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MULTI-CRITERIA SELECTION DECISION FOR THE OPTIMAL LOCATION OF THE CONCRETE BATCH PLANT - A COMPARISON STUDY OF APPLYING ANP AND AHP

Ibrahim M. Mahdi[1] & HadeelElba[2]

*[1]Associate Professor, Structural Engineering and Construction Management Department, Faculty of Engineering and Technology, Future University in Egypt

[2]M.Sc. Student, Department of Structural Engineering, Ain Shams University.

ABSTRACT

The selection of optimum location for concrete batch plant (CBP) became very important problem that needs a right decision to avoid many difficulties and problems may results due to select wrong location. For that we can use the analytic network process (ANP) in decision making process. The ANP is more generalized than the analytic hierarchy process (AHP).

This paper shows a form of questionnaire to identifying the factors affecting CBP location to deal with it or to construct a new batch plant after sending it to expert engineers and workers.

By applying SUPERDECISION software the ANP model presents the framework criteria and available alternatives ad feedback which can help to choose the best alternative.

The difference between these two methods papers in this paper by modeling the problem and determine the final priorities for the alternatives and the importance of each criteria by evaluating process. This paper gives a brief look at the difference of AHP and ANP.

Keywords: *Site Selection, Concrete Batch Plant, Optimization, AHP, ANP, Feedback Structure, Super Decision Software.*

Nomenclature:

1. RMCReady Mix Concrete
2. CBP Concrete Batch Plant
3. AHP Analytical Hierarchy Process
4. DFSS Design-for-six-sigma
5. ANP Analytic Network Process
6. MCDSS Multiple-Criteria Decision Support System

1. INTRODUCTION

The concrete batch plant is very important and became an element help the companies to success in its project which it provide high quality of RMC and the mixing process under fully controlled through computerized environment. There are table present examples of strength and weaknesses points in batch plants the affecting on the concrete. As shown in table

Table 1: The Weakness and Strength Points of CBP

STRENGTH POINTS			WEAKNESS POINTS:		
Reduce the rate of errors in the mixing ratios of the concrete components and the method of mixing them in the site, thus providing the stations with more precise mixtures.	A team of specialized engineers supervises the mixing of concrete from the receipt of raw materials to the delivery of the mixtures..	Concrete is followed after loading and pre-casting, and concrete samples supplied with certified inspection certificates are taken	Some stations are very far from the site and therefore the time to move from the concrete mixing plant to the site is very important and you may need to use additives for the mixtures.	The roads leading from and to the site must be paved and able to carry the heavy weights of the Arab women in addition to the load	Quantity and quality of admixture added to the concrete mix is very important. This is because the Limited time interval between mixing and curing Admixtures can be adjusted for that time period.

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The "Selection" of optimum location for batch plants needs more works to optimize this location, for the importance of this process and that will need to spend more time and efforts to study all the available alternatives and identifying the all criteria and sub – criteria can be affected on the decision making process about which alternative is preferred.

The ANP also introduced by Saaty, is a generalization of the AHP (Saaty, 1996). ANP allows for complex interrelationships among decision levels and attributes. The ANP feedback approach replaces hierarchies with networks in which the relationships between levels are not easily represented as higher or lower, dominated or being dominated, directly or indirectly (Meade and Sarkis, 1999). For instance, not only does the importance of the criteria determine the importance of the alternatives as in a hierarchy, but also the importance of the alternatives may have impact on the importance of the criteria (Saaty, 1996). Therefore, a hierarchical structure with a linear top-to-bottom form is not applicable for a complex system.[1]

Although ANP and AHP are similar in the comparative judgment phase, there are differences in the synthesizing phase. In the ANP, ratio scale priority vectors derived from pairwise comparison matrices are not synthesized linearly as in AHP. Saaty has an improved \super matrix" technique to synthesize ratio scales. Each ratio scale is appropriately introduced as a column in a matrix to represent the impact of elements in a cluster on an element in another cluster (outer dependence) or on elements of the cluster itself (inner dependence).[2]

2. CONCRETE BATCH PLANTS AND THEIR IMPORTANCE

The global trend is strongly oriented to use RMC that produced in patch plants. Because of that the choice of the factory site is one of the important and difficult decisions faced by industrial companies due to the process of selecting the right location for either the concrete mixing plant or for the construction of a CBP is one of the difficult decisions facing the owners of the industry due to the size of the large financial investments used in the newly established factories or in the old factories. This decision is based on long-term strategies affecting the future of corporate success, including marketing strategies and storage strategies .

Companies at various times have to re-evaluate the locations of the concrete batch plants they deal with in terms of the location availability of important and essential factors for companies. Therefore, there are many important aspects for the importance of mixing plants such as producing better quality concrete, minimizing the procurement / machinery hiring of plants, avoiding materials waste .In order for companies to avoid the problems of bad selection of the site of CBP, it is necessary to conduct preliminary studies and be flexible and easy to change or move the site at the lowest cost possible if the plans or circumstances change.

Examples of difficulties or problems that companies may encounter are the difficulty of disposal of waste, the high wages and employment of workers, the high cost of transport and the legal legislation for the protection of the environment from pollution caused by mixing stations.

Accordingly, the best location is chosen based on direct factors that help to make a decision that achieves long-term benefits and benefits, including defense and security efficiency.

3. IDENTIFYING THE FACTORS AFFECTING THE LOCATION OF CBP

The choice of the geographical location of the project should depend on several factors that may develop, grow and deepen the relationships between different industry areas because industry is a pioneering and vital activity. The select the suitable geographical location for CBP to deal with or to construct one that's Requires a thorough and accurate study of all the factors that can influence the selection of one of the alternatives provided through all aspects such as technical factors, economic factors, environment etc. The bad choice of the site may lead to many problems in several areas such as the quality of the concrete time and economic cost. Therefore, the decision of the appropriate location is one of the difficult and important decisions faced by factories, companies and investors and the decision is linked to long-term strategies that may affect the growth, development and success of companies such as storage, marketing and raw materials strategies.

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To be able to achieve the main target of this thesis which it is the optimum selection for the concrete mixing plant, it is necessary to study all aspects related to this target in terms of previous studies and research have spoken and studied this subject in advance to try to collect more and the most important factors and influences that effect on the decision making process to choose a best site for Concrete Mixing plant. I have collected more than 50 factors, whether by studying the prior researches and visiting the CBP inside Egypt, and interviewing many specialized engineers and workers in this field have more than 20 years' experience in this field for gathering the most influential factors and studying the available alternatives sites in terms of geographical conditions Political and economic aspects within Egypt and dividing those factors in different categories as follows.

4. DIVISION OF FACTORS AND QUESTIONNAIRE STRUCTURE:

After identified all the factors "criteria" by making the extensive interviews with experts and workers in RMC industry the questionnaire can be formed. The factors were studied from two points of views the first point concerning the choice of the best location for the ready mix concrete batch plant and the second for choosing the best project location as shown in figure 1.

