The Development and Application of a Multiple Criteria Model to Creating Teams

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Abstract

In many educational and professional environments, multiple-talent teams are created to solve problems requiring different skill sets. In these environments there may be several teams constructed to attack different problems. In the educational setting this may be to conduct a learning project while in a work setting this may be to develop a new product. Teams are usually constructed from “players” in different functional departments. Since the “best” player in each department can’t be on all of the teams, constructing teams so that all teams function effectively is a challenging process. This paper describes a multiple criteria model for a team selection problem that balances skill sets among the groups and varies the composition of the teams from period to period. The results of applying this team selection model to a cohort-structured Executive MBA (EMBA) program and to team selection in a Fortune 100 corporation are presented.

1. Introduction

Since the 1980s, studies have confirmed increasing reliance on workplace cross-functional teams to achieve strategic, tactical and operational objectives on time, within budget and at an appropriate quality level [2, 4]. Recognizing this industry need, most undergraduate and graduate business programs include team assignments. Consequently, it is vital that instructors at both the undergraduate and graduate levels develop teamwork skills in their students. One of the ways this can be accomplished is by increasing student understanding of how teams are formed, how they work, and how the overall team performance can be improved by establishing discrete, objective and quantifiable team formation factors.

The purpose of our model development is to improve the team selection process by reducing the level of dissatisfaction with team projects as well as to improve each member’s learning by balancing the appropriate knowledge and interpersonal skills that previous studies have shown to be important for team performance [7]. In many cases, the temporary nature of student teams is a detriment to team performance. Conversely, work teams tend to have members who know each other, have more permanence and have a shared interest in the continued success of the organization. Despite this difference, many similarities of team dynamics between the work place and classroom exist and, it is these attributes that we utilize in this modeling approach to improve student team performance and learning.

In this paper, we develop and apply a multiple-criteria nonlinear integer-programming model to improve the task of group identification and selection in academic and workplace environments. The model is similar to the class of combinatorial assignment-type optimization problems that are NP-complete. To accomplish this, we used commercial software packages to solve the problem successfully. The algorithm is used repeatedly over a multiple-semester period to vary the teams from semester to semester.

In the next section, we provide a brief background to decision support systems (DSSs), to multiple criteria decision-making and to approaches taken to creating teams in academia and industry. We then describe the evolution of the team formulation process used by Saint Joseph’s University’s cohort-based EMBA program, tracing the development of our sequential team selection model development. In the subsequent section, the results of applying the team selection model to our EMBA program and a workplace experiment are discussed. We have found that the EMBA team formation process has improved substantially with the application of our multiple criteria unbiased approach. In the last section, we discuss our conclusions and future applications.
2. Background

Despite the promise of significant returns, successful implementation of many operations research/management science (OR/MS) models has been notoriously spotty over the years. For many, it has been the disconnect between the mathematics of the OR/MS techniques and the vagaries of the real world decision-making processes. When management can understand a complex technique it more likely to be successfully implemented. As such, the role of OR/MS must also evolve along with decision makers’ expectations and knowledge of computer technology, [12, 18].

Decision support systems (DSSs) “offer great opportunities” to the OR/MS profession to place “models directly into the hands of those who can use them,” [31]. DSSs have long been in both the literature as well in the technology of information systems (IS). Contemporary DSSs have been developed to meet a variety of business issues such as structured or unstructured decisions, decisions for the classic levels of management (operational, tactical, strategic), and the phases of the process or the style of the decision maker, [16]. Software packages have been developed that permit decision-makers to generate specific reports in various formats and the data can be sliced and diced countless ways. The computer screen can be divided into several windows such that data from various sources may be simultaneously viewed.

With improved computer technology, it has made it possible for increase manager participation in the decision making process. Today’s managers want to be actively involved in decision-making process and they are also now addressing more complex problems, e.g., problems that are less structured, more fuzzy, and include qualitative factors. For example, managers are regularly using spreadsheets to model the impact of different scenarios by asking “what-if” questions. Further, managers intend to examine the problem under a variety of conditions, under different assumptions, and to consider several evaluation criteria. Real-world situations are inherently multiobjective. Decision-makers have more than the one objective of maximizing profits or minimizing costs. In addition, these other objectives are often in conflict with each other. Ignoring the multiobjective nature of these problems does not allow the decision-maker to address the various tradeoffs between these objectives. For example, in addition to maximizing revenues, a production planning problem might also consider minimizing the inventory of finished products and/or minimizing the impact of waste from the production process on the environment.

