

A Selection Method In Construction Project Management Using Analytic Network Process (ANP) As A Tool In Decision

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Abstract: The role of Construction Project Management in selecting the best contractor is necessary to eliminate the risks of project failure due to poor contractor's performance. Therefore, the evaluation of the prospective contractor's capability in a pre-qualification process is one of the important decisions to be made before executing the project. Instead of the existing industry practice in contractor selection which is based on expert judgement, reputation and lowest offer, a range of decision making tools that rely on multi-attribute ranking are available for solving the problem. In this paper the use of multi-criteria decision-making (MCDM) is suggested in determining criteria weights and contractor's selection during prequalification process. The analytic network process (ANP) is proposed to allow interdependent influences specified in the decision model. An example is illustrated to show how this tool is used, including the development of supermatrix and limit matrix. The result is compared to analytic hierarchy process (AHP) widely used tool for MCDM in ranking the score of each criterion and contractor. The results show that there is chance to make possible the objectives and rationalize complex decisions problems in construction project management. The significance of this paper will introduce ANP as a decision-making tool in determining the order of each criteria used to select the best alternative. ANP allows options for owner and construction managers in the selection of the best contractor for construction project and other selection activities.

Key Words: construction project management; contractor selection; multi-criteria decision-making; analytic network process; analytical hierarchy process



1. INTRODUCTION

Management of construction project is carrying out in control: have a hold over quality, schedule and costs. The significance of contractor's pre-qualification process in construction project management cannot be set aside. From the initial step of the building process to turn over ceremony, construction contractors plays a vital role. Failure to properly select a competent contractor can lead to problems for the entire project. The proper selection of contractors increases chances of project delivery within cost, time and quality.

The pre-qualification of contractors are very often conducted during pre-construction stage in the form of bidding or tendering. During tendering the potential contractors are selected based on their reputation or a set of pre-qualification criteria and with lowest proposals as shown in appendix 2 and table 1, respectively. In years, most owners and construction project managers made use of such method. As a result the lowest bidders often have problems in completing the project within cost, time and quality.

Table 1. Example Prequalification Evaluation Result

Description	%wt		Contract	Contractor Rating		
		А	В	С	D	
Methodology	13	7.65	3.85	9.46	8.69	
Schedule	10	7.78	1.11	6.67	6.67	
Quality	10	10.00	5.00	10.00	10.00	
Safety	10	8.57	8.57	10.00	10.00	
Manpower	4	3.33	0.00	4.00	2.67	
Equipment	5	2.00	0.00	3.75	3.75	
Organization	8	6.67	5.33	7.33	7.33	
Personnel	10	4.17	0.00	5.00	6.67	
Financial	30	20.93	10.80	24.09	23.70	
Total Points	100	71.10	34.66	80.30	79.48	

Several researchers (Holt *et al*, 1994; Russell *et al*, 1992; Ng, 1992) have identified different criteria in use for contractor selection. In a recent study, Hatush and Skitmore (1996a) found that all clients use what are implicitly the same type of criteria, but vary in the way they quantify the criteria, with most having to resort to a very subjective assessment based on information provided by the contractors. These common set of prequalification criteria (financial capability, past performance, past experience, resources, current workload and safety performance). Also many techniques are proposed and applied as a solution such as multi-criteria decision-making (MCDM), multi-attribute utility theory (MAUT), multi regression (MR), cluster analysis (CA), bespoke approaches (BA), fuzzy set theory (FST) and multivariate discriminant analysis (MDA) (Hatush and Skitmore, 1997; Holt, 1998; Mahdi et al., 2002). Among the techniques, MCDM is the well-known technique used in contractor selection. Analytical Hierarchy Process (AHP) is a multi-criteria decisionmaking method using a set of criteria for a decision problem and assign weights to the criteria (Saaty, 1990; Kamal et al., 2001; Chun-Chang Lin et al., 2008; Jaskowski et al., 2010). In the existing studies of contractor selection, AHP is used to develop a hierarchical framework wherein multi-attribute decision problems will be ordered(Fong and Choi, 200; Madhi et al., 2002). Theoretically, AHP only employ uni-directional relation between decision levels and not appropriate for multi-directional relationship (Saaty, 1988; Meade and Sarkis, 1998). To enhance AHP, analytic network process (ANP) is developed. ANP is a generic form of AHP and allows for more complex interdependent relationships among elements (Saaty, 1996). It is also known as the systems with feedback approach (Meade and Sarkis, 1998).

The objective of this research paper is to introduce the application of Analytical Network Process (ANP) on the contractor pre-qualification process. The paper will briefly review the concepts and application of ANP's implementation steps, and demonstrate ANP application on the contractor selection problem. It is hoped that this will encourage its application in construction project management.

2. METHODOLOGY

This research paper improves the AHP model by adding interdependence among criteria and feedback dependence from alternatives. Figure 1 shows the strict hierarchical structure being objective is on the highest level, with criteria and alternatives on lower levels, respectively, (Petronijevic et al., 2015). Figure 2 shows the new ANP decision network model. The difference from AHP model is a feedback network with components which indicates inner and outer dependence among



elements and a loop indicating each element depends only on itself (Promentilla et al., 2005). The new model assumed the six criteria (C1, C2, C3, C4, C5, and C6) are interdependent and there is a feedback loop from elements in alternatives (A, B, C and D) to criteria elements. Data gathered from interviews and survey questionnaires in the previous study of Almeida (2016) were used in this research paper. Appendix 3 presents the sample data survey questionnaire. Table 2 shows the questions used for data collection. The pair-wise comparison matrices were formulated based from Saaty's 9-point priority scale measurement as shown in Table 3 and Judgment consistency ratio (CR) of CI = $(\lambda_{max} - n)/(n)$ - 1), n is the matrix size with the appropriate value in Table 4. If CR is more than 0.10, the judgment matrix is inconsistent (Saaty, 1990). This paper adopts the original pair-wise comparison results in Almeida (2016) who compared six criteria for the four alternative contractors as shown in Tables 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 13, 14, 15, 16, 17.

The local priority vectors from the original pair-wise comparisons on the elements of the cluster and sub-cluster levels of Almeida (2016) was adopted to achieved a supermatix, which in turn obtains global priorities. Table 18 shows the supermatrix which contains the priorities for the judgement matrices. After entering the sub-matrices into the supermatix and adjusting its values to achieve column stochastic as shown in Table 19. The supermatrix is raised to limiting powers until weights have converged and remain stable (Saaty, 1996; Meade and Sarkis, 1998; Promentilla et al., 2005) as presented in Table 20.

