Chapter

An Integrated Approach for the Building and the Selection of Multidisciplinary Teams in Health Care System

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Abstract

This chapter presents a support approach for the building and the selection of multidisciplinary teams. In the first part, we propose a new general model for multidisciplinary team building. The proposed model takes professional's preferences into account when a team building process is required for any type of project. In the second part, we develop hybridization between a multicriterion decision method and a cognitive method for selection teams. The developed methodology is based on the experiences of the past operations in order to select the adequate team for a new operation. We test the effectiveness of the model using health care domains of different complexities and describe some practical experiences of using the model in the surgical team building process.

Keywords: team building, multidisciplinary team, selection team, analytic hierarchy process, case-based reasoning

1. Introduction

Hospital context has undergone multiple changes in the last decade economical field (expenditure growth of hospital logistics), technological field (integration of new technologies), and social field. In this context, hospital systems aimed to reduce expenditure while ensuring greater quality of care. Adverse events related to care affect 3.7–16.6% of patients care in the OECD countries. The incidence in France is 5.1% which represents an average of 6.6% of the adverse events for 1000 hospital days [1]. Also, around half of events occurs during surgical intervention [2, 3], which represents the emblematic of this component.

Investigations focus on complications in the operating rooms date from the 1980s. It is thus crucial to understand causes of complications. Several studies draw our attention for research on the causes of surgical complications. Atul et al. [4] have shown in their study about three hospitals that two-third of complications produced during operative phase. Three factors were cited as factors that contribute to error: the lack of experience/lack of competence for

Studies	The causes				
	Communication	Leadership	Technical skills	Fatigue/excessive workload	Collaboration
Atul et al. [4]	*		*	*	
Helmreich and Schafer (1994)	*				
Watson et al. [8]	*		*		
Taylor et al. [9]			*	*	*
JCSES [6]	*				
Wong et al. (2009)	*	*			
Fuchshuber et al. [7]	*				
Haller et al. (2011)	*				
Doppia et al. (2011)				*	

Table 1.
The causes of complication in the operating room.

surgical task was associated to 53% of incidents, communication problem (43%), fatigue or excessive working (33%). Fleming et al. [5] analyzed interpersonal skills for each members of cardiac surgery team to determine their attitudes regarding team work. Researchers have identified different factors as seniority in grade and adherence in professional community. Respondents reported that erroneous communication, execution of intervention at the wrong time and the not following of procedures that constitute the most frequent types of errors. Statistics of JCAHO show that 65% of severe events (for example, compresses forgotten, error in blood transfusion, etc.) are related to a lack of communication [6].

The results of the analysis of National Surgical Quality Improvement Program (NSQIP) identified the major problems like communication team, lack of skilled care during the patient postoperative care. It is important to note that problems are related to systems and not to individual performance of surgeon [7].

We often classify in the table below different studies depending on the causes identified.

Improvement of techniques and processes in the operating theater does not completely solve complications occurring. Refer to the studies mentioned (**Table 1**), we can conclude that team building constitutes an obvious starting point.

2. Domain and motivation

Operating theater is a containment with high concentration of human competence. An operation needs intervention of different actors from different disciplines (surgeons, anesthetists, nurses, etc.) with various levels of skills. Surgical team performance emerges as key points to ensure the best quality care and risk management. The operating theater is also a deep human place where the individual works on an individual and with an individual. These individuals have personalities, logic, interests, and specific different viewpoints and sometimes conflicting. They constitute a surgical team in which performance and outcomes depend on the degree of

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coordination the efforts made by everyone, that is, teamwork. Selection teams ensure that the right team is in place and that it will have a capable leader in place.

Successful building and 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 [10, 11], fuzzy-genetic algorithm [12], multiobjective optimization [13], fuzzy logic (Shipley et al., 2013), etc.

The main objective of this chapter is to propose a systematic evaluation model to help the decision maker for the building and selection of an optimal team among a set of available alternatives. For building team, we present a new algorithm applied to multidisciplinary team. Then, for selection team, we envelop a methodology where we combine a multicriterion decision method and a cognitive method.

The remainder of this chapter is organized as follows: In Section 3, proposed model for weapon building and selection team is presented and the stages of the proposed approach are explained in detail. In Section 4, experimental results and data analysis are discussed. Finally, conclusions of this study are made in Section 5.

