Journal of Economy & International Finance (EIF)
Vol.1pp.7-13

An integrated Case-Based Reasoning and AHP method for team selection

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***Abstract*—One of the problems in human resources management is selection teams. Moreover, good team is indispensable for improving project performance. This paper proposes a new general model for team selection. The proposed model integrates Case-Based Reasoning (CBR) system with the Analytic Hierarchy Process (AHP), to enhance the accuracy and speed in the process of team selection. We test the effectiveness of the model using medical domains of different complexities and describe some practical experiences of using the model in the surgical team selection process.**

***Keywords*— Selection teams; Operating theatre;Surgical team; Case-Based Reasoning; Analytic Hierarchy Process**

I.INTRODUCTION

For creating effective teams we should first build teams and then later selection team. The Selection teams ensure that the right team is in place and that it will have a capable leader in place.

Successful selection teams are still an open problem in various fields of social, business and hospital studies. To solve this problem, several methods were proposed such as AHP [1], KMDL [2], fuzzy-genetic algorithm [3], multi-objective optimization [4], fuzzy logic [5, 6]etc...

The main objective of this paper is to propose a systematic evaluation model to help the decision maker for the selection of an optimal team among a set of available alternatives. The team selection problem is an MCDM problem where many criteria should be considered in decision-making. Therefore, this model utilizes a MCDM method (AHP) to determine the importance weights of evaluation criteria and CBR approach to obtain the best team for each case that satisfies the most the decision maker preferences.

The remainder of this paper is structured as follows: Section 2 describes the CBR method and in section 3 briefly describes the AHP approach. In Section 4, proposed model for weapon selection is presented and the stages of the proposed approach are explained in detail. How the proposed model is used on a real world example is explained in section 5. In Section 6, experimental results and data analysis are discussed. Finally, conclusions of this study are made in section 7.

II. A DETAILED DESCRIPTION OF CBR

Case-based reasoning (CBR) is a problem-solving framework that focuses on using past experiences to solve new problems [7], by remembering a previous similar situation and by reusing information and knowledge of that situation [8]. Similar to human problem-solving process, CBR requires a knowledge-based learning mechanism to learn from old cases and reuse the most specific case or set of cases to ex-plain the new situations [9].

Case-based-reasoning has been applied in various scientific fields, one of which is medical domain [10, 11, 12, 13, 14, 15]. Aamodt and Plaza defined the four–step cycle of Case–Based Reasoning (CBR) back in 1994 [8] described by the following four processes [16] (Fig. 1):

1. RETRIEVE the most similar case or cases

2. REUSE the information and knowledge in that case to solve the problem

3. REVISE the proposed solution

4. RETAIN the parts of this experience likely to be useful for future problem solving.

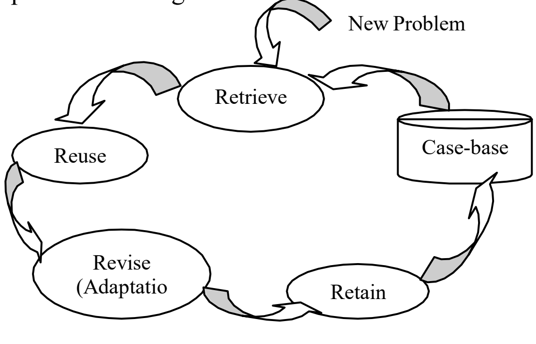

Fig. 1. The CBR-cycle

A new problem is solved by CBR can be broken down into two important steps: case retrieval and case adaptation [17]. CBR provides several advantages over rule base reasoning, such as the ability to extract maximum similar information from experience, and to dynamically update the system by entering new information [18].

In our context of selection teams we use the approach of CBR as a method of automatic learning for decision maker's Preferences over a search session. One major feature of case-based reasoning is it can store successful solution of past cases in case base, and when there is a new case coming, it will search the case base to find similar cases solutions to solve the new one.

III. A Brief Overview Of AHP

The AHP is a decision approach created to solve complex multiple criteria problems involving qualitative decisions [19].addresses how to determine the relative importance of a set of activities in a multi-criteria decision problem. The AHP is easy, comprehensive and logical. It can be used in both quantitative and qualitative multi-criteria decision making problems and it is widely accepted by the decision making community, be they the academics or the practitioners [20].AHP permits collection of all relevant elements of a decision problem into one model to work out their interdependencies and their perceived consequences interactively. It use of pairwise comparisons forces AHP users to articulate the relative importance of criteria and then to decide the relative contributions of the alternatives to the criteria [21].