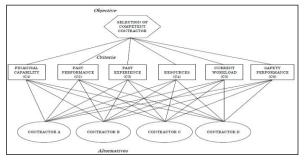


Fig.1, Hierarchical structure for AHP model

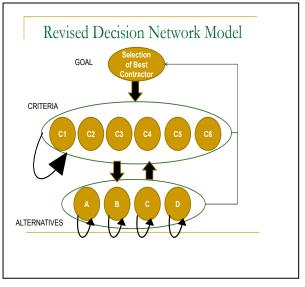


Fig.2, Analytic Network model

Table 2. Types of questions used for data collection

No.	Question	Answer
1	Which criteria between	Rating
	Financial Capability and	(1 to 9)
	Past Performance do you	
	think is best in contractor	
	selection?	
2	Which Contractor do you	
	think is best in Financial Capabi	lity?
3	Which criteria do you think is sat	isfied
	best by Contractor "A"?	

Table 3. Pair-wise comparison scale for AHP

	•
Numerical rating	Verbal judgments of preferences
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred



n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

3. RESULTS AND DISCUSSION

The AHP method was used in decision making process in selecting the best contractor during pre-qualification process. The ANP model consist of four alternatives as describe in appendix 1 and six criteria as follows:

C1 (Financial Capability) – involves contractor's sound financial position and profitability, here is considered minimum average annual construction turnover within the last five years;

C2 (Past Performance) – past client's levels of satisfaction with the quality of previous works and maintenance services during defects liability period by the contractors in the past five years;

C3 (Past Experience) – minimum value of contracts which are similar to the proposed works and which were successfully completed within the last five years;

 ${
m C4}$ (Resources) – availability of competent personnel, owned major plants and equipments for construction

C5 (Current Workload) – construction activities which are underway, on-going and nearing completion;

C6 (Safety Performance) – safety performance/ accident rate in the past five years;

The results obtained from ANP and AHP are compared to ascertain the value of the overall priority vector or weights of the criteria and alternatives. Table 17 shows the overall priority weights of the four alternatives based from ANP, as well as in AHP. In AHP where strict independency governs, contractor C has the largest priority weight which is the best alternative. While in ANP specify dependence and feedback, still contractor C with the highest priority weights is the best alternative.

Table 17 shows the comparison of priority weights of the six criteria based from ANP and AHP.

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In AHP, because of its limited application in simple hierarchical structures, Past Experience has the lowest priority weights among each criteria. Since ANP specify interdependent influences of each criteria, Safety Performance together with Current Workload has almost equal priority weights which explain the equal importance of the criteria during contractor selection process.

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Table 5. Pair	-wase com	narision	matrix	scores for	SIX (mtema
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	C1	C2	C3	C4	C5	C6	
C1	1	6	7	4	5	5	
C2	1/6	1	6	3	4	1	
C3	1/7	1/6	1	1	1	1	
C4	1/4	1/3	1	1	1	2	
C5	1/5	1/4	1	1	1	1	
C6	1/5	1	1	1/2	1	1	

m 11 a	NT 1º 1		C	•	• . •
Table 6	Normalized	matrix	tor	SIX	criteria
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	C1	C2	C3	C4	C5	C6	ω
C1	0.510	0.686	0.412	0.381	0.384	0.455	0.497
C2	0.085	0.114	0.353	0.286	0.308	0.091	0.200
C3	0.073	0.019	0.059	0.095	0.077	0.091	0.063
C4	0.128	0.038	0.059	0.095	0.077	0.182	0.089
C5	0.102	0.029	0.059	0.095	0.077	0.091	0.070
C6	0.102	0.114	0.059	0.048	0.077	0.091	0.085
						Σ =	1.00

 λ_{max} = 6.540, CI= 0.11, RI=1.24, CR= 0.086 < 0.10 OK.

Table 7. Pair-wise comparision matrix "alternatives"

1 4 510	· • • • • • •	wise com	par 15101.	mauna	anternati	1100
C1		А	В	С	D	
	А	1	3	1/2	1/2	
	В	1/3	1	1/4	1/4	
	С	2	4	1	1	
	D	2	4	1	1	
C2		А	В	С	D	
	А	1	5	1/2	1	
	В	1/5	1	1/5	1/4	
	С	2	5	1	2	
	D	1	4	1/2	1	
C3		А	В	С	D	
	А	1	4	1/2	1/3	
	В	1/4	1	1/5	1/6	
	С	2	5	1	1/2	



	D	3	6	2	1	
C4		А	В	С	D	
	А	1	6	1/3	1/2	
	В	1/6	1	1/8	1/7	
	С	3	8	1	1	
	D	2	7	1	1	
C5		А	В	С	D	
	А	1	2	1/2	1/2	
	В	1/2	1	1/2	1/3	
	С	2	2	1	1	
	D	2	3	1	1	
C6		А	В	С	D	
	А	1	1	1/2	1/2	
	В	1	1	1/3	1/2	
	С	2	3	1	1	
	D	2	2	1	1	

Table 8. Normalized matrix "alternatives"

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C1		А	В	С	D	ω
	А	0.188	0.25	0.182	0.182	0.200
	В	0.063	0.083	0.091	0.091	0.082
	С	0.375	0.333	0.364	0.364	0.359
	D	0.375	0.333	0.364	0.364	0.359
					Σ =	1.00
$\lambda_{max} = 4$.021,	CI=0.007	, RI=0.9	0, CR = 0	.008 < 0.1	0 OK.
C2		А	В	С	D	ω
	А	0.238	0.333	0.227	0.235	0.258
	В	0.048	0.067	0.091	0.059	0.066
	С	0.476	0.333	0.455	0.471	0.434
	D	0.238	0.267	0.227	0.235	0.242
					Σ =	1.00
$\lambda_{max} = 4$.047,	CI = 0.016	, RI=0.9	θ , CR= 0	.018 < 0.1	0 OK.
C3		А	В	\mathbf{C}	D	ω
	А	0.160	0.250	0.135	0.167	0.178
	В	0.040	0.063	0.054	0.083	0.060
	С	0.320	0.313	0.270	0.250	0.288
	D	0.480	0.375	0.541	0.500	0.476
					Σ =	1.00
$\underline{\lambda}_{max} = 4$.067,	CI= 0.022	, RI=0.9	θ , CR= 0	.025 < 0.1	<u>0 OK.</u>
C4		А	В	\mathbf{C}	D	ω
	А	0.162	0.272	0.170	0.137	0.188
	В	0.027	0.045	0.064	0.039	0.044