3. The model description

Proposed model is divided in two main parts: approach support for building multidisciplinary teams and approach for selection teams, presented in **Figure 1**.

These two approaches can be applied successively or separately, depending on the case of application.

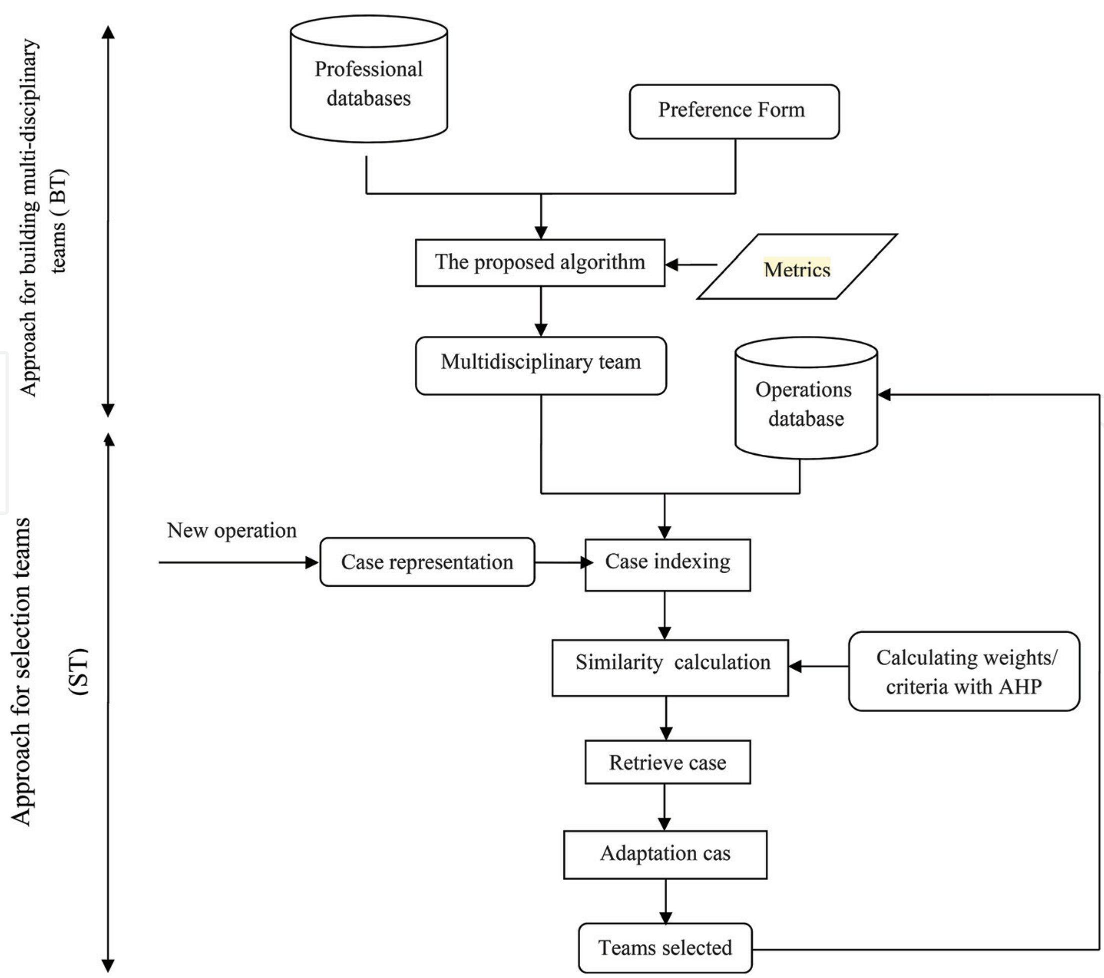

Figure 1.
Model support for building and selection teams.

3.1 Approach support for building multidisciplinary teams

This first approach presents a new model for multidisciplinary team building. It takes professional's preferences into account when a team building processes. The proposed approach is presented in four main steps explained below.