Figure 1: The three points of views of the factors affecting on site selection

And each of these points of views divided in 11 categories except the choice of plant location divided in three categories such as the following:
Factors affecting the choice of plant location e.g.**Impact of Egyptian works condition**,**Impact of work Region condition** and**Impact of work site condition**.
Factors affecting the Selection of CBP locationse.g.**Impact of Demand Characteristics (CBP selection), Impact of Proximity of Batch plant (CBP selection), Impact of Infrastructure Work Condition (CBP selection)etc.**
Factors affecting the selection of construction site location e.g.**Impact of Demand Characteristic (site work selection), Impact of Environment Condition (site work selection),Impact of Emergency condition (site work selection)etc.**
And under each of these categories there are a number of factors such as the table 2

Table 2: Snapshot of the questionnaire results after two trials of Delphi Technique

FACTORS		*AVERAGE*	*WEIGHT*
Factors Affecting The Choice Of Plant Location			
	A. Impact of Egyptian work condition		
A.1	Economic and cultural problems.	**92%**	**V. high**
A.2	The level of productivity in a country.	**86%**	**V. high**
A.3	Political stability.	**85%**	**V. high**
A.4	Currency exchange rates.	**85%**	**V. High**

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A.5	Laws and regulations.	**84%**	**V. High**
A.6	Availability of equipment.	**81%**	**V. High**
A.7	Market locations.	**80%**	**V. High**
A.8	Impressions.	**80%**	**V. High**
A.9	Availability of manpower.	**80%**	**V. High**
A.10	Costs.	**68%**	**High**
A.11	Telecommunications.	**67%**	**High**

5. THE CREATION OF QUESTIONNAIRE FORM

After the each of the previous categories had been divided to many factors and formed in questionnaire form, after compilation a group of experts, engineers and research scientists with extensive experience more than 15 years in the field and they have a direct dealing with the problems that emerged as a result of the poor selection of concrete mixing plant location, especially contractors and projects execution companies who are facing such a problems like that in the field. Then introduced these factors that collected in the form of A questionnaire to be published face to face or by sending it to them and sending it also to university professors with relevant Specializations such as project management and other Specializations to give a ranking of the importance of each factor from their point of view and their experience with various projects .

This assessment indicates the impact of each factor on the location of the CBP, the construction site and its workers, and its effect on the productivity and final product of the batch plant which is the RMC.

A total of 15 questionnaire forms were distributed among the collected groups in the construction industry, including consultants, contractors, engineers and experts in the RMCfields in Egypt,According to experts opinion and the previous studies and extensive interviews during the questionnaire formation some criteria added and deleted of initial set of criteria to make the final analysis of a total 50 criteria is ready to publish to the collected group.
And after receiving these results from the engineers and specialists and analyzed them to give a percentage of the importance of each factor for the first trial and to ensure the accuracy of the results so the results sent again to the same group of experts and engineers to re-evaluation the questionnaire and at the second trial found that the results are very close. Therefore, the final results adopted and this method is called Delphi technique and will be explained in detail further.

So, after the publication of the questionnaire the results of views gathering and analyze through the use of Delphi technique as Saied before to determine the minimum variance to select the optimum site location according to the priorities and importance of different factors, and the final results are used to developing the AHP modeling, the variance was very small so the weight of these factors can be adopted, and shown in table 2.

6. DELPHI TECHNIQUE

The Delphi Method is based on a structured process for collecting and distilling knowledge from a group of experts by means of a series of questionnaires interspersed with controlled opinion feedback. Delphi represents a useful communication device among a group of experts and thus facilitates the formation of a group judgment. It comprises a series of questionnaires sent either by mail or via computerized systems, to a pre-selected group of experts. These questionnaires are designed to elicit and develop individual responses to the problems posed and to enable the experts to refine their views as the group's work progresses in accordance with the assigned task. [3]
The Delphi technique usually used to determine the evaluation results of all criteria related to the problem of the CBP locations to be trustworthy for everyone. And the AHP and ANP tools used for a specific project under different conditions.

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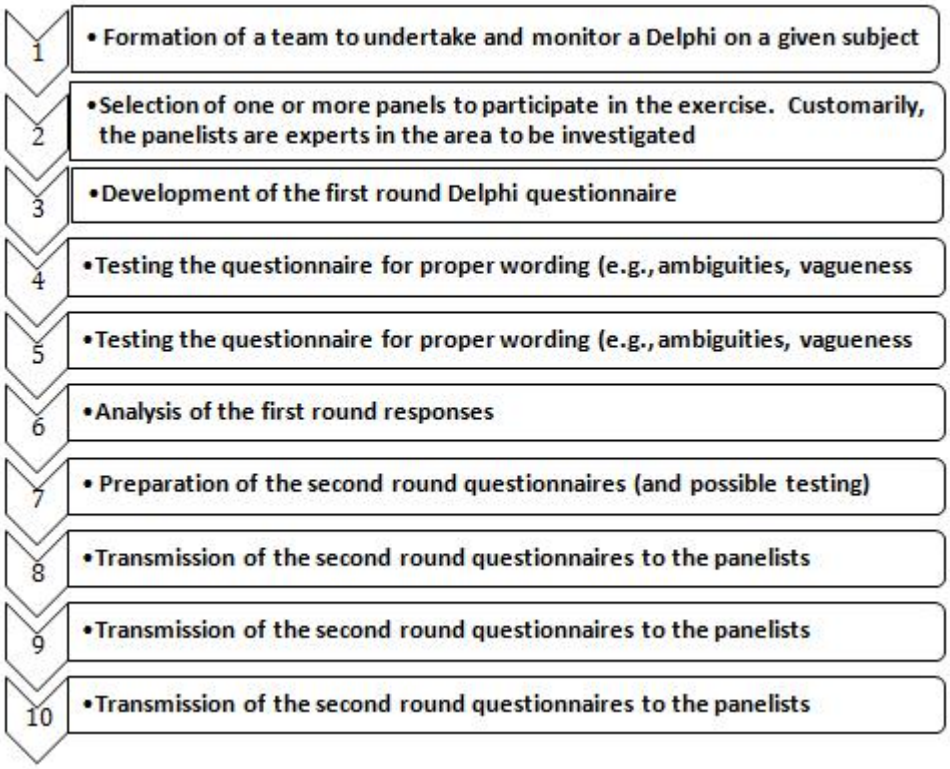
6.1. Delphi Method Steps



Multiple-Criteria Decision Support System (MCDSS) compares the list of the all criteria that it is related to CBP and site construction selection, to select the most preferred location of CBP between different available locations alternatives by using the AHP and ANP techniques.

