previous projects in the other field and task	Dealing with the owners of previous projects
Experience years		[ ]	[ ]	[ ]
Previous projects in the same field and same task			[ ]	[ ]
Previous projects in the others field and tasks				[ ]
Dealing with the owners of previous projects				

- **The relative importance of the sub-criteria (previous projects in the same field and same task criterion)**

The criteria	Number previous projects	The average value of previous projects
Number previous projects		[ ]
The average value of previous projects		

- **The relative importance of the sub-criteria (previous projects in the others field and others task criterion)**

The criteria	Number previous projects	The average value of previous projects
Number previous projects		[ ]
The average value of previous projects		

- **The relative importance of the sub-criteria dealing with the owners of previous projects criterion**

The criteria	The number of previous owners of projects	Percentage of owners of previous projects
The number of previous owners of projects		[ ]
Percentage of owners of previous projects		

- **The relative importance of the sub-criteria previous performance level criterion**

The criteria	the performance in the same field and task	performance in the other fields and tasks	Use of the self-assessment methodology
The performance in the same field and task		[ ]	[ ]
Performance in the other fields and tasks			[ ]
Use of the self-assessment methodology			

- **The relative importance of the sub-criteria assurance and quality control criterion**

The criteria	Assurance program and quality control	Obtain certificates quality
Assurance program and quality control		[ ]
Obtain certificates quality		

Appendix A: (Continue) Questionnaire Number (1)

Rate of the relative importance for each criteria

The values of the comparisons: (9) means extreme importance, (7) implies very strong importance, (5) mean strong importance, (3) equals moderate importance, (1) means equal importance. The values (2), (4), (6) and (8) are used when compromise is needed.

- **The relative importance of the sub-criteria (office equipment criterion)**

The criteria	Office area	Number of branches	The use of new technologies
Office area		[ ]	[ ]
number of branches			[ ]
The use of new technologies			

- **The relative importance of the sub-criteria (use of new technologies criterion for design stage)**

The criteria	Design	Drawing	Scheduling	Cost estimating	Management information systems	Electronic archiving
Design software		[ ]	[ ]	[ ]	[ ]	[ ]
Drawing			[ ]	[ ]	[ ]	[ ]
Scheduling				[ ]	[ ]	[ ]
Cost estimating					[ ]	[ ]
Management information system						[ ]
Electronic archiving						

- **The relative importance of the sub-criteria (use of new technologies criterion for supervision stage)**

The criteria	Scheduling software	Management information system	Electronic archiving
Scheduling software		[ ]	[ ]
Management information system			[ ]
Electronic archiving			

- **The relative importance of the sub-criteria (training and development criterion)**

The criteria	Staff training	Conferences participation	Library provides
Staff training		[ ]	[ ]
Conferences participation			[ ]
Library provides			

- **The relative importance of the sub-criteria (library provides criterion)**

The criteria	Copy specifications standards	Subscribe in specialized periodical magazines	Providing internet connection
Copy specifications and standards		[ ]	[ ]
Subscribe in specialized periodical magazines			[ ]
Providing internet connection			

- **The relative importance of the sub-criteria (administrative system criterion)**

The criteria	Procedures manual	Detailed scheduling for project every	Risk management program	Cost control program
Procedures manual		[ ]	[ ]	[ ]
Detailed scheduling for project every			[ ]	[ ]
Risk management program				[ ]
Cost control program				

Contracting companies / Government institutions / Consulting offices

No.	Expert	Contact information
1.	Device development and the development of administrative	www.nwd-ly.com
2.	National Company for the drilling and maintenance	www.gecol.ly
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4.	Railroads Project Execution and Management Board	www.railroads.org.ly
5.	Public Electrical Work Company	www.nricly.com
6.	Implementation Device of Housing Projects	www.hib.org.ly
7.	Africa Engineering and Projects Company	(+218) 21 4800574
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10.	National Company for housing and utilities contribute	www.nahuco.ly
11.	The General Electricity Company	www.amanplast.com
12.	Interest roads and land -The Ministry of Transportation	http://www.raba.ly
13.	Libyan Urban Planning Association	www.Gb.ly
14.	Interest of public lands	www.amlak.com.ly
15.	The Ministry of Planning - Projects Management Office	www.planning.gov.ly
16.	National Consulting Bureau	www.ucc.ly
17.	Terrace Engineering Consultants	www.terrace.ly
18.	Alsabagco Company for Contracting and Real Estate	www.alsabagco.com
19.	Tarek Al Amal General contracting	www.tagecoly.com
20.	Company of the standard for engineering works	www.almayar.ly
21.	Aracekhoon for Contracting General	www.alatkan.com
22.	Adi for Contracting General	www.majdal.ly
23.	Professional Work Company for General Contracting	www.sarycons.com
24.	Acacos Company for Construction & Investment	www.immartripoli.com
25.	Libyan Union for Construction Contract	www.aracekhoon.com
26.	Al-ebhar General Construction & Real Estate	www.pwcgc.com
27.	Golden Bridge Co Contracting and Real Estate	www.alasass.com
28.	Arab Contractors Osman Ahmed Osman & Co -Libya	wetco.blogspot.com
29.	New Tripoli's Contracting and Real Estate Investment	www.expoarabia.com
30.	FESSATO for Engineering Services (F.E.S.C)	www.fessato.org.ly