The AHP method has been used in a broad of range of domains to solve complex decision problems. The AHP method has widely applied in industrial engineering [22].Business [23].medical domain [24] and other field.

The AHP is a powerful decision-making methodology in order to determine the priorities among different criteria. The AHP method encompasses three main stages [25]:

1. Decomposing the decision problem into hierarchical sub problems,

2. Calculating the relative importance weights of decision criteria in each level of the hierarchy using pairwise comparisons.

3. Evaluating the decision alternatives taking into account the weights of decision criteria.

Many researchers have worked in this field and various techniques have been developed. To optimize the selection of teams, we propose a framework through this integrated CBR and MCDM approach. First, we use one of the known MCDM approach the Analytical Hierarchy Process (AHP) for identifies the main attributes of a case and related priority weight. Then, CBR to utilize these weights for calculate the similarity among the new case and each case in the base.

IV. The Model Description

For selection teams, this model (see Fig. 2) will help the decision maker to find in more appropriate team directly; that is to say, the team that is adapted to her preferences and the need of each operation.

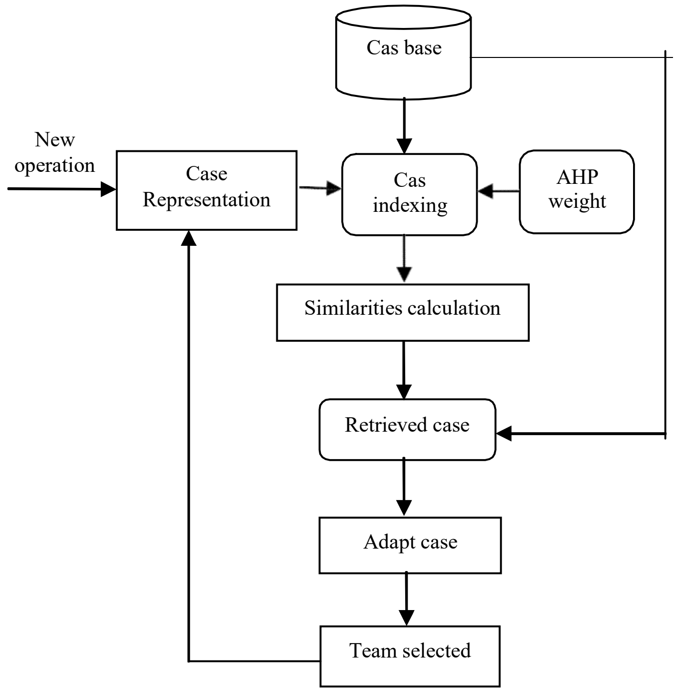

Fig. 2. The structure of a team selection system

The proposed model is presented in four main steps explained below.

A. Step1: Case base Construction

The presentation of the base depends strongly on the structure and content of such cases. A case-base contains problems and solutions that can be used to derive solution for a new situation. Among the steps of the CBR cycle, the most important step is case representation because the performance of the CBR system depend it [25].

In our work, cases contain a vector of attributes that define the problem and the solution. Which correspond to the best team that satisfies exactly the needs of operation and the preferences of the decision maker.

A case is described by criteria and also the solution:

<u>Criteria:</u>

The criteria which characterizing the team choice are:

- The time (T): the duration of operation
- Competence (Ct): the technical competence of team.

- Communication (Co): the communication in team.
- Risk criticality (R): the criticality degree of risk.

Solution:

It is represented by the best team which satisfies exactly the needs and the preferences of the decision maker. That is defined by a set of criteria.

B. Step2- Calculate the weights of criteria

In this step the AHP method is used to determine the weights of criteria for case similarity analysis. This weight is the key to case retrieval. For this reason we use the analytic hierarchy process (AHP) to determine the relative weight of each attribute according to its importance and use these importance weights to calculate the similarity among the new coming case and each case in the case base.

The first step is to compose our problem in three hierarchical levels presented by Fig. 3.