The Delphi method[4] was applied to determine the relative degrees of importance of the CBP location criteria, based on the rating of the experts, using both questionnaires and interviews as follows:

1. Questionnaires were issued to each expert (15 questionnaires sent). The experts evaluate each criterion in the questionnaire by assigning a percentage to indicate to this ranking. These ranged from (1) very high, (2) high; (3) average, (4) low and (5) very low.
2. Statistical analysis was carried out to refine these criteria with the purpose of identifying the relevant criteria and their relative degrees of importance.
3. Structured interviews (15 interviews) with key experts were conducted in the first round of Interviews, for the previous purposes described. The same forms of questionnaire were also used to organize these interviews.
4. Statistical analysis was carried out to refine the criteria, which resulted from the first roundof interviews with the purpose of identifying the relevant criteria and their relative degreesof importance.
5. The refined criteria that resulted from the previous step (4) were given back to the key experts for reassessment and to assure the relevancy of the identified criteria. This step was the second round within the Delphi method.
6. Statistical analysis was carried out to refine the criteria, which were the output of the previous step.
7. The criteria that resulted from the final statistical round were used directly in the AHP method, using their relative degrees of importance [5].

7. ANALYTIC NETWORK PROCESS

7.1 Analytic Network Process Overview:

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The process of decision-making is a necessary and very important part of human life. In order to make a correct decision, it is necessary to study all the factors affecting the decision-making from all aspects of the problem, whether the factors are political, social, environmental, cultural or psychological. When there is an interaction between higher levels and lower levels of the different elements of the problems that needs a decision, cannot be formed as hierarchical form. The diagram that called "network" can give a solution for problem that cannot be structured in hierarchical form as in AHP modelingbecause the importance of the all available alternatives themselves determines the importance of the criteria. As shown in figure 2.

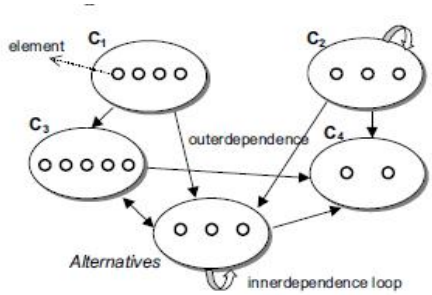

Figure 2: Feedback Network

The models shows in a hierarachical structure formand that means the models not necessarily to present in linear form from the top to bottom. The anp model has loops to connect between the clusters and between cluster and nodes, as shown in figure 3.

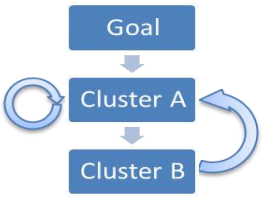

Figure 3: The ANP systems with feedback

The anp is one of the systems that called systems-with-feedback. The problems with feedback that need to solve by making a right decision the anp is the suitable technique to manage this processthrough overall methodical way.

The nodes in Analytic Network process (ANP) model are criteria, sub criteria and alternatives. Any of each node compared with any other node in the model. The preferring of alternatives not only depends on the weighting of criteria but the preferring of criteria also can depend on the weight of alternatives. Figure 4

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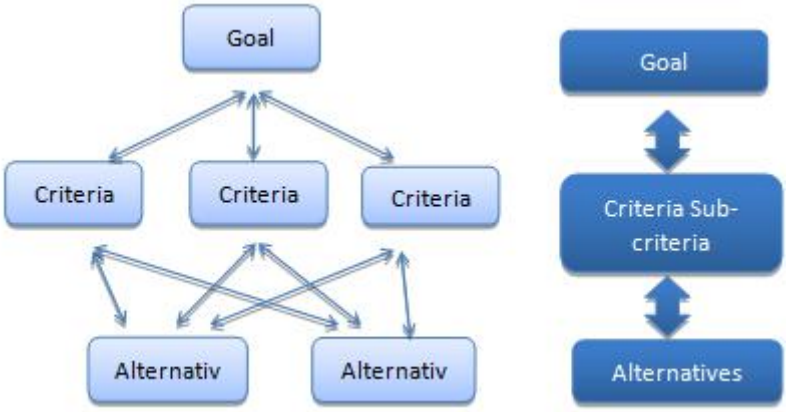
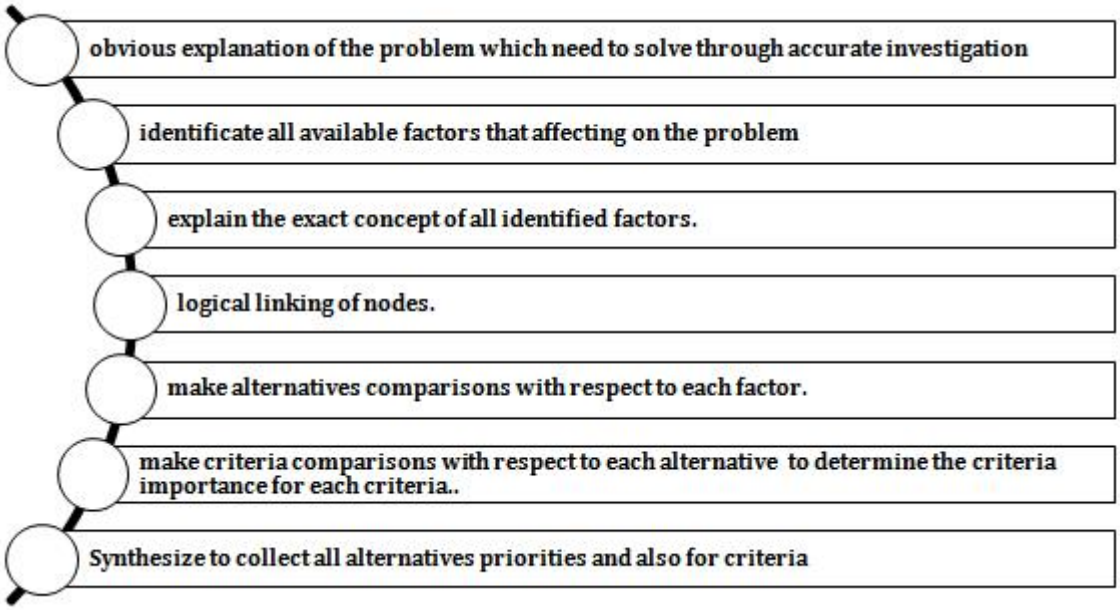


Figure 4: The Network Model

The AHP model answers the comparisons question: "how important is criteria A to criteria B with respect to the overall goal?"

The ANP model it is very important to determine the criteria priorities with respect to the alternatives, the comparing process became easier when the comparing question is dealing with actual alternatives.

7.2 ANP: Setting Up a Model



7.3 Pairwise Comparisons

The Fundamental Scale used for the judgments is given in Table 3. Judgments are first given verbally as indicated in the scale and then a corresponding number is associated with that judgment. The vector of priorities is the principal eigenvector of the matrix. This vector gives the relative priority of the criteria measured on a ratio scale. That is, these priorities are unique to within multiplication by a positive constant. However, if one ensures that they sum to one they are then unique and belong to a scale of absolute numbers. [6] When starting the comparison process, the factor that is more important than the other factor being compared is worth a larger number. Therefore, the comparison is described with an integer value from (1 to 9) where 1 (equal value) to 9 (very different), as shown in table 3.