Appendix C: The obtained weights of relative importance

~~**Appendix B: List of chosen experts in Libya**~~

No.	The criteria		Weights	
Human capabilities			**0.234**	
	Engineers		L=0.791	G=0.185
	Technicians		L=0.209	G=0.049
Sum			1	**0.234**
	•	Number of engineers	0.073	
	•	Experience of engineers	0.294	
	•	Training of engineers	0.187	
	•	Qualification of engineers	0.166	
	•	Registry in organizations	0.067	
	•	Disciplines:	0.213	
Sum			1	
	•	Architect engineer	0.27	0.23
	•	Structural engineer	0.247	0.251
	•	Plumbing engineer	0.115	0.079
	•	Mechanical engineer (HVAC)	0.096	0.077
	•	Electrical engineer	0.125	0.098
	•	Planning and scheduling engineer	0.071	0.188
	•	Preparation costs engineer	0.076	0.077
Sum			1	1
	•	Number of technicians	0.096	
	•	Experience of technicians	0.301	
	•	Training of technicians	0.187	
	•	Qualification of technicians	0.152	
	•	Registry in organizations	0.063	
	•	Disciplines:	0.200	
Sum			1	
	•	Starter specifications	0.155	---
	•	Painter	0.239	---
	•	Estimates specialist	0.170	---
	•	Quantities specialist	0.177	0.319
	•	Contracts specialist	0.131	0.153
	•	Scheduling specialist	0.127	0.135
	•	Inspector	---	0.164
	•	Safety technicians	---	0.098
Sum			1	1
Office experience			**0.179**	
	Experience years		L=0.263	G=0.047
	Previous projects in the same field and the task		L=0.527	G=0.095
	Previous projects in the fields and other tasks		L=0.118	G=0.020
	Dealing with the owners of previous projects		L=0.092	G=0.017
Sum			1	**0.179**
	•	Number previous projects in the same field and the task	0.481	
	•	Average of previous projects in the same field and the task	0.519	

Appendix C: (Continue) The obtained weights of relative importance

No.	The criteria	Weights	
Sum		1	
	• Number previous projects in the fields and other tasks	0.386	
	• Average of previous projects in the fields and other tasks	0.614	
Sum		1	
	• The number of previous owners of projects	0.433	
	• Percentage of owners of previous projects	0.567	
Sum		1	
Previous performance level		**0.147**	
	The performance evaluation in the same field and the task	L=0.499	G=0.073
	The performance evaluation in the other fields and tasks	L=0.187	G=0.028
	Use of the self-assessment methodology	L=0.314	G=0.046
Sum		1	**0.147**
Quality control		**0.163**	
	Quality control program	L=0.463	G=0.076
	Quality certificates	L=0.537	G=0.087
Sum		1	**0.163**
Office equipment		**0.049**	
	Office area	L=0.163	G=0.008
	Number consultant office the branches	L=0.207	G=0.010
	The use of new technologies:	L=0.630	G=0.031
Sum		1	**0.049**
	• Design software's	0.295	---
	• Drawing programs	0.260	---
	• Cost estimating software's	0.103	---
	• Scheduling programs	0.131	0.399
	• Management information systems	0.121	0.328
	• Electronic archiving	0.090	0.272
Sum		1	1
Training and development		**0.129**	
	Staff training in their field of specialization	L=0.559	G=0.072
	The participate in the scientific conferences	L=0.180	G=0.023
	Presence integrated library contains the following:	L=0.261	G=0.034
Sum		1	**0.129**
	• New copies of specifications and standards	0.40	
	• Subscribe in specialized periodical magazines	0.40	
	• Providing internet connection	0.20	
Sum		1	
Administrative system		**0.099**	
	Procedures manual	L=0.341	G=0.034
	Projects scheduling system	L=0.360	G=0.036
	Risk management program	L=0.134	G=0.013
	Cost management program	L=0.165	G=0.016
Sum		1	**0.099**