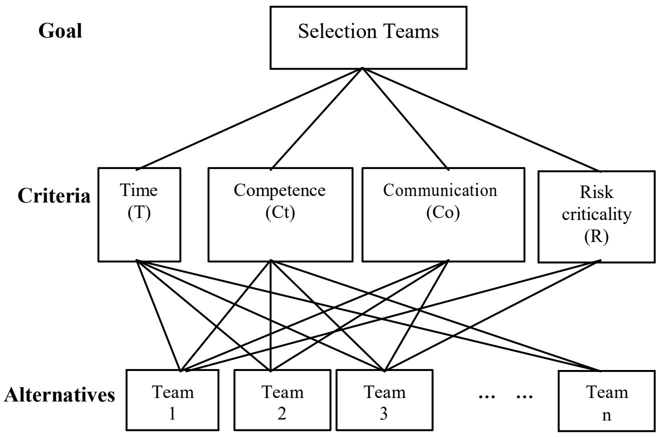

Fig. 3. An AHP Structure for selection teams

The next step is to conduct a questionnaire survey handed to each member. The value assigned is based to the scale in interval of 1-9. Then create square pair wise comparison matrices of the selection criteria. The table.I [20] present scale of preference in the pair- wise comparison process.

TABLE I. AHP COMPARAISON SCALE

Verbal judgments	Numerical rating
Equal importance	1
Moderate importance of one over another	3
Strong or essential importance of one over another	5
Very strong importance	7
Absolute importance	9
Intermediate values between to adjacent judgments	2, 4, 5,8

The consistency of results obtained is found by calculating the consistency index (CI). More consistency index becomes bigger and more the judgments of the user are coherent and vice versa.

C. Step3- Retrieving phase

The objective of Retrieving phase is to finding the most similar previous cases in case base, and retrieving them for analysis, in order to select one and reuse it in the next phase. The similar cases retrieve depends on the cases representation, their indexing in the case base. The objective is to measure the similarity between the new case (operation) and the stored cases in the case-base.

The question in our model, is which one of the previously teams is the most similar to the new operation (case) that must be treated. In order to evaluate the similarity, the similar attribute collection S = {sT_1… sT_n} should be determined first. Let us denote the new operation (case) to be considered by T'. By T, we denote operation (case) stored in the case base. We also denote by Sim the similarity degree between the new operation and the operation stored.

In the first step, we calculate the local similarity sT_i between attribute. We define this similarity in the following way:

$$sT_i - \left(1 - \frac{|T_i - T'_i|}{T_i^{max} - T_i^{min}}\right) \quad (1)$$

Where T_i: the i[th] attribute of the case in memory.

T'_i: is the i[th] attribute of the current case.

T_i^{max}, T_i^{min}: are the maximum and minimum values between all the cases for the i[th] attribute.

The second step, we calculate overall similarity by using the weights associated with each attribute. We thus introduce the importance of the attributes as a new variable. It's measures the importance of the i[th] attribute, which we express as T_i. In our model the weights W_i were calculated by using the AHP method. A general form of similarity measure function is shown in (2).

$$Sim(T,T') = \frac{\sum_{i=1}^{n} sT_i * W_i}{\sum_{i=1}^{n} W_i} \quad (2)$$

Where T is the case in memory, T' is the target case, and n is the number of attributes of each case. Finally, the case having the biggest global similarity with the new case will be selected.

D. Step4: Construction of the new case solution

The objective of this phase is to evaluate the retrieved solution. Thus, the decision-maker must judge if the selected case is well or no. If yes, this case solution will be adapted to the new case. Otherwise, he passes to the second more similar case, to the third, etc.

Finally, the new case and its validated solution is integrated into the case base. It is than necessary to know which information can be important to retain, how to index the case for a future retrieve, and how to integrate the new case in the case base.

V. Computational Study

To assess the efficiency of the developed model, we tested the operation of our model on a real data set that has 50 examples of a team selection's decisions on a set of department of operating theatre in 'Habib Bourguiba' hospital in Tunisia.

We report the results obtained one test on neurology department. We have 36 employees with three disciplines (10 Surgeons, 11 Anesthetists, and 15 Instrumentalists) and we need to select teams for each new case (operation).

Within our framework of aid to the choice of the best team which satisfies the preferences of decision maker and operation need. Our case base is formed by 20 operations witch satisfied this type of operation.