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Table 3: The Scale Ranging For Pairwise Comparisons

Verbal Judgment of Preference	*Numerical Rating*
Extremely preferred	**9**
Very strongly to extremely preferred	**8**
Very strongly preferred	**7**
Strongly to very strongly preferred	**6**
Strongly preferred	**5**
Moderately to strongly preferred	**4**
Moderately preferred	**3**
Equally to moderately preferred	**2**
Equally preferred	**1**

All previous Research and experience have definite the nine-unit scale as a reasonable basis for discerning between the two items.

- Moderate values for the scale are called Even numbers (2, 4, 6, and 8).
- If the two objects are equally preferred it will take a value of 1.

It is recommended that should be less than or equal to 0.10. Inconsistency may be thought of as an adjustment needed to improve the consistency of the comparisons. But the adjustment should not be as large as the judgment itself, nor so small that it would have no consequence. Thus inconsistency should be just one order of magnitude smaller. On a scale from zero to one, the overall inconsistency should be around 10 %. The requirement of 10% cannot be made smaller such as 1% or .1% without trivializing the impact of inconsistency. But inconsistency itself is important because without it, new knowledge that changes preference cannot be admitted [7], the values of random index shown in table4.

Table 4: The Average Random Index (RI)										
Order	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

8. DIFFERENCE BETWEEN ANP AND AHP

Although ANP and AHP are similar in the comparative judgment phase, there are differences in the synthesizing phase.[2]The AHP/ANP assumes that the structure is developed carefully to include all that is necessary to consider from expert understanding that also provides the judgments. Its outcome is totally subjective in this sense of using experts when needed.[6]

The Analytic Hierarchy Process (AHP) is a theory of relative measurement with absolute scales of both tangible and intangible criteria based on the judgment of knowledgeable and expert people. How to measure intangibles is the main concern of the mathematics of the AHP. In the end we must fit our entire world experience into our system of priorities if we are going to understand it. The AHP reduces a multidimensional problem into a one dimensional one. Decisions are determined by a single number for the best outcome or by a vector of priorities that gives an ordering of the different possible outcomes. We can also combine our judgments or our final choices obtained from a group when we wish to cooperate to agree on a single outcome. [8]

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Although the ANP and AHP models using the pairwise comparisons by the previous basic scale to determine the priorities but the different between them presents in modeling form and in determining the final results of all available alternatives priorities.

When a decision for problems with complicated interrelationships must take the ANP model is the suitable tool to use.

Analytical Network Process (ANP)	
Advantages	**Disadvantages**
can be used with any problems need to making decision	You may have difficulty explaining AHP to manage the relevant companies to use it as a tool to make decisions
with some problems ANP can be the only tool structured the problems	to determine the results its necessary to use a special software via one of a free programs available
the ANP model actually require to carefully identify the nodes and the interconnections	the results of feedback loops and interrelated are unfeasible to confirmation
the ANP is the perfect technique to aware the problem, the suitable decision and the effect of all factors and how they are linked	in organization it is so difficult to use ANP as a standard tool in workable making decision

Analytical Hierarchy Process (AHP):	
Advantages	**Disadvantages**
Hierarchical structuring of a decision problems.it provides a hierarchical structural model for problems that needs decisions	the pairwise comparisons is totally unrealistic way to make comparisons between a group of elements
to obtain unified result by entering many various information	We have problems to review the information entered into the model if the result of the consistency indicator is too high
most of the time the companies concur the final results of the alternatives priorities Calculation of results possible using Excel sheet.	
most of procedures of calculations to determine the priorities by using excel sheet	

The AHP model answers the comparisons question: "how important is criteria A to criteria B with respect to the overall goal?"

The ANP model it is very important to determine the criteria priorities with respect to the alternatives, the comparing process became easier when the comparing question is dealing with actual alternatives.

When take deeper looking into the problems that need complex decisions, it is best to use ANP technique.However, if groups of experts or a team work to prioritize the affecting factors, AHP can be used.

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9. THE ANP MODEL OF OPTIMUM SELECTION OF CBP LOCATION BY USING SUPER DECISION SOFTWARE

This model introduce a descriptive for the case study project of selecting the best location for CBP, by the SUPERDECISIONS software application together with the major factors that chosen from the previous formed questionnaire. Also include the results determine from implementing the developed software application which applied on two different CBP locations (location in region) and (location outside) to determine the most preferred location to deal with 16 major factors in this type of projects. The results will be discussed to demonstrate the efficiency of the software in such cases.

9.1 Illustrate ANP Model

The first step to construct the ANP model is to breakdown in logical groupings of the nodes and clusters that structure the problem. The purpose of CBP site selection Model is to determine the priorities of locations achievement the 16major factors that affecting on the site selection. The hierarchical site selection structure depicted Figure 5, shows a snapshot of the ANP Model which was developed with the SUPERDECISIONS software

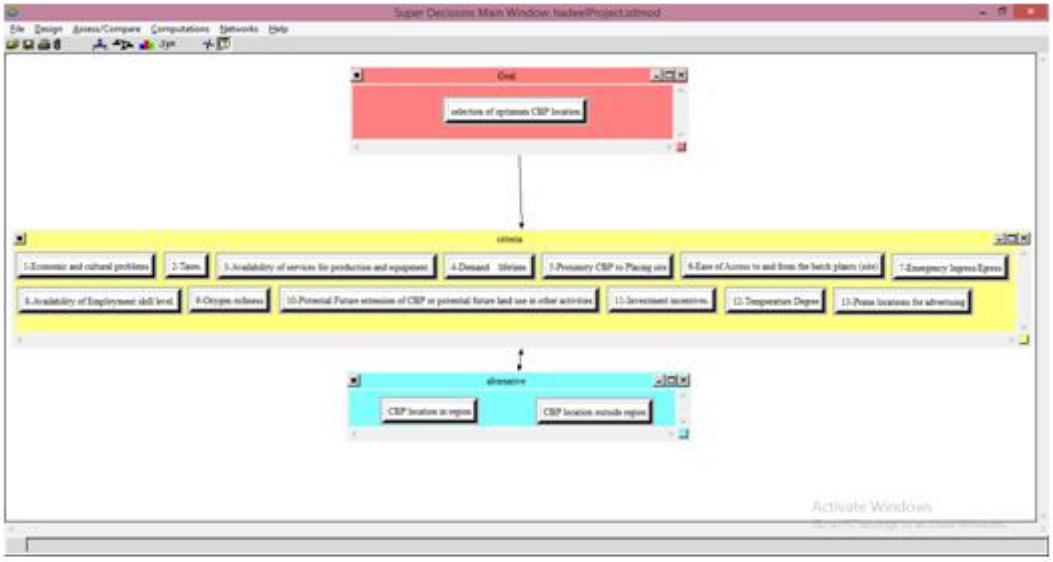

Figure 5: Snapshot of ANP Model for Best Site Selection Breakdown Structure for CBP Site Location

The ANP model consists of a network which has all clusters and their nodes in one window. Therefore, all the comparison questions are evaluated from the viewpoint of what is more important with respect to most preferred location for CBP.