	С	0.486	0.364	0.511	0.549	0.413
	D	0.324	0.318	0.255	0.275	0.356
					Σ =	1.00
$\lambda_{max} = 4$.071,	CI= 0.024,	RI=0.9	, CR= 0.	.027 < 0.1	0 OK.
C5		А	В	С	D	ω

C5		А	В	С	D	ω
	А	0.182	0.250	0.167	0.176	0.194
	В	0.091	0.125	0.167	0.118	0.125
	С	0.364	0.250	0.333	0.353	0.326
	D	0.364	0.375	0.333	0.353	0.356
					Σ =	1.00
$\lambda_{max} = \Delta$	1.046.	CI = 0.015	. RI=0.9	CR=0	0.017 < 0.1	0 OK.

Λ_{max} = 4.046, CI= 0.015, RI=0.9, CR= 0.017 < 0.10 OK.									
C6		А	В	С	D	ω			
	А	0.167	0.143	0.176	0.167	0.163			
	В	0.167	0.143	0.118	0.167	0.148			
	\mathbf{C}	0.333	0.429	0.353	0.333	0.363			
	D	0.333	0.286	0.353	0.333	0.326			
					Σ =	1.00			

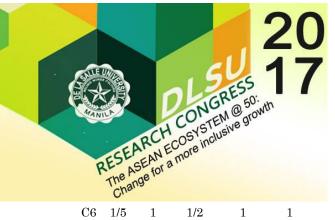
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\lambda_{max}= 4.021, CI= 0.007, RI=0.9, CR= 0.008 < 0.10 OK.
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Table	9.	Priority	matrix
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	А	В	С	D
C1(0.471)	0.200	0.082	0.359	0.359
C2(0.206)	0.258	0.066	0.434	0.242
C3(0.069)	0.178	0.060	0.288	0.476
C4(0.096)	0.188	0.044	0.413	0.356
C5(0.075)	0.194	0.125	0.326	0.356
C6(0.082)	0.163	0.148	0.363	0.326
Overall	0.206	0.083	0.374	0.341
priority vect	or			

Table 10. Pair-wise comparision matrix scores for six criteria Interdependency

mua						
C1	C2	C3	C4	C5	C6	
C2	1	6	3	4	1	
C3	1/6	1	1	1	1	
C4	1/3	1	1	1	2	
C5	1/4	1	1	1	1	
C6	1	1	1/2	1	1	
00	1	1	1/2	1	1	
C2	C1	C3	C4	C5	C6	
C2	C1	C3	C4	C5	C6	
C2 C1	C1 1	C3 7	C4 4	C55	C6 5	
C2 C1 C3	C1 1 1/7	C3 7 1	C4 4 1	C5 5 1	C6 5 1	



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C6	1/5	1	1/2	1	1	
C3	C1	C2	C4	C5	C6	
C1	1	6	4	5	5	
C2	1/6	1	3	4	1	
C4	1/4	1/3	1	1	2	
C5	1/5	1/4	1	1	1	
C6	1/5	1	1/2	1	1	
C4	C1	C2	C3	C5	C6	
C1	1	6	7	5	5	
C2	1/6	1	6	4	1	
C3	1/7	1/6	1	1	1	
C5	1/5	1/4	1	1	1	
C6	1/5	1	1	1	1	
C5	C1	C2	C3	C4	C6	
C1	1	6	7	4	5	
C2	1/6	1	6	3	1	
C3	1/7	1/6	1	1	1	
C4	1/4	1/3	1	1	2	
C6	1/5	1	1	1/2	1	
C6	C1	C2	C3	C4	C5	
C1	1	6	7	4	5	
C2	1/6	1	6	3	4	
C3	1/7	1/6	1	1	1	
C4	1/4	1/3	1	1	1	
C5	1/5	1/4	1	1	1	

Table 11. Normalized matrix for six different interdependency									
C1	C2	C3	C4	C5	C6	ω			
C2	0.364	0.600	0.462	0.500	0.167	0.423			
C3	0.061	0.100	0.154	0.125	0.167	0.119			
C4	0.121	0.100	0.154	0.125	0.333	0.163			
C5	0.091	0.100	0.154	0.125	0.167	0.126			
C6	0.364	0.100	0.077	0.125	0.167	0.169			
					ς –	1.00			
					Σ =	= 1.00			
λ _{max}	x= 5.43	5, CI=	0.11, F	RI=1.11	_	= 1.00 098 < 0.10 OK.			
$\frac{\lambda_{max}}{C2}$	x= 5.43 C1	,	0.11, F	RI=1.11 C5	_	1.00			
C2	C1	,	C4	C5	, CR= 0.	098 < 0.10 OK.			
C2 C1	C1 0.510	C3	C4 0.381	C5 0.384	, CR= 0. C6	098 < 0.10 OK. ω			
C2 C1 C3	C1 0.510 0.073	C3 0.412	C4 0.381 0.095	C5 0.384 0.077	, CR= 0. C6 0.455	098 < 0.10 OK. ω 0.559			
C2 C1 C3 C4	C1 0.510 0.073 0.128	C3 0.412 0.059	C4 0.381 0.095 0.095	C5 0.384 0.077 0.077	, CR= 0. C6 0.455 0.091	098 < 0.10 OK. ω 0.559 0.103			

					Σ =	1.00	
C6	0.102	0.059	0.048	0.077	0.091	0.096	
C5	0.102	0.059	0.095	0.077	0.091	0.109	

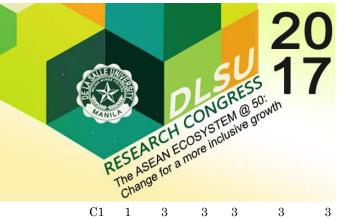
 $\overline{\lambda_{max}}$ = 5.072, CI= 0.18, RI=1.11, CR= 0.016 < 0.10 OK.