TABLE II. Case Base Construction For The TEAM Selection Problems

Case	Criteria				Team
	T	*CT*	*CO*	*R*	
1	125	4	6	1	{C2, C3, A5, I2, I3}
2	122	5	3	2	{C4, C1, A2, I1, I4}
3	130	5	5	3	{C6, C3, A6, I2, I5}
4	110	4	5	2	{C10, C2, A5, I12, I3}
5	160	4	4	5	{C4, C2, A2, I3, I2}
6	74	3	6	2	{C1, C7, A10, I6, I14}
7	115	6	5	3	{C3, C6, A3, I9, I10}
8	65	5	4	1	{C5, C8, A1, I8, I7}
9	85	2	3	1	{C2, C1, A3, I12, I3}
10	75	4	5	3	{C7, C5, A8, I8, I11}
11	100	6	5	2	{C4, C3, A2, I10, I2}
12	92	4	6	3	{C9, C5, A7, I9, I5}
13	122	3	4	3	{C6, C10, A3, I5, I6}
14	160	5	4	5	{C6, C2, A10, I12, I5}
15	125	3	6	4	{C3, C10, A2, I14, I9}
16	140	1	3	1	{C2, C4, A6, I3, I6}
17	76	3	4	1	{C5, C9, A1, I9, I15}
18	85	2	3	1	{C3, C6, A9, I13, I2}
19	134	5	2	2	{C8, C1, A3, I15, I3}
20	124	3	5	2	{C2, C4, A2, I4, I10}
CNew	120	5	5	3	?

Our objective consists to searching the best team of a new case arising to the case base. This new case is described by the same attributes that those of the others cases in base, described in table.II.

VI. Experimental Results And Data Analysis

The objective of similarities measures is to look for the nearest case which satisfies the most the preferences of the new operation in the case base. Indeed, by applying Eq (1), we calculate all local similarities between attributes (Table. III).

TABLE III. Similarities Local Calculation

Case	T	CT	CO	R
1	0.9473	0.8	0.75	0.5
2	0.0210	1	0.5	0.75
3	0.8947	1	1	1
4	0.8947	0.8	1	0.75
5	0.5789	0.8	0.75	0.5
6	0.5157	0.6	0.75	0.75
7	0.9473	0.8	1	1
8	0.4210	1	0.75	0.5
9	0.6315	0.4	0.5	0.5
10	0.5263	0.8	1	1
11	0.7894	0.8	1	0.75
12	0.7052	0.8	0.75	1
13	0.9789	0.6	0.75	1
14	0.5789	1	0.75	0.5
15	0.9473	0.6	0.75	0.75
16	0.7894	0.2	0.5	0.5
17	0.5368	0.6	0.5	0.5
18	0.6315	0.4	0.5	0.5
19	0.8526	1	0.25	0.75
20	0.9578	0.6	1	0.75

The relative importance weighting attributes obtained by AHP method, W_i, as listed in (Table. IV).

TABLE IV. Criteria Weight

Attributes	T	CT	Co	R	Weight (W_i)
T	0.1	0.086	0.076	0.120	0.095
CT	0.3	0.260	0.307	0.240	0.276
Co	0.2	0.130	0.153	0.159	0.160
R	0.4	0.521	0.461	0.480	0.465

The attributes weights are then employed in Eq. (2) to measure the similarity between the cases in memory and the new case. Next, we obtain the following result:

TABLE V. Global Similarities Calculation

Case	Global similarities	Rank
1	0.3065	15
2	0.4065	11
3	0.9859	1
4	0.5367	7
5	0.3058	16
6	0.7178	4
7	0.8706	2
8	0.3177	13
9	0.2791	18
10	0.8595	3
11	0.5354	8
12	0.6232	5
13	0.6156	6
14	0.3129	14
15	0.4187	10
16	0.2753	20
17	0.2830	17
18	0.2791	19
19	0.3939	12
20	0.5118	9

The computational study pretends to analyze if the model improves the effectiveness of team in operating theatre and how good is its contribution. For this study, team performance identified by 50 tests. Respectively, 10 tests in orthopedics department, 20 tests in Urology department and 20 tests in the neurology department. Figure 1 shows the percentage of operation success in each department. It is analyzed the comparison of results before and after the integration of our model.