Step 1: Completion of preference form

At the beginning of the year, the professionals in the operating theater (proposers) are asked to complete a form (**Figure 2**) for ranking their colleagues (acceptors) using a preference scale from 1 to 6 (1 being highest and 6 being lowest) according to their willingness to be in the same group. This process should be finalized within a period of 7 days. Although proposers are completing the forms, they should agree to the following rules:

1. All professionals must submit a form at the beginning of the year; otherwise the proposer agrees that all the acceptors will be regarded as having the same priority with the highest level.

2. They cannot give the same preference order for more than one acceptor.

Step 2: Constructing the preference matrix

We transform the forms into a preference matrix. Several revisions are made on the matrix according to Assumptions 1 and 2.

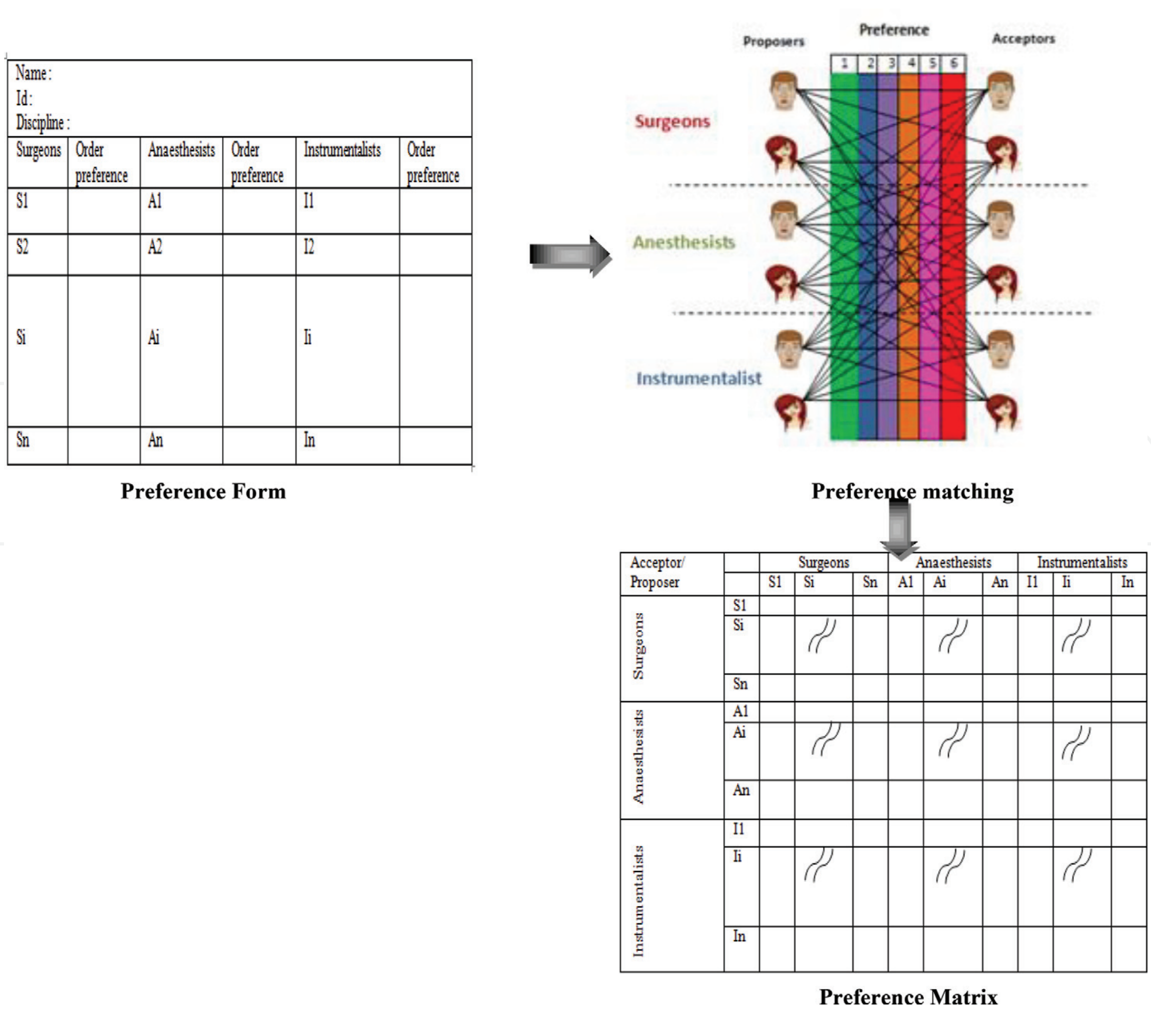

Figure 2.
Transfer sequence of the preference forms to a preference matrix.