9.2 Pairwise Comparison of ANP Model for the Selection of CBP Location:

In ANP model the alternatives are pairwise compared against to the criteria. In such a ratings model the alternatives are rated against the criteria.

The ANP model consists of clusters and they are the goal criteria and sub criteria and alternatives but In this paper there are no sub criteria. each cluster including nodes such as the criteria cluster includes the nodes of the 16 major factors that choosing from the previous questionnaire which affecting on the selection of CBP best location, such as economic and cultural problem, temperature degree, proximity of CBP to site and availability of skilled workers.

Consequently, the comparisons can be completed by selecting from the drop-down menu the Assess/Compare command, after that select the required cluster and its node to serve as parent node, to starting with respect to the selected node. This process will present the comparisons screen in the questionnaire mode.

Therefore, the first pairwise comparison questionnaire is evaluating from the point of view of what is more important factors with respect to CBP best selection "Goal" which is shown in Table 6.

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	1- Economic and cultural problems	2- Taxes.	3- Availability of services for production and equipment.	4- Demand lifetime.	5- Proximity CBP to Placing site	6- Ease of Access to and from the batch plants (site)	7- Emergency Ingress/Egress	8- Availability of Employment skill level.	9- Oxygen richness	10- Potential Future extension of CBP or potential future land use in other activities	11- Investment incentives.	12- Temper-ature Degree	13- Prime locations for advertis-ing
1-Economic and cultural problems	1.00	2.00	4.00	4.00	1.00	2.00	3.00	2.00	2.00	2.00	3.00	4.00	8.00
2-Taxes.	0.50	1.00	3.00	3.00	0.50	2.00	1.00	1.00	1.00	1.00	1.00	3.00	7.00
3-Availability of services for production and equipment.	0.25	0.33	1.00	0.50	0.14	0.20	0.20	0.25	0.25	0.33	0.25	1.00	6.00
4-Demand lifetime.	0.25	0.33	2.00	1.00	0.11	0.17	0.14	0.13	0.13	0.14	0.17	1.00	6.00
5-Proximity CBP to Placing site	1.00	2.00	7.00	9.00	1.00	4.00	5.00	6.00	5.00	5.00	4.00	8.00	9.00
6-Ease of Access to and from the batch plants (site)	0.50	0.50	5.00	6.00	0.25	1.00	0.33	0.25	0.33	0.50	0.50	3.00	8.00

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7-Emergency Ingress/Egress	0.33	1.00	5.00	7.00	0.20	3.00	1.00	0.50	1.00	1.00	2.00	4.00	9.00
8-Availability of Employment skill level.	0.50	1.00	4.00	8.00	0.17	4.00	2.00	1.00	2.00	2.00	3.00	5.00	9.00
9-Oxygen richness	0.50	1.00	4.00	8.00	0.20	3.00	1.00	0.50	1.00	1.00	2.00	6.00	9.00
10-Potential Future extension of CBP or potential future land use in other activities	0.50	1.00	3.00	7.00	0.20	2.00	1.00	0.50	1.00	1.00	1.00	6.00	9.00
11-Investment incentives.	0.33	1.00	4.00	6.00	0.25	2.00	0.50	0.33	0.50	1.00	1.00	4.00	8.00
12-Temperature Degree	0.25	0.33	1.00	1.00	0.13	0.33	0.25	0.20	0.17	0.17	0.25	1.00	9.00
13-Prime locations for advertising	0.13	0.14	0.17	0.17	0.11	0.13	0.11	0.11	0.11	0.11	0.13	0.11	1.00

Table 6: Snapshot of Excel sheet for the Questionnaire Mode for Comparisons with respect to Goal from super-decision software

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In figure 6 the weighting results presents as following, for example Economic and cultural problems 13.6% , taxes 7.35, temperature degree 2.3% and the most important criteria is proximity of CBP to placing site 24.3%.

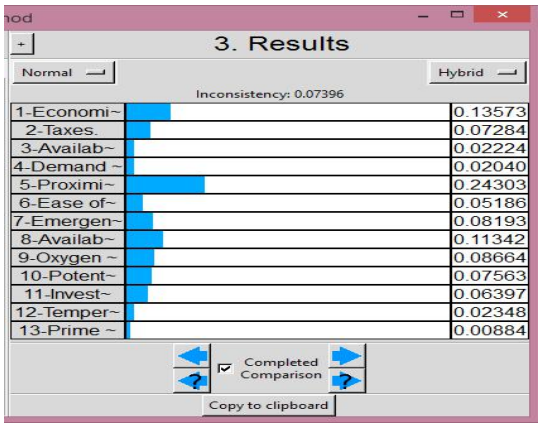

Figure 6: Snapshot of the Result of Factors Importance Weight With Respect To Goal

The second pairwise comparison questionnaire are evaluating from the point of view of what is more important of each criteria with respect to each actual alternative for CBP selection location "alternative", as shown in table 7

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	1- Economic and cultural problems	2- Taxes.	3- Availability of services for production and equipment.	4- Demand lifetime.	5- Proximity CBP to Placing site	6- Ease of Access to and from the batch plants (site)	7- Emergency Ingress/Egress	8- Availability of Employment skill level.	9- Oxygen richness	10- Potential Future extension of CBP or potential future land use in other activities	11- Investment incentives.	12- Temperature Degree	13- Prime locations for advertising
1-Economic and cultural problems	1.00	4.00	0.17	0.25	0.17	0.50	0.50	0.25	7.00	6.00	0.17	0.17	0.13
2-Taxes.	0.25	1.00	0.20	4.00	0.14	2.00	2.00	0.13	3.00	9.00	0.25	0.20	0.13
3-Availability of services for production and equipment.	6.00	5.00	1.00	5.00	1.00	4.00	3.00	1.00	5.00	5.00	1.00	1.00	1.00
4-Demand lifetime.	4.00	0.25	0.20	1.00	0.17	0.50	0.50	0.13	3.00	3.00	1.00	1.00	0.17
5-Proximity CBP to Placing site	6.00	7.00	1.00	6.00	1.00	7.00	7.00	1.00	6.00	9.00	8.00	5.00	1.00
6-Ease of Access to and from the batch plants (site)	2.00	0.50	0.25	2.00	0.14	1.00	1.00	0.14	6.00	9.00	2.00	6.00	1.00