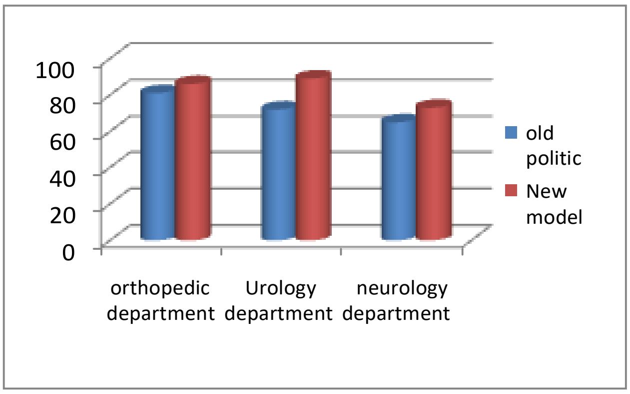

Fig. 4. Percentage of successful operations

We are next interested in comparing the performance of our model with other proceeding models for selection teams is presented in Table. VI below:

TABLE VI. APPROACHS USED FOR SELECTION TEAMS

Models	**Strnad, 2010**	**Ahmed, 2013**	**Our approach**
Used approach for selection team	fuzzy logic and genetic algorithm	Multi-objective optimization and genetic algorithm	AHP and CBR
Type of teams	Monodisciplinary Team	Multidisciplinary Team	Multidisciplinary Team
Field application	Artificially constructed domains	Sport domain	Medical domain

Sternad and Guid [3] proposed a team selection model, that makes up for some shortages of previous models. In her model, he used fuzzification to automatically obtain fuzzy skill assessments from numerical data. An island genetic algorithm is then used to find the optimal solution for problems of scale that surpasses previous attempts. Her model is essentially a single-objective optimization method. Although multiple criteria are internally used to define this objective (i.e., compatibility of team member skills to project requirements), the global optimum is well defined that facilitates the extraction of such solution.

But is a limitation in cases where many independent fuzzy objectives exist. Another restriction of that approach is a disregard for crisp constraints like budget limits and deadlines used by some previous approaches. He considered a batch team selection, in which the whole project team is constructed before the project starts. This is possible when the project specifications are adequately detailed and stable and when the nature of the project allows at least a speculative planning for the whole project lifetime. Unfortunately, many real-time projects are not like that so the teams must be frequently supplemented. Also takes into account the criteria related to each member.

Ahmed et al., [4] proposed a novel gene representation scheme and a multi-objective approach using the NSGA-II algorithm to selection bowling teams. He used for the first time emergent computing methodologies for an objective evaluation of cricket team selection using a multi-objective genetic algorithm and multiple criteria decision making aids. The consideration of multiple objectives during optimization and during the decision-making process provides team selectors a plethora of high-performing team choices before they can select a single preferred team. In a dynamic selection of players one at a time, the team selectors may put more emphasize in selecting such players. Some fine-tuning of the proposed methodology and a GUI-based user-friendly software can be developed to customize a franchise's options, that can be used in practice without much knowledge of multi-objective optimization, genetic algorithms, or decision making aids. For the optimization task, a novel representation scheme has allowed feasible solutions to be found in a convenient manner and enabled simple genetic operators to be employed.

But the limitation of this approach is that it takes into account the criteria related to each member not related to the team, and it requires a large number of cases for the release of game very different and the performance of player in one version of the game does not extrapolate to another version for most players.

In order to overcome the limitations in the two previous approaches, we proposed a new approach of selection team. Our method based on a multi-criteria aid model and using the CBR. The combination of the two techniques seems to be more appropriate in our problem.

Team selection problem can be assimilated to a decision-making problem. This is due to the fact that team selection problems usually associate several criteria. These criteria can be qualitative or quantitative. For this reason the AHP method provide a framework to cope with multiple criteria problems. Then, the CBR technique allows us to reuse base contain teams to generate new solution that respect the new preference decider. With this tow phase of evaluation the system can provide a high quality teams.

VII. CONCLUSION

In this paper, we present a team selection method based on a Multi-criteria aid model using Case-Based Reasoning technique. The proposed approach was tested on the real data sets collected from the 'Habib Bourguiba' Hospital in Tunisia. However, because of the nature of the information and the difficult of obtaining the data, the number of available data points was limited. By comparing the results obtained through the model with those resulting, it was found that the developed model is highly representative of reality because it use last experience case that satisfies the most the decision maker preferences.

The next step in our work will be the use of our approach in other Areas. We are also planning to imbed this model in a general project management system we are currently developing. The model can be improved by adding others attributes (experience, leaderschip…) which can be studied in the future.