C3	C1	C2	C4	C5	C6	ω	
C1	0.510	0.686	0.381	0.384	0.455	0.534	
C2	0.085	0.114	0.286	0.308	0.091	0.183	
C4	0.128	0.038	0.095	0.077	0.182	0.105	
C5	0.102	0.029	0.095	0.077	0.091	0.079	
C6	0.102	0.114	0.048	0.077	0.091	0.095	
					Σ	= 1.00	
λ́ma	x= 5.44	7, CI=	0.11, F	RI=1.11	, CR= (0.10 = 0.10	OK.
C 4	C1	C2	C3	C5	C6	ω	
C1	0.510	0.686	0.412	0.384	0.455	0.564	
C2	0.085	0.114	0.353	0.308	0.091	0.197	
C3	0.073	0.019	0.059	0.077	0.091	0.065	
C5	0.102	0.029	0.059	0.077	0.091	0.074	
C6	0.102	0.114	0.059	0.077	0.091	0.101	
					Σ :	= 1.00	
λ́ma	x= 5.44	9, CI=	0.11, F	RI=1.11	, CR= (0.10 = 0.10	OK.
C5	C1	C2	C3	C4	C6	ω	
C1	0.510	0.686	0.412	0.381	0.455	0.556	
C2	0.085	0.114	0.353	0.286	0.091	0.191	
C3	0.073	0.019	0.059	0.095	0.091	0.067	
C4	0.128	0.038	0.059	0.095	0.182	0.084	
C6	0.102	0.114	0.059	0.048	0.091	0.102	
					Σ :	= 1.00	
$\lambda_{\rm ma}$	x= 5.43	5, CI=	0.11, F	RI=1.11	, CR= (0.098 < 0.1	0 OK.
C6	C1	C2	C3	C4	C5	ω	
C1	0.510	0.686	0.412	0.381	0.384	0.562	
C2	0.085	0.114	0.353	0.286	0.308	0.226	
C3	0.073	0.019	0.059	0.095	0.077	0.062	
C4	0.128	0.038	0.059	0.095	0.077	0.080	
C5	0.102	0.029	0.059	0.095	0.077	0.071	
					Σ=	1.00	
Χ	- 5 26	0 CI -	0 11 F	DT-1 11	CP = 0	0.083 < 0.10	ON

 λ_{max} = 5.369, CI= 0.11, RI=1.11, CR= 0.083 < 0.10 OK.

Table 12. Pair-wise comparision matrix scores for criteria and alternative feedback

A	C1	C2	C3	C4	C5	C6	
C1	1	1	4	3	3	3	
C2	1	1	3	3	3	3	
C3	.25	.33	1	.33	2	2	
C4	.33	.33	3	1	.33	4	
C5	.33	.33	5	3	1	5	
C6	.33	.33	.50	.25	.20	1	
В	C1	C2	C3	C4	C5	C6	



C1	1	3	3	3	3	3	
C2	.33	1	2	2	2	2	
C3	.33	.50	1	.33	.33	.33	
C4	.33	.50	3	1	.25	.25	
C5	.33	.50	3	4	1	1	
C6	.33	.50	3	4	1	1	
С	C1	C2	C3	C4	C5	C6	
C1	1	.33	3	.20	1	1	
C2	3	1	5	1	5	5	
C3	.33	.20	1	.20	.25	25	
C4	5	1	5	1	5	2	
C5	1	.20	4	.20	1	1	
C6	1	.20	4	.50	1	1	
D	C1	C2	C3	C4	C5	C6	
C1	1	3	.33	3	1	1	
C2	.33	1	.20	1	.33	.50	
C3	3	5	1	4	3	3	
C4	5	1	.25	1	.33	2	
C5	1	3	.33	3	1	2	
C6	1	2	.33	.5	.50	1	

Table 13. Normalized matrix for criteria and alternative feedback dependence

Α	C1	C2	C3	C4	C5	C6	ω			
C1	0.395	0.300	0.194	0.283	0.388	0.167	0.291			
C2	0.079	0.300	0.194	0.283	0.388	0.167	0.281			
C3	0.132	0.100	0.065	0.031	0.025	0.111	0.062			
C4	0.132	0.100	0.193	0.094	0.043	0.222	0.116			
C5	0.132	0.100	0.322	0.283	0.129	0.278	0.198			
C6	0.132	0.100	0.032	0.024	0.026	0.056	0.052			
						Σ =	1.00			
$\overline{\lambda_{max}}$ = 6.601, CI= 0.12, RI=1.24, CR= 0.096 < 0.10 OK.										
В	C1	C2	C3	C4	C5	C6	ω			
			00	<u> </u>						
	-	-		-		0.396				
	0.387	0.500	0.200	0.209	0.396		0.349			
C1	0.387 0.097	0.500 0.167	0.200 0.133	0.209 0.139	0.396	0.396	0.349 0.187			
C1 C2	0.387 0.097 0.129	0.500 0.167 0.083	0.200 0.133 0.067	0.209 0.139 0.023	0.396 0.364	$0.396 \\ 0.264$	0.349 0.187 0.061			
C1 C2 C3 C4	0.387 0.097 0.129 0.129	0.500 0.167 0.083 0.083	0.200 0.133 0.067 0.200	0.209 0.139 0.023 0.070	0.396 0.364 0.044	0.396 0.264 0.044	0.349 0.187 0.061 0.085			
C1 C2 C3 C4 C5	0.387 0.097 0.129 0.129 0.129	0.500 0.167 0.083 0.083 0.083	0.200 0.133 0.067 0.200 0.200	0.209 0.139 0.023 0.070 0.279	0.396 0.364 0.044 0.033	0.396 0.264 0.044 0.033	0.349 0.187 0.061 0.085 0.159			
C1 C2 C3 C4 C5	0.387 0.097 0.129 0.129 0.129	0.500 0.167 0.083 0.083 0.083	0.200 0.133 0.067 0.200 0.200	0.209 0.139 0.023 0.070 0.279	0.396 0.364 0.044 0.033 0.132	$\begin{array}{c} 0.396 \\ 0.264 \\ 0.044 \\ 0.033 \\ 0.132 \\ 0.132 \end{array}$	0.349 0.187 0.061 0.085 0.159			
C1 C2 C3 C4 C5 C6	0.387 0.097 0.129 0.129 0.129 0.129	$\begin{array}{c} 0.500 \\ 0.167 \\ 0.083 \\ 0.083 \\ 0.083 \\ 0.083 \end{array}$	$\begin{array}{c} 0.200 \\ 0.133 \\ 0.067 \\ 0.200 \\ 0.200 \\ 0.200 \end{array}$	0.209 0.139 0.023 0.070 0.279 0.279	$\begin{array}{c} 0.396\\ 0.364\\ 0.044\\ 0.033\\ 0.132\\ 0.132\\ \end{array}$	$\begin{array}{c} 0.396 \\ 0.264 \\ 0.044 \\ 0.033 \\ 0.132 \\ 0.132 \end{array}$	$\begin{array}{c} 0.349 \\ 0.187 \\ 0.061 \\ 0.085 \\ 0.159 \\ 0.159 \\ 0.159 \\ \vdots \\ 1.00 \end{array}$			
C1 C2 C3 C4 C5 C6	$\begin{array}{c} 0.387\\ 0.097\\ 0.129\\ 0.129\\ 0.129\\ 0.129\\ 0.129\\ \end{array}$	0.500 0.167 0.083 0.083 0.083 0.083 0.083	0.200 0.133 0.067 0.200 0.200 0.200 0.1, RI	0.209 0.139 0.023 0.070 0.279 0.279	0.396 0.364 0.044 0.033 0.132 0.132 CR= 0	$\begin{array}{c} 0.396 \\ 0.264 \\ 0.044 \\ 0.033 \\ 0.132 \\ 0.132 \\ \Sigma = \end{array}$	$\begin{array}{c} 0.349 \\ 0.187 \\ 0.061 \\ 0.085 \\ 0.159 \\ 0.159 \\ 0.159 \\ \vdots \\ 1.00 \end{array}$			