In an effort to address this deficiency, multiple criteria decision making (MCDM) tools have been developed. MCDM tools/models allow the decision-maker to address and explore the tradeoffs of the conflicting objectives/criteria decision makers face. But one of the more important tasks in developing these MCDM tools is defining the criteria upon which the decision is based. This is an important structuring process, and requires the decision maker to provide a rule or a method of defining these criteria, [26]. The applicability to a MCDM model is in structuring the “front-end” for goal oriented results of the model. Additional research has been conducted in the area of strategic decision making. Models have been developed that attempt to codify the decision maker’s process in a sequential, rational, and analytic procedure, [30]. Subsequent research has refined the decision making process to incorporate both an artificial intelligence component with the multiple criteria approach, [27].

2.1. Approaches to team formation

In both the workplace and academic settings we find increasing emphasis on the use of teams to achieve desired project results. Nevertheless, negative attitudes by individuals towards team participation continue to exist, both in professional work environments and classroom settings. When the negative attitudes are investigated, they fall into five major categories:

1. unclear goals for the team,
2. lack of team leadership,
3. internal conflict,
4. “social loafing” and
5. individual rather than group efforts [1].

To overcome these negative attitudes, organizations, which are serious about using teams, do not hesitate to invest the time and money necessary to train their workforce to improve team dynamics and outcomes [5]. Consistent with this need, it is important that emphasis on team performance be nurtured in academic programs to prepare students to participate effectively on teams in their work environments. Accordingly, faculty/management need to appreciate that establishing student teams requires more than just haphazardly assigning students to a team and asking them to perform at a level to meet expected results. Instead, a key goal a team project should be the development and enhancement of good team working skills [1].

Using student groups in university business programs, especially graduate business programs, is a commonly employed pedagogy for enhancing learning as well as simulating “real world” or organizational work group relationships. The formation of student
groups or teams, however, appears to be a more varied and haphazard process. The criteria most commonly used to assign students into teams vary from the instructor making the team assignments to the students being told to “choose up teams” [22]. Occasionally, the professor or program director may assign students according to some specific criteria/characteristic, e.g., geographic proximity or major [32]. In very few instances are these decisions based on either qualitative (categorical) or quantitative attributes of the students.

A significant body of research about teams examines how teams deal with employee work group formation and performance [6]. Though many studies have been conducted on both the positive and negative aspects of group learning, the literature indicates that the preponderance of measures of group efficacy are focused on either results of group learning or the amount of or degree to which the instructor structures the group effort [3]. In contrast, our focus in this paper is on the beginning of the process, the procedures and methods by which groups are formed. It is our opinion that few, if any, quantitative or objective measures are used in this important and significant step in group learning.

The primary issue is whether to let students form their own work groups or whether to have the instructor make team assignments. Too often, students will form groups based on familiarity, friendship, or classroom “neighbors”, [9, 23]. These personal proclivities may actually inhibit, rather than contribute to enhanced learning because those teams tend to be more homogeneous than heterogeneous. Seldom, if ever, are considerations, such as skills, knowledge or contribution potential, considered, [7]. Furthermore, teams are rarely formed with an optimal mix of knowledge, skills, abilities, personal characteristics, learning styles, and personality types, [7]. The objective of team formation and team-centered learning is to enhance the creativity and problem-solving skills of these students. In addition to the traditional pedagogy of lecture, assignments and student research, a growing body of literature suggests that an additional dimension of learning is fostered by team learning experiences, [24]. However, simply increasing the number of group experiences for students will not necessarily result in an increase in learning or the development of team skills. In an attempt to improve all aspects of the group experience, the more structured, controlled and balanced team membership is, the more likely both group efficiency and effectiveness will be improved [6].

2.2. EMBA teams at Saint Joseph’s University

The EMBA at Saint Joseph’s University (SJU) is...
Model I

\[
\text{Max } \sum_{k=1}^{P} \sum_{i=1}^{P} v_{ik} x_{ij} x_{kj} \\
\text{st. } \sum_{j=1}^{J} x_{ij} = 1 \quad \forall i \\
\sum_{i=1}^{P} x_{ij} = S_j \quad \forall j \\
x_{ij} \in \{0,1\} \quad \forall i,j
\]

\(v_{ik}\) = desirability of student i to be with student k

where:

i: student i \(i = 1, \ldots, P\)

j: group j \(j = 1, \ldots, J\)

P: total number of students

J: number of groups

\(S_j\): number of students in group j

The objective function (1) maximizes the total desirability of group assignments. The \(v_{ik}\) desirability values would be assigned by the students. Constraint (2) assures that each student is assigned to one and only one group. Lastly, constraint (3) makes sure each group has the right number of students, \(S_j\).