References

[1] S.J. Chen., L. Lin, "Modeling team member characteristics for the formation of a multifunctional team in concurrent engineering," IEEE Transactions on Engineering Management 51 (2), 2004, pp111–124.
[2] N.Gronau, J.Froming, S.Schmid, U. Russbuldt, "Approach for requirement oriented team building in industrial processes," Journal of Computers in Industry, Vol. 58 No. 2, 2006, pp. 179–187.
[3] D.Strnad, N. Guid," A fuzzy-genetic decision support system for project team formation," Applied Soft Computing 10, 2010, pp 1178–1187.
[4] F. Ahmed, K. Deb, A. Jindal, Multi-objective optimization and decision making approaches to cricket team selection, Applied Soft Computing 13, 201, pp 402–414.
[5] M.F. Shipley., M. Johnson, "A fuzzy approach for selecting project membership to achieve," European Journal of Operational Research 192, 2009, pp 918–928.
[6] T.L. Tseng, C.C. Huang, H.W. Chu, R. Gung, "Novel approach to multi-functional project team formation," International Journal of Project Management 22, 2004, pp147–159.
[7] D. Leake. Case-Based Reasoning: Experiences, Lessons, and Future Directions. Menlo Park, CA, AAAI Press. 1996.
[8] A.Aamodt and E. Plaza, "Case-based reasoning: founda-tional issues, methodological variations and system approaches," AI Communications, vol.7, 1994, pp.39-59.
[9] K. J. Hammond, "Case-based planning", Academic Press Inc, 1989.
[10] Bichindaritz, Marling, "Case-based reasoning in the health sciences: What's next?, Journal of artificial intelligence in Medecine, volume 36 Issue 2, February, 2011, Page 127-135.
[11] J. Bajo, J.F.Paz, Y. Paz, J.M.Corchado:, " Integrating case-based planning and RPTW neural networks to construct an intelligent environment for health care," Expert Syst. Appl. 36(3): 5844-5858 (2009).
[12] A.Aamodt, O.E.Gundersen, J.H. Loge, E. Wasteson, T. Szcepanski," Proceedings of CBMS 2010 - The 23RD IEEE International Symposium on Computer-Based Medical Systems. Perth, Australia, 2010, IEEE Symposium Series, 2010.
[13] D. Teodorovic, M. Selmic, L. M. Teodorovic, "Combining case-based reasoning with Bee Colony Optimization for dose planning in well differentiated thyroid cancer treatment," *Journal of Expert Systems with Applications* 40, 2013, pp 2147–2155.
[14] Z.Y.Zhuang, L.Churilov , F.Burstein , K.Sikaris, "Combining data mining and case-based reasoning for intelligent decision support for pathology ordering by general practitioners," *European Journal of Operational Research* ,Vol.(195),2009, pp. 662–675.
[15] Mukesh Kumar Jha, Debanjan Pakhira, Baisakhi Chakraborty, Diabetes Detection and Care Applying CBR Techniques, International Journal of Soft Computing and Engineering, ISSN: 2231-2307, Volume-2, Issue-6, 2013.
[16] R. Shank, and R. Albreson, "Script, plans, goal and un-derstanding", Hillsdale, NJ: Erlbaum, 1977.
[17] D. Leake. Case-Based Reasoning: Experiences, Lessons and Future Directions. InAAAI Press,1996.
[18] J. Kolodner, "Case-based reasoning", California: Morgan Kaufmann Inc., 1993.
[19] T.L. Saaty, "The analytic hierarchy process". New York: Mac Gray-Hill, 1994.
[20] N.J.Z. Mamat, J.K. Daniel, Statistical analyses on time complexity and rank consistency between singular value decomposition and the duality approach in AHP: A case study of faculty member selection. Mathematical and Computer Modelling 46, 2007, pp 1099–1106.
[21] C.Carlsson, , P. Walden. AHP in political group decisions: A study in the art of possibilities. *Interfaces* 25, 1995, pp14-29.
[22] A.Calabrese, R.Costa , T.Menichini, Using Fuzzy AHP to manage Intellectual Capital assets: An application to the ICT service industry, Journal ofExpert Systems with Applications xxx (2013) xxx–xxx.
[23] S. Kumar and N. Parashar, "Analytical Hierarchy Process Applied to Vendor Selection Problem, Small Scale, Me-dium Scale and Large Scale Industries," *Business Intelligence Journal,* Vol.2No.2, August, 2009.
[24] L.A. Vidal , E. Sahin , N. Martelli , M. Berhoune, B.Bonan , Applying AHP to select drugs to be produced by anticipation in a chemotherapy compounding unit. Journal of Expert Systems with Applications 37, 2010, pp 1528–1534.
[25] A. Bouhana, M.Abed, H.Chabchoub, An integrated Case-Based Reasoning and AHP method for personalized itinerary search, *Logistics (LOGISTIQUA),* 2011.