C2	0.265	0.341	0.227	0.322	0.377	0.488	0.342
C3	0.029	0.068	0.045	0.064	0.019	0.024	0.040
C4	0.441	0.341	0.227	0.323	0.377	0.195	0.320
C5	0.088	0.068	0.182	0.064	0.075	0.098	0.094
C6	0.088	0.068	0.182	0.161	0.075	0.098	0.109
						Σ =	1.00

λ́max	λ_{max} = 6.313, CI= 0.11, RI=1.24, CR= 0.050 < 0.10 OK.										
D	C1	C2	C3	C4	C5	C6	ω				
C1	0.150	0.200	0.136	0.024	0.162	0.105	0.167				
C2	0.050	0.067	0.082	0.080	0.054	0.053	0.064				
C3	0.450	0.333	0.408	0.320	0.486	0.315	0.387				
C4	0.050	0.067	0.102	0.080	0.054	0.210	0.092				
C5	0.150	0.200	0.136	0.024	0.162	0.210	0.184				
C6	0.150	0.133	0.136	0.040	0.081	0.105	0.106				
						Σ =	1.00				

 λ_{max} = 6.312, CI= 0.06, RI=1.24, CR= 0.050 < 0.10 OK.

Table 17. Overall priority weights (AHP and ANP)

	AHP	ANP
C1	.497	.391
C2	.200	.217
C3	.063	.088
C4	.089	.114
C5	.070	.092
C6	.085	.098
А	.206	.205
В	.083	.082
С	.374	.373
D	.341	.340

For prequalification purposes the decision makers can ensure the correctness of his judgement on the overall priorities of each criteria, sub-criteria and alternative using ANP.

4. CONCLUSIONS

The paper has presented ANP as an improved decision-making tool compared to AHP in determining not only hierarchic order of each criteria but also the interdependent relationship and feedback dependence used to select the best alternative. This enhanced selection method avoids many risks which may result to problems if the project was awarded to less capable contractor. Managing complex projects involves complex



decision making abilities. Project failures not only result to poor selection of contractors but who made the selection process. The method can also be used in selecting who will be the best capable construction project manager.

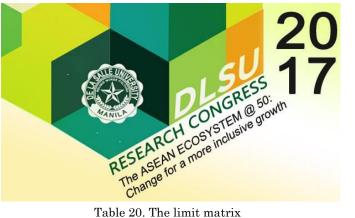
Table 18. The supermatrix

SUPERMATRIX		GOAL	SELECTION CRITERIA							CONTRACTOR ALTERNATIVES			
			C1	C2	C3	C4	C5	C6	А	В	\mathbf{C}	D	
GOAL		1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
SELECTION	C1	0.497	0.000	0.559	0.538	0.564	0.556	0.562	0.291	0.349	0.094	0.167	
CRITERIA	C2	0.197	0.423	0.000	0.183	0.197	0.191	0.226	0.281	0.187	0.342	0.064	
	C3	0.063	0.119	0.103	0.000	0.065	0.067	0.061	0.062	0.061	0.040	0.387	
	C4	0.089	0.163	0.133	0.105	0.000	0.084	0.080	0.116	0.085	0.320	0.092	
	C5	0.070	0.126	0.109	0.079	0.074	0.000	0.071	0.198	0.159	0.094	0.184	
	C6	0.085	0.169	0.096	0.095	0.101	0.102	0.000	0.052	0.159	0.109	0.106	
CONTRACTOR	А	0.000	0.200	0.258	0.176	0.188	0.194	0.163	1.000	0.000	0.000	0.000	
ALTERNATIVES	В	0.000	0.082	0.065	0.059	0.044	0.124	0.148	0.000	1.000	1.000	0.000	
	С	0.000	0.359	0.435	0.289	0.413	0.326	0.363	0.000	0.000	1.000	0.000	
	D	0.000	0.359	0.242	0.476	0.356	0.356	0.326	0.000	0.000	0.000	1.000	

Table 19. The normalized Supermatrix

NORMALIZED	
SUPERMATRIX	

		GOAL	SELEC'	TION CR	ITERIA				CONTR	ACTOR	ALTERNA	ATIVES
			C1	C2	C3	C4	C5	C6	А	В	С	D
GOAL		0.5000	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333
SELECTION CRITERIA	C1 C2 C3 C4 C5 C6	0.2483 0.0984 0.0314 0.0445 0.0348	$\begin{array}{c} 0.0000\\ 0.1410\\ 0.0397\\ 0.0544\\ 0.0419\\ 0.05222\end{array}$	0.1864 0.0000 0.0342 0.0445 0.0363	0.1792 0.0611 0.0000 0.0349 0.0265	0.1879 0.0657 0.0216 0.0000 0.0245	0.1852 0.0638 0.0223 0.0280 0.0000	0.1874 0.0752 0.0205 0.0266 0.0237	0.0969 0.0937 0.0207 0.0387 0.0660	0.1163 0.0622 0.0205 0.0282 0.0531	0.0315 0.1141 0.0135 0.1068 0.0312	0.0556 0.0213 0.1291 0.0307 0.0614
CONTRACTOR ALTERNATIVE	A B C D	0.0427 0.0000 0.0000 0.0000 0.0000	0.0563 0.0666 0.0272 0.1198 0.1198	0.0319 0.0860 0.0218 0.1450 0.0806	0.0317 0.0586 0.0197 0.0963 0.1587	0.0336 0.0626 0.0145 0.1376 0.1186	$\begin{array}{c} 0.0341 \\ 0.0645 \\ 0.0414 \\ 0.1086 \\ 0.1188 \end{array}$	$\begin{array}{c} 0.0000\\ 0.0543\\ 0.0493\\ 0.1210\\ 0.1087\end{array}$	0.0173 0.3333 0.0000 0.0000 0.0000	0.0531 0.0000 0.3333 0.0000 0.0000	0.0363 0.0000 0.0000 0.3333 0.0000	0.0353 0.0000 0.0000 0.0000 0.3333