Model I is a member of the family of assignment problems and is similar to the quadratic assignment problem (QAP), the generalized quadratic assignment problem (GQAP), and the generalized assignment problem (GAP). QAP is known to NP-complete, [11], and GAP is NP-hard, [25]. Even GAP model with a linear objective function is known to be NP-hard, [25]. Each remains a very difficult combinatorial optimization problem to solve. Only recently have optimal algorithms been developed to solve benchmark problems of size \(P = 36\) for QAP [8]. In a typical class-team formation problem where twenty-five students and five groups are desired, i.e., \(P = 25, S_j = 5 \quad \forall j\), Model I would have 3,125 decision variables and 30 constraints.

To decrease the model size, we reformulated Model I into the following nonlinear model [20]:

Model II

\[
\text{Max } \sum_{k=1}^{N} \sum_{i=1}^{N} (v_{ik} + v_{ki}) y_{ik} \\
\text{st. } \sum_{j=1}^{J} x_{ij} = 1 \quad \forall i \\
\sum_{j=1}^{N} x_{ij} = S \quad \forall j \\
\sum_{j=1}^{N} (x_{ij} + x_{k} - 1) = d_{ik} \quad \forall i,k \\
x_{ij}, d_{ik} \in \{0,1\} \quad \forall i,j,k
\]

\(d_{ik}\) = \(1\) if student i and student k in the same group

\(0\) otherwise.

\(x_{ij}\) = \(1\) if i assigned to group j

\(0\) otherwise.

where:

i: student i \(i = 1, \ldots, N\)

k: student k \(k = 1, \ldots, N\)

j: group j \(j = 1, \ldots, J\)

P: total number of students

J: number of groups

\(S\): number of students in each group

\(S = \text{Round}(P/J + 0.5)\)

\(N = J * S\)

Similar to Model I, the objective function in Model II (4), maximizes the total desirability of the group assignments and constraints (5) and (6) are respectively similar to constraints (2) and (3). Constraint (7) defines \(d_{ik}\) as equaling 1 if student i and student k are in the same group (0 otherwise). For all possible combinations of students i and k, the corresponding \(d_{ik}\) values are listed in Table I.

<table>
<thead>
<tr>
<th>(x_i)</th>
<th>(x_j)</th>
<th>(d_{ik})</th>
<th>Results (considering all groups j)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>It cannot occur because each student must be assigned to a group, (5).</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>In this situation, student i and student k are in different groups.</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>In this situation, student i and student k are in the same group.</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>In this situation, student i and student k are in the same group.</td>
</tr>
</tbody>
</table>

The definition of \(d_{ik}\) requires us to generate only
one PxP matrix instead of a JxPxP matrix. Reexamining the hypothetical example we looked at with Model I, with 25 students to be assigned to five groups, where we needed 3,125 decision variables and 30 constraints, the corresponding problem formulated into Model II requires only 750 decision variables and 655 constraints. The number of decision variables is significantly smaller. However, constraint (7) makes Model II nonlinear.

We used three mathematical programming software packages, Premium Solver in Excel (NLP option), Evolutionary Solver, and OptQuest to solve Model I and II using a small set of hypothetical data (22 students into 5 groups generating 484 decision variables and 27 constraints). Evolutionary Solver in Premium Solver, is a genetic algorithm package, while OptQuest (Version 2000) is part of Crystal Ball’s Excel add-in package. OptQuest uses a methodology called scatter search, developed by Glover [14], which incorporates some of the genetic algorithm and tabu search features into one methodology. Genetic algorithm (GA) procedures were developed by John Holland [15]. Fred Glover created the principles and rules of tabu search (TS) in the 1970s [13]. GA is an adaptive heuristic search algorithm based on the evolutionary ideas of natural selection and genetics such as inheritance, mutation, selection and crossover. It is an intelligent exploitation of a random search within a defined search space to solve a problem. Tabu search uses a neighborhood search procedure to iteratively move from a solution to solution until some stopping criterion has been satisfied. The solutions admitted to the new neighborhood are determined through the use of special memory structures. Genetic algorithms, tabu search and their hybrids are effective heuristics to solve combinatorial problems, such as GAP-GA: [21], TS: [33], QAP-GA: [28], hybrid GA: [10], TS: [29], hybrid TS/GA: [33], QAP-hybrid TS: [8]. In addition to the listed Models I and II, we examined the different solutions when we slightly modified the objectives and added some constraints. The OptQuest package consistently provided better solutions in less time, so, it was decided to use only the OptQuest in subsequent models.