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7-Emergency Ingress/Egress	2.00	0.50	0.33	2.00	0.14	1.00	1.00	0.17	3.00	7.00	0.25	1.00	0.17
8-Availability of Employment skill level.	4.00	8.00	1.00	8.00	1.00	7.00	6.00	1.00	9.00	9.00	8.00	9.00	8.00
9-Oxygen richness	0.14	0.33	0.20	0.33	0.17	0.17	0.33	0.11	1.00	0.25	0.20	0.33	0.13
10-Potential Future extension of CBP or potential future land use in other activities	0.17	0.11	0.20	0.33	0.11	0.11	0.14	0.11	4.00	1.00	0.17	0.33	0.14
11-Investment incentives.	6.00	4.00	1.00	1.00	0.13	0.50	4.00	0.13	5.00	6.00	1.00	3.00	0.33
12-Temperature Degree	6.00	5.00	1.00	1.00	0.20	0.17	1.00	0.11	3.00	3.00	0.33	1.00	0.11
13-Prime locations for advertising	8.00	8.00	1.00	6.00	1.00	1.00	6.00	0.13	8.00	7.00	3.00	9.00	1.00

Table 7: Snapshot of Excel sheetfor the Questionnaire Mode for Comparisons With respect To Each actual alternative from SUPERDECISION software

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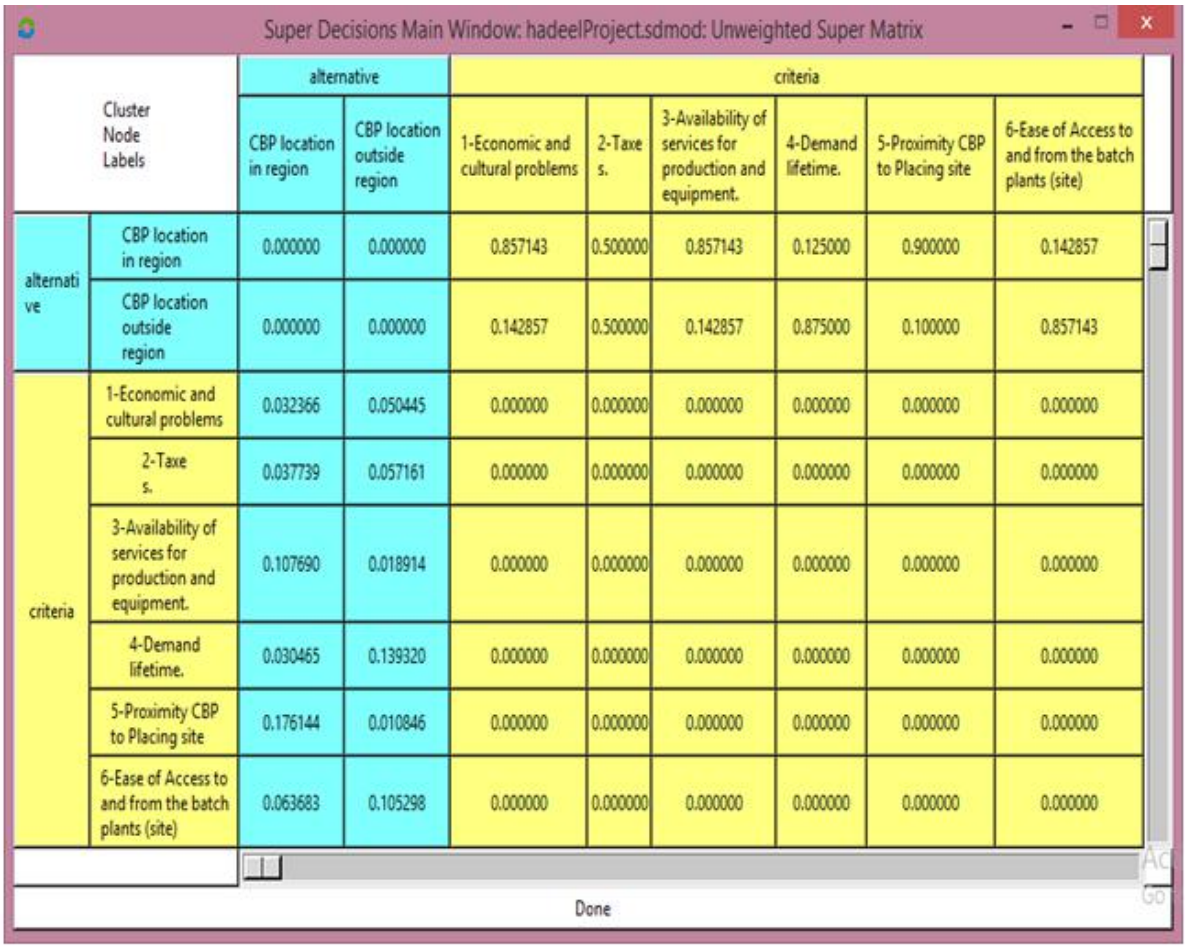
9.3 The Supermatrix:

During the construct ANP model in the SUPERDECISION there are different computations included the super-matrix.To show the various super-matrices, the computations command should be selected from the menu in software. Each network associated with three super-matrices: the weighted, un-weighted and limit super-matrix.The un-weighted super-matrix includes the local priorities derived from the pairwise comparisons through the network.

Consequently, the results of all pairwise comparisons are extracting in the un-weighted super-matrix. Figure 7 shows part of the un-weightedsupermatrix of the optimum selection of CBP location. Has defined a component in a supermatrix, it is the block defined by a cluster name at the left and a cluster name at the top of the supermatrix. The weighted supermatrix is derived by multiplying all the elements in a component of the unweighted supermatrix by the corresponding cluster weight. Segment of the weighted supermatrix for the optimum selection of CBP location is shown in Figure 8[9]



Cluster Node Labels		alternative		criteria					
		CBP location in region	CBP location outside region	1-Economic and cultural problems	2-Taxes.	3-Availability of services for production and equipment.	4-Demand lifetime.	5-Proximity CBP to Placing site	6-Ease of Access to and from the batch plants (site)
alternative	CBP location in region	0.000000	0.000000	0.857143	0.500000	0.857143	0.125000	0.900000	0.142857
	CBP location outside region	0.000000	0.000000	0.142857	0.500000	0.142857	0.875000	0.100000	0.857143
criteria	1-Economic and cultural problems	0.032366	0.050445	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2-Taxes.	0.037739	0.057161	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	3-Availability of services for production and equipment.	0.107690	0.018914	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	4-Demand lifetime.	0.030465	0.139320	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	5-Proximity CBP to Placing site	0.176144	0.010846	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	6-Ease of Access to and from the batch plants (site)	0.063683	0.105298	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Figure 7: Snapshot of a Part of the Unweighted Supermatrix for the optimum selection of CBP location

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Super Decisions Main Window: hadeelProject.sdmod: Weighted Super Matrix