Assumption 1. If a proposer professional does not complete a form, the proposer would accept being a member of any team without complaint. Thus, the rows of these proposers in the matrix are filled with 1 (highest preference level) for each acceptor (column), P(j) = 1, for j = 1 to n−1.

Assumption 2. If an author does not give a priority level for acceptors, the author agrees that all these acceptors have the same priority level. Thus, the priority level of the acceptor (columns) is set to the lowest priority given by the author plus 1. P(j) = P(i) + 1 for j = i + 1 to n−1.

When the preference matrix is constructed, it is transformed into a lower triangular matrix by adding the weights of each cross proposer and acceptor ($M_{ij} = M_{ij} + M_{ji}$).

Step 3: The team building algorithm

The algorithm of the proposed model is straightforward, and it is similar to Prim's minimum spanning tree algorithm and Sahin algorithm. **Figure 3** presents the pseudocode of the algorithm. We begin by traversing all the elements of the first discipline in order to find the two groups who have the minimum weights. For this, we use the function FindMinRelationShip. The function chekGroupComposition permits to verify if it is possible to merge the two groups (e.g., if we merge the two groups, the total number of surgeons is less than maximum surgeon authorized in one group). If the merging of the groups is possible, we remove the second group and we recalculate the new weights. If the merging is not possible, we put a negative value in a matrix of preferences. We repeat the same steps until all the weight values are negative. When this first phase is finished, i.e., we can no longer create a new group using the first discipline, we add the individuals of the second discipline. We recall the same function, FindMinRelationShip, chekGroupComposition, merge, until no way to merge groups. This last phase is repeated until all disciplines are added.

A sample example is presented in **Figure 4**, for application of the proposed algorithm. Suppose we have nine employees with three disciplines (three surgeons, three anesthetists, three instrumentalists) and we need to compose teams with three members (one surgeon, one anesthetist, and one instrumentalist). We apply the algorithm above; we obtain this composition (Step 4—**Figure 4**) of three teams.

This developed approach represents an improvement for Sahin algorithm [14]. We have developed our computer algorithm on the Java platform within the Eclipse. The next step of procedure is selection teams, as detailed below.

3.2 Approach for selection teams

Once we have teams already built, we are going to apply this second approach that helps the decision maker to find more appropriate team; which means, the team that is adapted to his preferences and the need of each operation. The proposed model is presented in four main steps explained below.

Step 1: 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. 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 the operation and the preferences of the decider. A case is described by the criteria and also the solution.

Algorithm 1: Multidisciplinary Team Building algorithm

```
Input: Number_discipline,                //number of discipline
 Number_indiv_by_type[],                 // number of individual by discipline
Max_indiv_by_Type[],                     // Max of individual in team for each discipline
Nb_total_individu;                       // Total number of individuals
Preference Matrix Mij,
Output: groups
   For j : 1.. NbGroup
        Maxpref= Max(M[j]) ;
        For i :1..NbGroupe do
          If M[i,j] = 0 then Set M[i,j] = maxpref+1
         end {for}
  end {for}
Transform (M)                            // each individual is considered as team composed by a single person
For ( i=0, i< Number_discipline , i++)   //We construct the team by using the first discipline
  For (j =0,j<nbgroupe,j++)              //  by using the same algorithm used by sahin to find all possible team.
        FindMinRelationShip (group1, group2, weight)   //When we finish with first discipline
                //we add the all group of the second discipline and so forth until the last discipline

        IF checkGroupComposition (group1, group2,Max_indiv_by_Type[])
                Merge (group1, group2)
                Remove (group2)
                NbGroupe - -
        Else M[g1,g2] = -1
     end {if}
  B=False
For i : 1..NbGroup
    For j : 1.. NbGroup
        If (M[i, j] <> -1) B=True;
         break;
    end {For}
  If (B==True) Break;
end {For}

        If (B==True) Break;
      end {For}
     If (B==False) Break;
     end {For}
     end {For}
     Chek GroupeComposition (groupe1, groupe2, Max_indiv_by_Type[])
     For ( i=0, i< Number_discipline , i++)        // we check for each type if the sum the individuals in

        If (groupe1.nbre(i)+ groupe2.nbre(i)) >Max_indiv_by_Type[i])  //Groupe 1 et Groupe 2 is
            return false;     //greater than the maximal number authorized for this discipline we return False
        end{IF}
     end {For}
           return true;
```

Figure 3.
The algorithm's pseudocode.