Model II was first applied to determining team selection in our EMBA program during AY 2004 and 2005. Student and administration initial reactions were extremely positive. A typical response was “this approach is more objective and not subjective like before.” The administration was overall satisfied with this approach. However, students and administration raised a number of concerns. First, students were reluctant to “rank” their classmates. Also, after several runs of the model, the administration felt that the desirability criteria should not be considered. “It’s too much of a popularity contest.”

### 3.2. Current EMBA model

As a result, we developed the form shown in Table II to solicit student skills and competencies (completed prior to orientation). The current model for developing teams is the following multiple criteria nonlinear integer programming model:

**MODEL III**

\[
\begin{align*}
\text{Min:} & & \sum_{i=1}^{P} w_i \sum_{j=1}^{J} v_{ij} + w_2 \left( \sum_{m=1}^{M} f_{mj} \right) - \\
& & \sum_{m=1}^{M} \left( \sum_{j=1}^{J} f_{mj} \right) + w_3 \left[ \sum_{m=1}^{M} \left( \sum_{j=1}^{J} f_{mj} - g_m \right) \right] \\
\text{st.} & & \\
\sum_{j=1}^{J} x_{ij} & = 1 & \forall i \\
\sum_{i=1}^{P} x_{ij} & = S_j & \forall j \\
Max \left( x_{ij} + x_{jk} - 1 \right) & = d_{ik} & \forall i,k \\
v_i & = \sum_{k=1}^{P} e^{(d_{ik} \lambda_k)} - 1 & \forall i \\
f_{mj} & = \sum_{i=1}^{P} y_{im} x_{ij} & \forall m,j \\
x_{ij}, d_{ik} \in \{0,1\} & \forall i, j, k \\
f_{mj} & \geq 0 & \forall j, m
\end{align*}
\]

where:
- \( i \): student \( i = 1, \ldots, P \)
- \( k \): student \( k = 1, \ldots, P \)
- \( j \): group \( j = 1, \ldots, J \)
- \( m \): skill \( m = 1, \ldots, M \)
- \( D \): desired group size
- \( P \): total number of students
- \( J \): number of groups = \( \text{Int}(P/D) \); where Int rounds off the number to an integer
- \( N \): total number of possible students where each group has the same number of students = \( \frac{P}{J} \)
- \( M \): total number of skills
L = P - N: number of groups with not the desired size
S_j: total number of students to be assigned to group j
= \begin{cases} D & j = 1, \ldots, J - L \\ D + 1 & J - L + 1, \ldots, J \end{cases}

h_{ik} = \text{number of times student i and student k have been in the same group}
\begin{cases} 0 & \text{if } h_{ik} = 0 \\ 5^{h_{ik} - 1} & \text{otherwise} \end{cases}

r_{ik} = \text{a penalty for historically how many times student i and student k have been in the same group}
\begin{cases} 1 & \text{if student i has skill } m \\ 0 & \text{otherwise} \end{cases}

y_{im} = \begin{cases} 1 & \forall m \\ 0 & \forall m \end{cases}

\text{minimum projected number of students with skill } m \text{ in a group}
= \text{Int} \left( \frac{\sum_{i=1}^{P} y_{im}}{J} \right)

x_{ij} = \begin{cases} 1 & \text{if student i assigned to group j} \\ 0 & \text{otherwise} \end{cases}

d_{ik} = \begin{cases} 1 & \text{if student i and student k are assigned to same group} \\ 0 & \text{otherwise} \end{cases}

f_{mj} = \text{sum of students with skill } m \text{ in group j}

v_i = \text{weighted penalty for the number times student i is assigned a group with students he/she has already been with}

<table>
<thead>
<tr>
<th>Table II. Form to input student’s skills and competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functional Area (Please choose up to 2)</strong></td>
</tr>
<tr>
<td>Accounting</td>
</tr>
<tr>
<td>Finance</td>
</tr>
<tr>
<td>IT/MIS</td>
</tr>
<tr>
<td>General Management</td>
</tr>
<tr>
<td>Marketing</td>
</tr>
<tr>
<td><strong>Major Skill Set (Please choose up to 2)</strong></td>
</tr>
<tr>
<td>Research</td>
</tr>
<tr>
<td>Data Analysis</td>
</tr>
<tr>
<td>Project Management</td>
</tr>
<tr>
<td>Team Management</td>
</tr>
<tr>
<td>Writing</td>
</tr>
<tr>
<td>Verbal Presentation</td>
</tr>
</tbody>
</table>

The team formation model now has three objectives (9).