LIMIT SUPERMATRIX			LIMIT SUPERMATRIX									
		GOAL	SELEC'	TION CR	ITERIA				CONTR	ACTOR	ALTERNA	ATIVES
			C1	C2	C3	C4	C5	C6	А	В	С	D
GOAL		0.4006	0.4006	0.4006	0.4006	0.4005	0.4006	0.4006	0.4005	0.4006	0.4006	0.4006
	C1	0.1568	0.1568	0.1568	0.1568	0.1567	0.1568	0.1568	0.1567	0.1568	0.1568	0.1568
	C2	0.0868	0.0868	0.0868	0.0868	0.0868	0.0868	0.0868	0.0868	0.0868	0.0868	0.0868
SELECTION	C3	0.0354	0.0354	0.0354	0.0354	0.0354	0.0354	0.0354	0.0354	0.0354	0.0354	0.0354
CRITERIA	C4	0.0457	0.0456	0.0456	0.0456	0.0456	0.0456	0.0456	0.0456	0.0456	0.0456	0.0456
	C5	0.0367	0.0367	0.0367	0.0367	0.0367	0.0367	0.0367	0.0367	0.0367	0.0367	0.0367
	C6	0.0393	0.0393	0.0393	0.0393	0.0393	0.0393	0.0393	0.0393	0.0393	0.0393	0.0393
	А	0.0410	0.0410	0.0410	0.0410	0.0410	0.0410	0.0410	0.0410	0.0410	0.0410	0.0410
CONTRACTOR	В	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165
ALTERNATIVE	С	0.0747	0.0747	0.0747	0.0747	0.0747	0.0747	0.0747	0.0747	0.0747	0.0747	0.0747
	D	0.0682	0.0682	0.0682	0.0682	0.0681	0.0682	0.0682	0.0681	0.0682	0.0682	0.0682

5. ACKNOWLEDGMENTS

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APPENDICES

Procurement

Construction

Companies.

and

ADDENIDIV 1 C inti D.

Contractor A	Contractor B	Contractor C	Contractor D
Is recognized as one of	Started as a modest	Established in 1975, is	Over the years has lef
the leading	sub-contractor and	a leading	its mark on a
construction	gradually worked	international	multitude buildin
companies in the	their way to become	construction company.	projects an
Philippines, known for	an AAA Contractor. In	Headquartered in	structures in th
the quality of its work	a span of only twelve	Hong Kong, contractor	Philippines an
and the excellence of	(12) years from its	C delivers a portfolio	abroad. Built it
its workforce. It has	inception.As service	of high-profile	legacy and soli
the broadest range of	oriented organization,	infrastructure projects	reputation of
construction and	contractor B give	throughout Asia. As a	enduring values o
engineering services,	utmost importance to	proven leader in the	excellence, high
with expertise in the	client satisfaction by	delivery of complex	standards of qualit
construction of large-	continually improving	tunnel, rail and road	and completed project
scale heavy and light	the means of	networks, contractor C	on or ahead o
industrial projects,	delivering projects, in	also delivers turn-key	schedule. Continue
infrastructure, and	the safest way	renewable energy	to undertake new
property development	possible, of highest	infrastructure	construction
projects all over the	quality attainable,	including utility-scale	techniques and usin
world. Over the years,	shortest time	wind, geothermal	new products and
Contractor A has built	achievable, at a	energy and waste-to-	processes. With mor
several power plants,	reasonable cost.	power installations.	than 5 decades of soli
refineries,		Its building projects	track record
petrochemical plants,		range from schools,	contractor D buil
cement plants, mining		embassies and luxury	world-class expertis
facilities, industrial		high-rise residential	and extensive portfoli
plants, buildings,		towers, to large scale	in high-rise an
schools, hospitals,		leisure complexes, a	commercial buildin
roads, bridges,		growing number of	construction.
seaports, airports,		which are built to	
railways, water		international green	
distribution stations,		building and energy	
flood control systems,		efficiency standards.	
steel structures and		Contractor C currently	
modular assemblies.		operates in Hong	
As such, it is a		Kong, Indonesia,	
preferred contractor of		India, Macau,	
global Engineering,		Malaysia, Philippines,	

Singapore, Thailand

and Iraq.