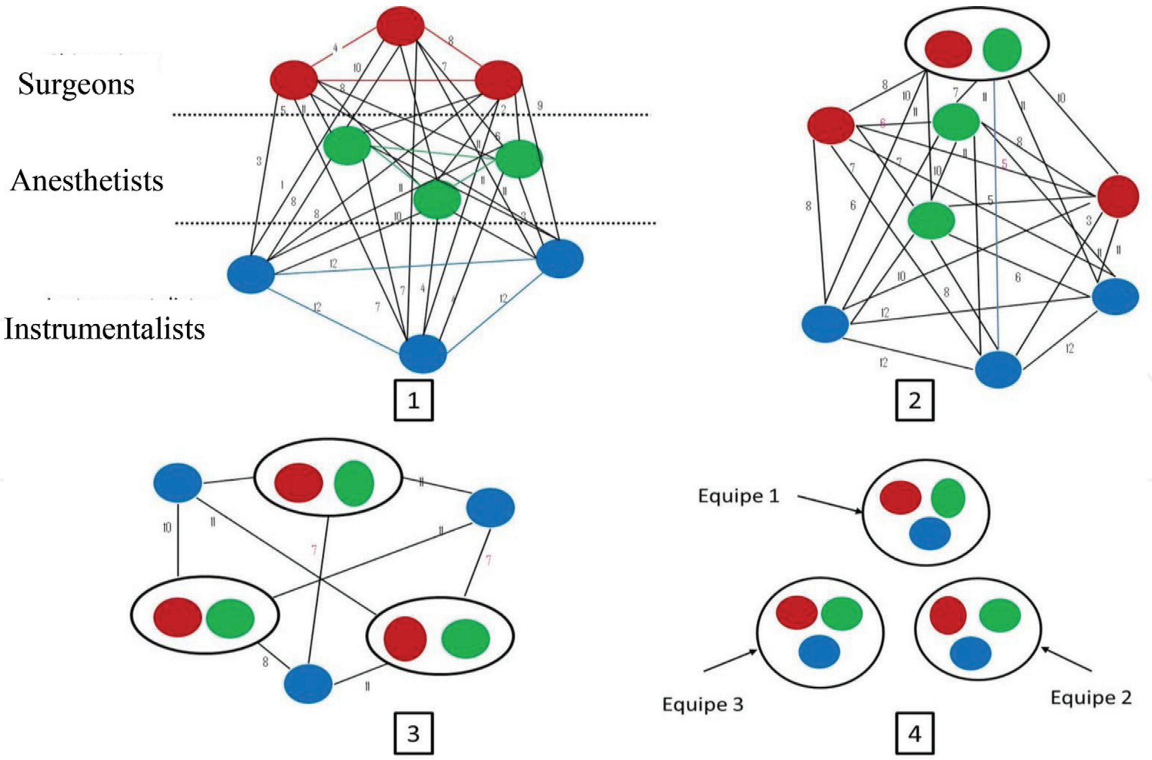

Figure 4.
Sample steps for the multidisciplinary team building algorithm.

Criteria:

The criteria which characterize the team choice are:

- The time (T): the duration of the operation
- The competence (Ct): the technical competence of the team.
- The communication (Co): the communication in the team.
- The risk criticality (R): the criticality degree of the 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.

Step 2: 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 important 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 **Figure 5**.

The next step is to conduct a questionnaire survey handed to each member. The value assigned is based on the scale in interval of 1–9. Then, create square pair-wise comparison matrices of the selection criteria. **Table 2** [15] presents the scale of preference in the pair-wise comparison process.

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.