1. Minimize the number of times, more than once, that a student is in the same group with individuals he/she already has been in the same group.

2. Minimize the difference between the maximum and minimum of the sum of the skills in a group, i.e., minimize the range/difference of skills.

3. Minimize the sum of the differences for all skills between the maximum number of students with a particular skill in all the groups and the desired minimum number of students with that skill.

The first objective assures the diversity of the team composition. Constraint (13) defines the weighted penalty for each student i, \(v_i\), for being more than once in the same group with other students. The variable \(r_{ik}\) is a penalty for being historically in the same group with another student. Table III lists some of the possible \(r_{ik}\) penalty values. If two students are not in the same group then \(d_{ik}\) will be equal to 0, and hence, \(d_{ik}r_{ik}\) will equal 0, regardless if they were previously in the same group. If two students are in the same group then \(d_{ik}\) will equal 1. If the two students were never in the same group prior to this model execution (or semester run), then \(h_{ik} = r_{ik} = 0\) and therefore, \(d_{ik}r_{ik}\) will still be equal to 0. On the other hand, if two students
are in the same group, \( d_{ik} = 1 \), and they were previously in the same group, perhaps, one or more times, then, \( d_{ik} r_{ik} \) is weighted exponentially. For example, if it is the second time two students, \( i \) and \( k \), are in the same group, then, \( d_{ik} r_{ik} \) will equal 1. As a result, in constraint (13) \( v_i \) is defined as an aggregate penalty for student \( i \) being assigned to a group with one or more students that he/she has previously been in similar groups. The weighted sum of these \( v_i \) values characterizes the first part of the objective function.

Table III. Typical values of \( h_{ik} \) and \( r_{ik} \)

<table>
<thead>
<tr>
<th>Number of times in the same group, ( h_{ik} )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penalty, ( r_{ik} )</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>25</td>
</tr>
</tbody>
</table>

The second and third objectives address skill balance among the teams. Constraint (14) defines \( f_{mj} \) as the sum of students with skill \( m \) in group \( j \). The expression \( \sum_{m=1}^{M} f_{mj} \) sums all skills in a group. The second part of the objective function takes the difference between the maximum sum of group skills and the minimum sum of group skills and attempts to minimize this difference, thus trying to balance the aggregate skills among the groups. The last part of the objective function attempts to balance the individual skills among the groups by minimizing the weighted sum of the difference between the maximum number of students with skill \( m \) and the desired minimum, \( g_m \), for each skill \( m \).

Constraints (10) and (11) are similar to previous models where constraint (10) assures that each student is assigned to one and only one group and constraint (11) makes sure each group \( j \) is assigned \( S_j \) students. Constraint (12) defines \( d_{ik} \) as equaling 1 if student \( i \) and student \( k \) are in the same group, otherwise \( d_{ik} \) is equal to 0, which similar to constraint (7) in Model II.

4. Applications

4.1. EMBA program

Model III has now been successfully applied for the past four years for three different EMBA cohort groups. The model is executed before each semester. Table IV is an example of the model output provided to administrators and students. Parameters \( h_{ik} \) and \( r_{ik} \) are updated based on last semester’s team assignments. Additionally, since some students leave the program, for personal or academic reasons, some other parameters must also be updated, i.e., \( D, P, J, N, S_j \), and \( g_m \). Responses from students and administration to the team formation process, thus far, have been especially positive. Students find themselves getting to know more of their classmates. More so, students and are more satisfied with team performance. The EMBA administration has noticed a significant decrease in personal and academic team related problems. Further, instead of one or two dominant teams the faculty and administration have noticed more balance among the groups.

The above multiple criteria nonlinear integer programming model has been solved in Excel using a newer version of Crystal Ball’s add-in OptQuest (Version 7.2). The new OptQuest version now integrates algorithms based on tabu search, scatter search, a mixed integer programming solver, and a procedure to configure and train neural networks. Solution times are now less than seven minutes.