Cluster Node Labels		alternative		criteria					
		CBP location in region	CBP location outside region	1-Economic and cultural problems	2-Taxes.	3-Availability of services for production and equipment.	4-Demand lifetime.	5-Proximity CBP to Placing site	6-Ease of Access to and from the batch plants (site)
alternative	CBP location in region	0.000000	0.000000	0.857143	0.500000	0.857143	0.125000	0.900000	0.142857
	CBP location outside region	0.000000	0.000000	0.142857	0.500000	0.142857	0.875000	0.100000	0.857143
criteria	1-Economic and cultural problems	0.032366	0.050445	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2-Taxes.	0.037739	0.057161	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	3-Availability of services for production and equipment.	0.107690	0.018914	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	4-Demand lifetime.	0.030465	0.139320	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	5-Proximity CBP to Placing site	0.176144	0.010846	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	6-Ease of Access to and from the batch plants (site)	0.063683	0.105298	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Done

Figure 8: Snapshot of a Part of the Weighted Supermatrix for the optimum selection of CBP location

Limit super-matrix is derived by raising the weighted super-matrix to powers by multiplying it times itself. If columns of numbers become typical the limit matrix has been reached.

Thus, the matrix multiplication process is stopped. As shown in figure 9 that present a screenshot of limit super-matrix for the optimum selection of CBP location.

Super Decisions Main Window: hadeelProject.sdmod: Limit Matrix

Cluster Node Labels		alternative		criteria					
		CBP location in region	CBP location outside region	1-Economic and cultural problems	2-Taxes.	3-Availability of services for production and equipment.	4-Demand lifetime.	5-Proximity CBP to Placing site	6-Ease of Access to and from the batch plants (site)
alternative	CBP location in region	0.225100	0.225100	0.225100	0.225100	0.225100	0.225100	0.225100	0.225100
	CBP location outside region	0.274900	0.274900	0.274900	0.274900	0.274900	0.274900	0.274900	0.274900
criteria	1-Economic and cultural problems	0.021153	0.021153	0.021153	0.021153	0.021153	0.021153	0.021153	0.021153
	2-Taxes.	0.024209	0.024209	0.024209	0.024209	0.024209	0.024209	0.024209	0.024209
	3-Availability of services for production and equipment.	0.029441	0.029441	0.029441	0.029441	0.029441	0.029441	0.029441	0.029441
	4-Demand lifetime.	0.045157	0.045157	0.045157	0.045157	0.045157	0.045157	0.045157	0.045157
	5-Proximity CBP to Placing site	0.042632	0.042632	0.042632	0.042632	0.042632	0.042632	0.042632	0.042632
	6-Ease of Access to and from the batch plants (site)	0.043282	0.043282	0.043282	0.043282	0.043282	0.043282	0.043282	0.043282

Done

Figure 9: Snapshot of a Part of the Limit Supermatrix for the optimum selection of CBP location

The main point of the importance of limit super-matrixis provides the priorities for the different criteria that affecting the problem that need to solve.

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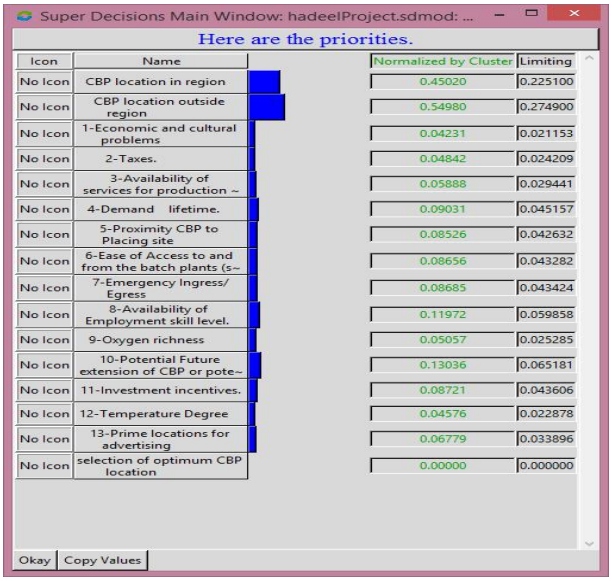
Because the columns of limit super-matrix are typical the priorities of all criteria and alternatives can be read directly from any column. Furthermore, the computation priorities command on displays menu the priorities in two different ways, they present in limit super-matrix. As shown in figure 10 present the priorities as result from limit super-matrix.

When alternatives are included in the model, the SUPERDECISION software can synthesize them to give the optimum choice from the available locations alternatives depend on the provided judgments.