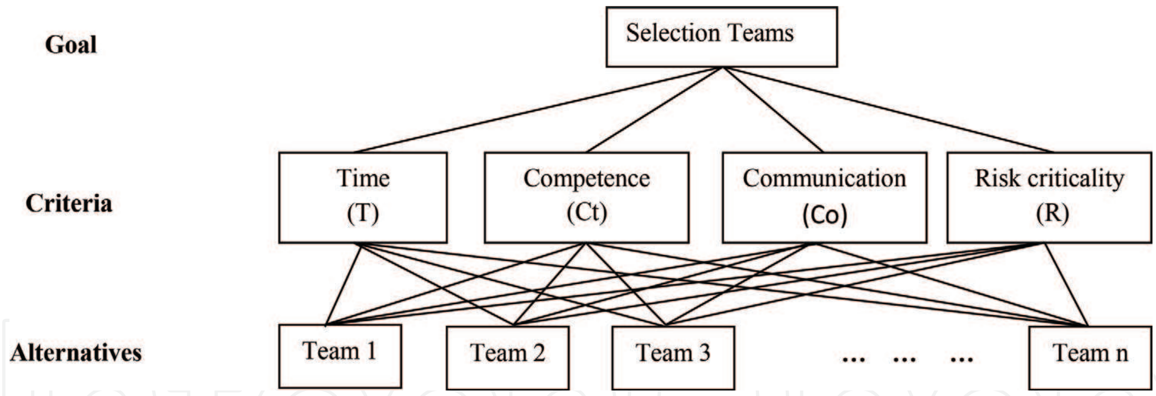

Figure 5.
An AHP structure for selection teams.

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 two adjacent judgments	2, 4, 5, 8

Table 2.
AHP comparison scale.

Step 3: Retrieving phase

The objective of the retrieving phase is to find 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 case retrieval depends on the case representation and 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 previous 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 = $\{sT_1,\ldots, sT_n\}$ 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 is the i^{th} attribute of the case in memory, T'_i is the i^{th} attribute of the current case, and T_i^{max} and T_i^{min} are the maximum and minimum values between all the cases for the i^{th} attribute.

In 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 measures the importance of the ith 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 Eq. (2).

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

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.

Step 4: 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 are integrated into the case base. It is then 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.

4. Experimental results and data analysis

To assess the computational tractability and efficiency of the developed model, we tested the operation of our model on a set of department of operating theater in "Habib Bourguiba" hospital in Tunisia. We report the results obtained on three departments of different sizes. The comparative **Table 3** shows the relevant parameters of scale for the three departments.

The table shows the number of professionals for each discipline (D1: surgery, D2: anesthesia, D3: instruments) in the second column. The third column lists the possible size of team for each department which depends on the nature of the operation.

During 3 months, the team performance of the first support for building multidisciplinary teams is identified by seven tests. Respectively, two tests in orthopedics department, three tests in urology department, and two tests in the neurology department. **Table 4** shows respectively the team size for each test and size of each discipline.

Then, we apply the second support for selection team. 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 which satisfied this type of operation.

Our objective consists on 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 other cases in base, described in **Table 5**.

The objective of similarity measures is to look for the nearest case which satisfies the most preferences of the new operation in the case base. Indeed, by applying Eq. (1), we calculate all local similarities between attributes (**Table 6**).

The relative importance weighting attributes obtained by AHP method, W_i, are listed in **Table 7**.

Department	Nb professionals	D1	D2	D3	Team size
1	22	8	8	6	5-6
2	36	10	12	14	4-5-6
3	42	12	15	16	6-7

Table 3.
The experimental departments.

Test	Team size	Size of each discipline		
		D1	D2	D3
1	5	2	2	1
2	6	3	2	3
3	4	2	1	1
4	5	2	1	2
5	6	2	2	2
6	6	3	2	1
7	7	3	3	1

Table 4.
Tests of proposed model.