APPENDIX 2. Sample Prequalification Evaluation

				CONTRACTOR C				
DESCRIPTION		PARAMETERS	CHECKLIST	REMARKS	ASSESSMENT	PS	CP	
1.00 Construction Methodolog	10%	(1) With program for mobilization at site, including procedure for	(1) Included in submittal.	(1) With submittals in proposal for:		1	1	
		turn-over of Excavation Works		a. Temporary MEPS Layout for Temfacil	a. Proposal is acceptable.			
				b. Procedure on Turn-over of Site/Joint Survey	b. Clarify if in cost offer soil bear test is in	cluded		
				with Excavation Contractor	as it is identified in method statement			
		(2) Proposed work schedule should be validated by a pre-	(2) Included in submittal.	(2) With proposal for:	(2) Conflict in schedule is identified in MEPF/	1	0	
		established calculations, with specific work flow-sequence		a. Basis of Calculation of Projected Milestones	Equipment Works; should be rechecked.			
		(3) Construction Procedures and Method Statements to be	(3) Included in submittal.	(3) General Method Statements given as:	(3) Schematics on methods shown and detail	ed-out		
		included (but not limited to):			particularly on concrete pour works, white	:h is		
					tailored-fit with the project			
		(a) Mobilization		a. Noted		1	1	
		(b) Site Preparation; Temfacil, including equipment		b. Noted		1	1	
		(c) Formworks		c. Noted; with illustrations	c. Use of FUVI for formworks for better q	u 1	1	
		(d) Concrete Works		d. Noted; with illustrations		1	1	
		(e) Basic Architectural Works and MEPF Works (including		e. Noted; with illustrations		1	1	
		interface works)						
		(f) Curtain Wall Works		f. Noted; with illustrations		1	1	
		(g) Project Close-out and Demobilization		g. Noted.		1	1	
		(4) Interfacing with and Attendance to other Work Packages	(4) Included in submittal.	(4) Noted in proposal.	-	1	1	-
								-
		(5) Submittal Schedule	(5) See remarks.	(5) Not included in proposal.	(5) Clarify Submittal-Schedule preparation.	1	1	-
								1
		(6) Preparation of CSDs	(6) See remarks.	(6) Not clearly defined in proposal.	(6) Clarify attendance for CSDs preparation.	1	0	1
					-			-
		(7) Compliance to Drawings and Specifications	(7) See remarks.	(7) Noted in proposal.		1	1	
							7.	_
						13	11	
			have a second					_
00 Temporary Facility Layour	3%	(1) At least one (1) established control point for egress and	Identified in submittal.	(1) With two (2) egress/ingress points.	(1) Two egress/ingress points with identified	1	1	+
		ingress at site			and security at site		-	+
		(2) Orientation of temfacil should consider the actual location	(2) Identified in submittal.	(2) VMU location indicated not as per actual conditions.	(2) Check if ocular visit was conducted. Temfa	» 1	0	-
		of VMU which will have a direct effect on the layout			layout may be revised accordingly.			
		(3) A proposed floor layout of the offices should be defined and	(3) See remarks.	(3) With defined layout/floor plan for PM's Site Office	(3) Confirm location of waste disposal units	1	0	-
		presented, including the contractor's laydown area, storage		and Gencon's Office, etc.				-
		areas, waste disposal unit(s), etc.		10 · · · · · · · · · · · · · · · · · · ·				-
		(4) Accesway to the building from the temfacil/offices to the	(4) See remarks.	(4) Accessway to activity area/site and Alimak	(4) Access layout is acceptable as identified in	1	0	-
		construction site should be properly identified, including the		clearly defined and identified in layout.	proposal.			
		the equipment to be used during operations/construction						
		(5) Office requirement for the Owner/Owner's Rep. should be	(5) See remarks.	(5) Noted. Included in proposal.	(5) Complying with requirements (with floor	a 1	1	-
		at least 270sqm, with Conference Room (cap. Min. 20 people)			including MEP plans).			1
		(6) Office layout of Gencon should be presented, identifying the	(6) See remarks.	(6) Noted. Included in proposal.	(6) Complying with requirements (with floor	a 1	0	
		(6) Office layout of Gencon should be presented, identifying the proposed location and layout of each departments in line w/ the proposed organization chart/manpower requirements.	(6) See remarks.	(6) Noted. Included in proposal.	(6) Complying with requirements (with floor including MEP plans).	a 1	0	
00 Construction Schedule	10%	proposed location and layout of each departments in line w/ the proposed organization chart/manpower requirements.			(6) Complying with requirements (with floor l including MEP plans).	6	2	
00 Construction Schedule	10%	proposed location and layout of each departments in line w/ the proposed organization chart/manpower requirements. (1) Project Schedule should cover a maximum 24-month timeline	(1) Stipulated in submittal.	(1) Noted. With 24-month project timeline.	 (6) Complying with requirements (with floor including MEP plans). (1) With diagrams and illustrations on sequer 	6	0	
00 Construction Schedule	10%	proposed location and layout of each departments in line w/ the proposed organization chart/mapower requirements. [1] Project Schedule should cover a maximum 24-month timeline [2] Set on a minimum of -/_200gam per day of concrete works,		 Noted. With 24-month project timeline. Noted. Target daily or weekly accomplishment not 	 (6) Complying with requirements (with floor including MEP plans). (1) With diagrams and illustrations on sequer works, only, conflict with MEP/Equipment 	6 1	2	
20 Construction Schedule	10%	proposed location and layout of each departments in line w/ the proposed organization chart/manpower requirements. (1) Project Schedule should cover a maximum 24 month timeline (2) Set on a minimum of 47/200gm per day of concrete works, shell of the building hould be about on a to 3 to 3 To-from/month	(1) Stipulated in submittal.	[1] Noted. With 24-month project timeline. (2) Noted. Target daily or weekly accomplishment not uperfilially detailed out and presented.	(6) Complying with requirements (with floor including MEP plans). (1) With diagrams and illustrations on sequer works, only, conflict with MEP/Equipment Schedule block block the main works.	6 nt rks.	2	
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0 Quality Policy & Procedur	:: 10%	proposed location and layout of each departments in line w/ the proposed organization chart/fmanpower requirements. (1) Project Schedule should cover a naminum 24-month himself (2) Set of a simulation chart/fmanpower requirements. (3) Set of a simulation chart of a solution of a 10-3.5 hord/month or about 10-10 months for the substructure is and relatively 3 to 6 months duration for the substructure (and relatively 3 to 6 months duration for the substructure (and relatively 3 to 6 months duration for the substructure (and relatively 3 to 6 months duration for the substructure (and substructure) (4) Expect Schedule Calculations & Branmeters were based on: (a) Target Stellar (and your 6 doncen, much building call of test 4 5 months laffore project hand-over (4) Project Schedule Calculations & Branmeters were based on: (a) Target Stellar (2011) (b) Expect Schedule Calculations & Branmeters were based on: (c) Target 7-8 the advert 0 Garcon, much building test of test (c) Target 7-8 the 2011 (c) Target 7-8 the corresistoring by September 2009 (c) Target 7-8 the Calculations (c) and Stellar Movember 2009 (c) Target 7-8 the Calculations (c) and Calcular (c) and (c) (c) Target 7-8 the Calculations (c) and Calcular (c) (c) Target 7-8 the Calculations (c) (c) Target 7-8 the Calculat	(1) Stipulated in submittal. (2) See remarks. (3) See remarks. (4) See remarks. (5) See remarks. (5) See remarks. (1) Included in submittal. (2) See remarks.	[1] Moted. With 24-models project tensilies. [2] Noted. Target dialy or search project tensilies. [3] Noted. Target dialy or search project tensilies. [3] Structural is at 21 Promotits to to go off. 21 mos. for superstructure and 5.0 mos. for substructure. [3] CWU is at 31/more, 11 mos to complete, from October 2010 to August 2011. [4] Noted. [6] Noted in proposal.	(6) Complying with requirements (with floor including MEP plant). (1) With diagrams and Bustrations on sequences of the sequence of t	6 6 6 6 7 7 8 6 1 1 7 7 8 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2 1 1 0 1 1 1 1 0 0 0 1 1 1 1 1 2 2	
00 Quality Policy & Procedur	:: 10%	proposed location and layout of each departments in line w/ the proposed organization chart/Manpower requirements. (1) Project Schedule should comer a maximum 24-month timeline (2) Set on a minimum of -/ JOSDapp per day of concrete works. (3) Set on a minimum of -/ JOSDapp per day of concrete works. (3) Set on a minimum of -/ JOSDapp per day of concrete works. (3) Set on a minimum of -/ JOSDapp per day of concrete works. (3) Set on the starts for the substructure and relatively 3 to 6 months day attach of the substructure (and schedule 3) Set and the project tail of the substructure (and schedule 3) Set and the project tail of the substructure (and schedule 4) Set and the project tail of the substructure (and schedule 4) Taget Stept term project tail of the substructure and relatively (4) Taget Stept Renards the Steptameters were based on: (4) Taget Stept Renards the Steptameter Steptameter Steptameter (4) Taget Stept Renards (and schedule tail of the substructure) (4) Taget Stept Renards (and schedule tail Steptameter) sets based on: (5) Taget AT (2011) (6) Temaster Anget Renards (and schedule tail of the substructure) (2) Orimisers Anget Renards (and schedule tail) (3) With written Quality Policies, which will include the company's Quality PRin, Quality Control and Quality Assurance (2) With established Quality Systems which is ISO 9001.2000 Centified	(1) Stipulated in submittal. (2) See remarks. (3) See remarks. (4) See remarks. (5) See remarks. (5) See remarks. (1) Included in submittal. (2) See remarks.	[1] Moted. With 24-models project tensilies. [2] Noted. Target dialy or search project tensilies. [3] Noted. Target dialy or search project tensilies. [3] Structural is at 21 Promotits to to go off. 21 mos. for superstructure and 5.0 mos. for substructure. [3] CWU is at 31/more, 11 mos to complete, from October 2010 to August 2011. [4] Noted. [6] Noted in proposal.	(6) Complying with requirements (with floor including MEP plans). (1) With diagrams and Illustrations on sequence works, only, conflict with MEP/Elganses and State (State State	6 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2 1 1 0 0 1 1 1 0 0 0 1 1 1 1 1 2 1 1	