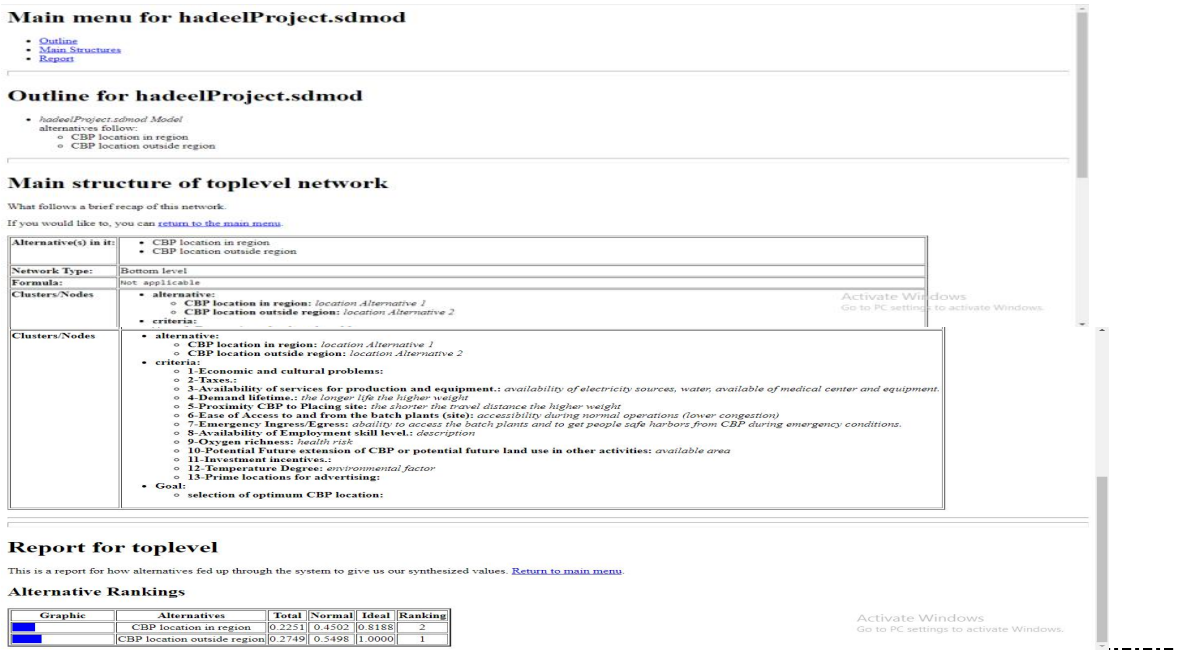


Icon	Name	Normalized by Cluster	Limiting
No Icon	CBP location in region	0.45020	0.225100
No Icon	CBP location outside region	0.54980	0.274900
No Icon	1-Economic and cultural problems	0.04231	0.021153
No Icon	2-Taxes.	0.04842	0.024209
No Icon	3-Availability of services for production ~	0.05888	0.029441
No Icon	4-Demand lifetime.	0.09031	0.045157
No Icon	5-Proximity CBP to Placing site	0.08526	0.042632
No Icon	6-Ease of Access to and from the batch plants (s~	0.08656	0.043282
No Icon	7-Emergency Ingress/ Egress	0.08685	0.043424
No Icon	8-Availability of Employment skill level.	0.11972	0.059858
No Icon	9-Oxygen richness	0.05057	0.025285
No Icon	10-Potential Future extension of CBP or pote~	0.13036	0.065181
No Icon	11-Investment incentives.	0.08721	0.043606
No Icon	12-Temperature Degree	0.04576	0.022878
No Icon	13-Prime locations for advertising	0.06779	0.033896
No Icon	selection of optimum CBP location	0.00000	0.000000

Figure 10: Snapshot of the Priorities the Limit Supermatrix

10. CONCLUSION

Also the SUPERDECISION software can generate the HTML file of reports about the ANP and AHP models. The report gives the names and descriptions of the nodes and clusters and important priorities of alternatives. As shown in figure 11



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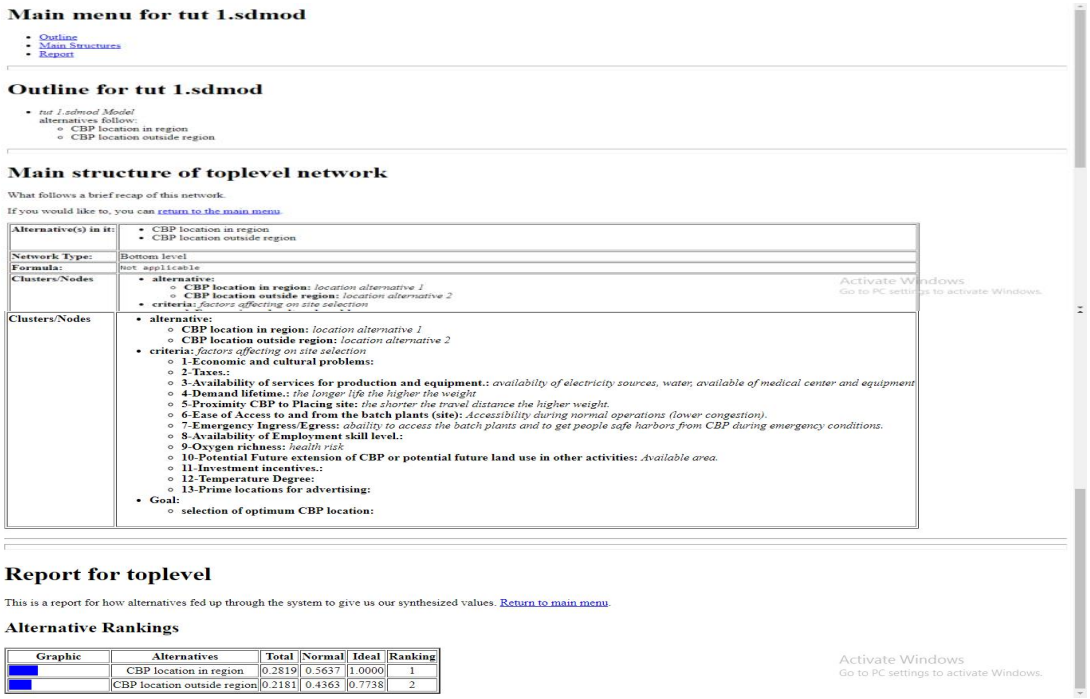

Figure 11: Snapshot of the full report AHP and ANP Model

After completing all comparisons in ANP model the final results for the selection of optimum CBP location model are decided by selecting the most optimum location from the available alternatives. The result shows that: (CBP location in region) is obtained 45%, alternative (CBP location outside region) is obtained 55%. As shown in figure 12.

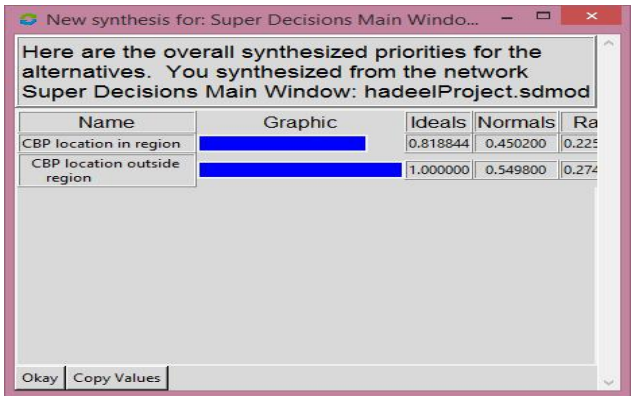

Figure 12: the result for the best CBP location in ANP

While, after completing all comparisons in ANP model the final results for the selection of optimum CBP location model are decided by selecting the most optimum location from the available alternatives. The result shows that: (CBP location in region) is obtained 56.4%, alternative (CBP location outside region) is obtained 43.6%. As shown in figure 13

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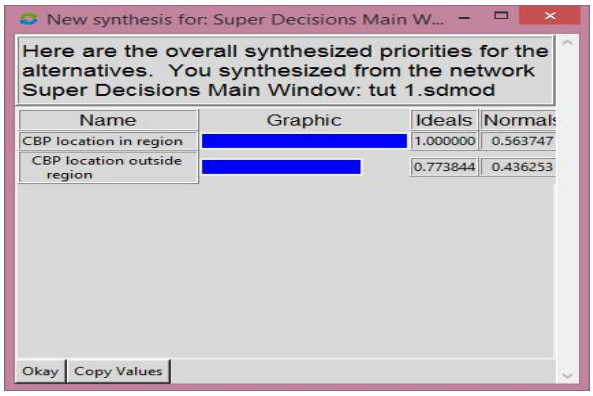

Figure 13: the result for the best CBP location in AHP

Why are the results different?In AHPthe user, going top-down making comparisons, when asked without referring to actual alternatives, with respect to Goal. While, In ANP – the user learned through feedback comparisons (going down-top) that priority for actual alternative.

Comparison of results shows that there are significant differences between AHP and ANP outcome derived from interdependencies, outer dependencies and feedbacks

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