4.2. Team experiment with a corporation

In early 2007, we worked with a Fortune 100 corporation which was marketing a therapeutic intervention based on the combination of a pharmaceutical and diagnostic to deliver an effective therapy to patients. Our engagement required us to work with a group of about 50 employees with diverse backgrounds (e.g., Sales, Marketing, Clinical, R&D and Technical Support), who were charged with the goal of improving their support for customers, physicians and their staffs, who were based in large group practices and/or Ambulatory Surgical Centers. Our role was to provide information about effective team performance and facilitate several exercises to help attendees accomplish that goal. This afforded us an ideal opportunity to assess the group diversity and skill balance objectives of the model.

After reviewing attributes of high performing teams during the first part of our interaction, the group was encouraged to form teams for one of several group exercises [17]. Not surprisingly, teams were formed based on familiarity, friendship or seating proximity [9, 23]. This meant that teams were largely homogeneous (e.g., Sales team and Clinical team) and the solutions they generated lacked perspectives that required integrated thinking by the team. For example, the team
Table IV. Example of Model Output.

<table>
<thead>
<tr>
<th>Team</th>
<th>Team 1</th>
<th>Team 2</th>
<th>Team 3</th>
<th>Team 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Student 2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Student 3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Student 4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Student 5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Student 6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Student 7</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Student 8</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Student 9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Student 10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Student 11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Student 12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Student 13</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Student 14</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Student 15</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Student 16</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

of Sales professionals were proficient about the business aspects of customer interaction but missed other elements of the business relationship that were important to customers, such as the medical relevancy of the treatment when a patient exhibited side effects not previously experienced.

After reviewing attributes of high performing teams during the first part of our interaction, the group was encouraged to form teams for one of several group exercises [17]. Not surprisingly, teams were formed based on familiarity, friendship or seating proximity [9, 23]. This meant that teams were largely homogeneous (e.g., Sales team and Clinical team) and the solutions they generated lacked perspectives that required integrated thinking by the team. For example, the team of Sales professionals were proficient about the business aspects of customer interaction but missed other elements of the business relationship that were important to customers, such as the medical relevancy of the treatment when a patient exhibited side effects not previously experienced.

To improve the teams’ solutions during the second part of our interaction, we realigned the teams using the results of Model III to ensure heterogeneity of backgrounds, personal characteristics and skills [7]. These “realigned” teams considered more comprehensive aspects of business situations and developed more comprehensive solutions. For example, team members from R&D understood implications about the difficulty of unpacking the diagnostic that team members from Technical Support did not understand. Technical Support needed to know the information about unpacking because they had to explain this to medical customers. Interestingly, in addition to generating more comprehensive solutions, the teams seemed to eclipse many of the negative attitudes associated with teams, such individual rather than group efforts, because they recognized that the different perspectives were necessary for the solution.

One negative attitude that was observed was internal conflict for the same reason that the team developed better solutions, heterogeneity of backgrounds.

Notwithstanding the improvement of team performance during the second part of our interaction, we must speculate and conclude that implantation of a quantitative method, such as Model III, would markedly enhance teams’ performance. Furthermore, that performance is likely to be achieved in a more timely manner than without objective determination of the team, especially when immersion among team members is considered. Lastly, the team’s functioning is less likely to be accompanied by the negative attitudes aligned with teams, such as the internal conflict we observed.

5. Conclusions

The process of developing teams, especially for lock-step, cohort programs such as an Executive MBA program may be critical to a class or program’s success. To assess this, a multiple criteria nonlinear integer programming rotating team formulation model to determine group compositions objectively was developed. Using an Excel add-in, with state-of-the-art meta-heuristics, optimization and data mining algorithms, we successfully solved this model and applied it to determine teams in the SJU’s EMBA program.

Presently, two further enhancements are currently being discussed. First, prior to their orientation to the EMBA program, each student is asked to provide what they perceive as their skill and competencies as illustrated in Table II. Over the years, we have found that some students tend to “underestimate” or “overestimate” their skills and competencyiciencies. Second, as students progress thru the
program, a few are identified as “bad” team players. Measuring, executing and incorporating these enhancements into the model are being examined.

In the future, we will continue or research on the model’s application in the academic setting and possible workplace situations. We plan to explore applying the model in other team oriented programs and individual classes. As part of investigating implementation of the model in a workplace setting, we are optimistic that empirical data generated from its use for corporate team formation will provide valuable insights about the model’s applicability in that setting as well as offer a practical alternative to enhance the performance of corporate teams.

6. References


[32] Website: http://members.tripod.com/MrGsPEpage/groups.htm