		(a) Company EHS Policies and Program			(a) Included.	1	1	
		(b) Housekeeping			(b) Included.	1	1	
		(c) Accident, Emergency and Fire Prevention/Control Plan			(c) Included.	1	1	
		(d) Environment Management			(d) Included.	1	1	
		(e) Site and Building Security Measure and Program			(e) Included.	1	1	
		(2) With established Safety Manual which is ISO 14001 Certified	(2) See remarks.	(2) Noted.	(2) With certification.	1	1	
		and DOLE Accredited						
						7	7	10.00
6.00 Manpower Loading	4%	(1) Use of Approximation to Manpower Loading to check	(1) Included in submittal.	(1) Noted; with illustrations.		1	1	
		Validity of proposal:						-
		(a) The maximum manpower at site is 160% of the average		(a) Max. manpower alloted is 745.	(a) As per calculations, max. manpower shou	1	1	
		manpower site			745 (at peak), hence, acceptable.			
		(b) The maximum manpower at site first occurs after 40% of the		(b) Max. manpower alloted is at 7th month.	(b) As per calculations, max. manpower is at n	1	1 1	
		total manpower requirement has been expended.			10 also, hence, acceptable.			
		(c) The period of maximum manpower at site accounts for 40%		(c) Max. manpower alloted is at 5,272 from month 7	(c) As per calculation max. manpower is at 47	1	1	
		of the Total Manpower Requirement		to month 14	during the peak period, hence, acceptable.			
		(d) The maximum manpower at site first occurs when 50% of		(d) Max. manpower alloted is at 12th month	(d) As per calculation max. manpower is at mo	1	1	
		the project time has elapsed.			12 also, hence, acceptable.			
		(e) The period of maximum manpower at site occurs for 25% of		(e) Max. manpower alloted is in 8 months, from month 7	(e) As per calculation max. manpower is about	1	1	
		the project time.		to month 14.	33.33%, hence, acceptable.			
						6	6	4.00



APPENDIX 3. Sample Survey Data

NAME:	JONATHAN BIONA
COMPANY:	DESIGN COORDINATES, INC.
POSITION:	OCMD HEAD

Instruction: Put a "x" mark on the box provided for your answers. Choose only one (1) answer for every question.

		1	2	3	4	5	6	7	8	9
No.	Question	Equally			Moderately to	Strongly	Strongly to		strongly	Extremely
	Which which have an Electrical Constellity and Dark Derformance	preferred	moderately	preferred	strongly	preferred	very strongly	preferred	to	preferred
1	Which criteria between Financial Capability and Past Performance do you think is best in contractor selection?						x			
-	Which criteria between Financial Capability and Past Experience						^			
2	do you think is best in contractor selection?							X		
3	Which criteria between Financial Capability and Resources do you think is best in contractor selection?				x					
4	Which criteria between Financial Capability and Current Workload do you think is best in contractor selection?					x				
5	Which criteria between Financial Capability and Safety Performance do you think is best in contractor selection?					x				
6	Which criteria between Past Performance and Past Experience do you think is best in contractor selection?						x			
7	Which criteria between Past Performance and Resources do you think is best in contractor selection?			x						
8	Which criteria between Past Performance and Current Workload do you think is best in contractor selection?				x					
9	Which criteria between Past Performance and Safety Performance do yopu think is best in contractor selection?	x								
10	Which criteria between Past Experience and Resources do you think is best in contractor selection?	x								
11	Which criteria between Past Experience and Current Workload do you think is best in contractor selection?	x								
12	Which criteria between Past Experience and Safety Performance do you think is best in contractor selection?	x								
13	Which criteria between Resources and Current Workload do you think is best in contractor selection?	x								
14	Which criteria between Resources and Safety Performance do you think is best in contractor selection?		x							
15	Which criteria between Current Workload and Safety Performance do you think is best in contractor selection?	x								