Appendix D: Questionnaire (2) the average rate of certain criteria

•The average number of engineers							
Give a value from 1-100							
•The average experience years							
☐	5	☐	10	☐	15	☐	>20 years
•The average number of months training							
☐	5	☐	10	☐	15	☐	20
•The average percentage of registered engineers in specialized professional organizations							
☐	25%	☐	50%	☐	75%	☐	100%
•The ratio the certificate holders (Master)							
☐	25%	☐	50%	☐	75%	☐	100%
•The ratio the certificate holders (Bachelor)							
☐	25%	☐	50%	☐	75%	☐	100%
•The average number of technicians							
Give a value from 1-100							
•The average experience years							
☐	5	☐	10	☐	15	☐	>20 years
•The average number of months training							
☐	5 months	☐	10 months	☐	15 month	☐	20 month
•The average percentage of registered engineers in specialized professional organizations							
☐	25%	☐	50%	☐	75%	☐	100%
•The ratio the certificate holders (Diploma)							
☐	25%	☐	50%	☐	75%	☐	100%
•The average of experience years for the office							
☐	10	☐	15	☐	20	☐	25
•The average number of previous projects in the same field and the same task							
☐	15	☐	20	☐	25	☐	30
•The average values the previous projects in the same field and the same task							
☐	200	☐	400	□	600	☐	800
•The average number of previous projects in the same field (building) and the same task (design)							
☐	25	☐	50	☐	75	☐	100
•The average number of previous projects in the other fields and others tasks							
☐	3	☐	6	☐	9	☐	12
•The average values the previous projects in the other fields and tasks, construction cost, (LYD)							
☐	200	☐	300	☐	400	☐	500
•The average number of previous projects in the fields and other tasks							
☐	25	☐	50	☐	75	☐	100
•The average number of previous owners of projects who have been dealing with them							
☐	5	☐	10	☐	15	☐	20
•The average percentage of owners repetition who has been dealing with them							
☐	20 %	☐	40%	☐	60%	☐	80%
•The average office area							
☐	200 m^2	☐	300 m^2	☐	400 m^2	☐	500 m^2
•The average number of consultant office the branches							
☐	1	☐	2	☐	3	☐	4
•The average of the training months provided by the office for staff							
☐	0.5 month	☐	1 month	☐	1.5 month	☐	2 month
•The average posts in scientific conferences and seminars							
☐	2	☐	4	☐	6	☐	8

Appendix E:

Basic information for the office

Name of the consultant office:		----------		
Telephone:	----------	Mobile:	----------	
E-mail:	----------	Website:	----------	
Field of selection required:		☐ Buildings	☐ other	
Selection task required:		☐ Design	☐ Supervise	☐ other

Information about all the engineers in the office

No.	Name	Qualification scientific	Graduation year	Training period (month)		Specialty	Professional association membership
				Since graduation	By working in the office		
1.	---	---	---	---	---	---	☐
2.	---	---	---	---	---	---	☐
n.	---	---	---	---	---	---	☐

Information about all the technicians in the office

No.	Name	Qualification scientific	Graduation year	Training period (month)		Specialty	Professional association membership
				Since graduation	By working in the office		
1.	---	---	---	---	---	---	☐
2.	---	---	---	---	---	---	☐
n.	---	---	---	---	---	---	☐

Information about the projects implemented out by the office

No.	Type of project	Owner	The cost of implementing the project	Task the office in the project	Project field	Date end the contract	Assessment the performance of the office
1.	---	---	---	---	---	---	---
2.	---	---	---	---	---	---	---
n.	---	---	---	---	---	---	---

General data for the office

(4)	1st project start date	-------/--------/-------
(5)	The number of previous owners of projects	[ ]
(6)	Percent of client repetition	[ ]
(7)	Total office area (m^2)	[ ]
(8)	Number consultant office the branches	[ ]
(9)	Number of posts in scientific conferences and symposia	[ ]

Technical expertise to the office

(10) Extent to use the office for the following programs:					
● The used program: gives a grade 100 ☑					
● The unused program: gives a degree zero ☒					
(a)	Quality certificate	☐	Yes	☐	No
(b)	Design software's	☐	Yes	☐	No
(c)	Drawing programs	☐	Yes	☐	No
(d)	Cost estimating software's	☐	Yes	☐	No
(e)	Scheduling software's	☐	Yes	☐	No
(f)	Management information system (MIS)	☐	Yes	☐	No
(g)	Electronic archiving	☐	Yes	☐	No
(h)	Internet connection	☐	Yes	☐	No

(11) Assessment use the following programs in the office, between (0-100):

No.	The program	Grade
(a)	Performance assessment self-methodology	[ ]
(b)	Program assurance and quality control	[ ]
(c)	Copies of specifications and standards	[ ]
(d)	Participate in specialized magazines and periodicals.	[ ]
(e)	Procedures manual	[ ]
(f)	● Prepare a detailed schedule for each project ● Supervision and periodic follow the stages of completion of the project	[ ]
(g)	costs management system	[ ]
(h)	Risk management program	[ ]