Case	Criteria				Team
	T	CT	CO	R	
1	125	4	6	1	$\{C_2, C_3, A_5, I_2, I_3\}$
2	122	5	3	2	$\{C_4, C_1, A_2, I_1, I_4\}$
3	130	5	5	3	$\{C_6, C_3, A_6, I_2, I_5\}$
4	110	4	5	2	$\{C_{10}, C_2, A_5, I_{12}, I_3\}$
5	160	4	4	5	$\{C_4, C_2, A_2, I_3, I_2\}$
6	74	3	6	2	$\{C_1, C_7, A_{10}, I_6, I_{14}\}$
7	115	6	5	3	$\{C_3, C_6, A_3, I_9, I_{10}\}$
8	65	5	4	1	$\{C_5, C_8, A_1, I_8, I_7\}$
9	85	2	3	1	$\{C_2, C_1, A_3, I_{12}, I_3\}$
10	75	4	5	3	$\{C_7, C_5, A_8, I_8, I_{11}\}$
11	100	6	5	2	$\{C_4, C_3, A_2, I_{10}, I_2\}$
12	92	4	6	3	$\{C_9, C_5, A_7, I_9, I_5\}$
13	122	3	4	3	$\{C_6, C_{10}, A_3, I_5, I_6\}$
14	160	5	4	5	$\{C_6, C_2, A_{10}, I_{12}, I_5\}$
15	125	3	6	4	$\{C_3, C_{10}, A_2, I_{14}, I_9\}$
16	140	1	3	1	$\{C_2, C_4, A_6, I_3, I_6\}$
17	76	3	4	1	$\{C_5, C_9, A_1, I_9, I_{15}\}$
18	85	2	3	1	$\{C_3, C_6, A_9, I_{13}, I_2\}$
19	134	5	2	2	$\{C_8, C_1, A_3, I_{15}, I_3\}$
20	124	3	5	2	$\{C_2, C_4, A_2, I_4, I_{10}\}$
C^{New}	120	5	5	3	?

Table 5.
Case base construction for the team selection problems.

The attribute weights are then employed in Eq. (2) to measure the similarity between the cases in memory and the new case. Next, we obtain the resul in **Table 8**.

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

Table 6.
Similarities local calculation.

Attributes	T	CT	Co	R	Weight (Wi)
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

Table 7.
Attributes weight.

The computational study pretends to analyze if the model improves the effectiveness of the team in operating theater and how good is its contribution. For this study, the team performances are identified by 30 tests. Respectively, 10 tests in orthopedics department, 10 tests in urology department, and 10 tests in the neurology department.

Finally, to assess the efficiency of our proposed model, we used model in the three departments of Habib Bourguiba hospital and we obtained the percentage of operation success in each department (see **Figure 6**). It analyzes the comparison of results before and after the integration of our model.

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

Table 8.
Global similarities calculation.

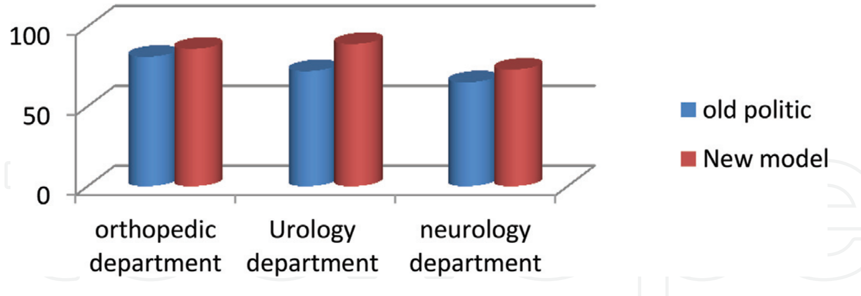

Figure 6.
Percentage of successful operations.

5. Conclusion

The proposed team building-selection model makes up for some shortages of previous models. An important contribution of this chapter is to bring in a practical case a theoretical modeling effort to describe a complex environment of health care services. The use of the first part of approach has allowed us to obtain high-quality solutions in very short commuting times, in spite of the size of the problem and the complexity of data and objectives. In the second part of approach, we present a team selection method based on a multicriteria aid model using case-based reasoning technique.

The proposed model was tested on the real datasets collected from the "Habib Bourguiba" Hospital in Tunisia. However, because of the nature of the information and the difficulty of obtaining the data, the number of available data points was limited. The developed model is highly representative of the reality because it uses the 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 that we are currently developing. The model can be improved by adding other attributes (experience, leadership, etc.) which can be studied in the future.

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