



TEAM FORMATION MODEL OF SELECTING TEAM LEADER: AN ANALYTIC HIERARCHY PROCESS (AHP) APPROACH

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ABSTRACT

Teamwork is important element to enhance learning experiences. In order to build effective teamwork, team formation is a critical process to ensure that team consists of effective team members. In a team, leadership is the most significant role which contributes to the success of a software project. However, extant literature demonstrated that criteria which suits into team members specifically for leadership role is inconclusive. Therefore, this study aims to construct a software team formation model for selecting team leader by using AHP approach. AHP is chosen because it is able to achieve high accuracy and robustness in dealing with selection process. To evaluate the model, experimental research design was employed and the sample comprised of 24 students enrolled in Information Technology (IT) course from Universiti Utara Malaysia. The initial results showed that the team using AHP to select team leader experienced significantly higher level of satisfaction compared to team with self-selection team leader. The proposed model provides a mechanism for decision maker to form and select team leader in a group work project, and thus can enhance team performance.

Keywords: team formation, team leader, multi criteria decision making (MCDM), analytic hierarchy process (AHP), team performance.

INTRODUCTION

Teams are often refers to members that have common goals for enhancing organizational performance. It is believed that teams are capable of increasing an organization's adaptability to dynamic environment, are able to dealing with complexities of working and production processes (Molleman 2004),(Amir et al. 2014). In a similar vein, Katzenbach (2003), pointed out that an effective team composed of a small number of people with complementary skills who are committed to a common purpose, established performance goals, and approach that hold themselves mutually accountable. Marques and Ochoa (2014), indicated that the teamwork can mean the difference between success and failure of a software project.

One of the important elements in building effective teamwork is team formation. The team member formation is the first task to carry out in order to make sure successful team performance (Guzzo, Hollenbeck, and DeRue, 2004), (Kozanoglu and Fahri, 2009), (Paris et al., 2000). Guzzo et al. (2004), added that the team formation describes matching personal to team roles and appropriate teams. An understanding about team formation could serve as a significant and valuable tool to form and building an effective team (Kozanoglu and Fahri, 2009).

Team leader plays an important role in the success or failure of the team (Rong and Shao 2012), (Gilley et al. 2010), (Humphrey 2000). According to Gilley et al. (2010), good leadership is required by effective teams which is used for managing their external as well as internal associations of teams and align teams towards their objectives. Levi (2007), stated that teams require quality leadership for facilitating interactions of team and for providing assistance to the members of the team when problems or conflicts happen.

There are many author such as (Venkatamuni and Rao 2010), (Ahn et al. 2007), (Tseng et al. 2004) that have been developed different types of technique for team formation, using for example multi-dimensional trust is shown that worthiness assessment have significant benefit in solving the team formation problem. However Cann, Jansen and Brinkkemper (2012), indicated that this techniques have lacking number of attributes, like the experience or expertise of potential team members, the project characteristics, and the functions of the team members.

During team formation, there are several criteria that should be considered for decision makers to select which criteria that suit into which team. With regard to this problem, team formation can be considered as Multi Criteria Decision Making (MCDM) problem whereby many criteria should be considered in decision-making. According to Christopher and John (2014), MCDM is concerned with structuring and solving decision and planning problems involving multiple criteria, the purpose is to support decision makers facing such problems.

Several approaches have been developed to standardize the process of making decisions. Velasquez and Hester (2013), pointed out some techniques in MCDM such as Analytic Hierarchy Process, Fuzzy Set Theory, Multi-Attribute Utility Theory, Goal Programming, and Data Envelopment Analysis. However, selecting a proper technique for decision making is based on the kind of issue being dealt with, the attributes of the method of decision making and the aims of decision makers (Deniz and Metin, 2009), (Trab, 2012).

One of the popular techniques of MCDM is Analytical Hierarchical Process (AHP) technique (Dalalah et al. 2010). AHP is probably the best known and most widely used model in decision making because of its



promising accuracy, theoretical robustness, ability to handle both intangible and tangible criteria, simplicity, and importantly, its capacity to directly measure the inconsistency of the respondent's judgments. It is essentially a formal way of understanding a complex problem using a hierarchical structure (Gibney and Shang 2007), (Deniz and Metin 2009), (Zendeh and Aali 2011), (Bouhana et al. 2011), (Jain & Rao 2013), (Khatrouch et al. 2014).

Gibney and Shang (2007), conclude that AHP is a valuable tool and should be incorporated into personnel selection processes in academia; the AHP provides a convenient and effective tool for evaluating personnel. AHP is widely used during decision situations, such as in government, business, industry, healthcare, and education fields (Deniz and Metin 2009).

Hence, this paper addressed this area by constructing a team formation model of selecting software team leader by using an Analytic Hierarchy Process (AHP) approach which can help decision maker to form an effective team in educational group project teamwork.

TEAM FORMATION METHODS

During team formation, there are three main methods to form team members (Cann et al., 2012), (Hamilton, 2010), (Liu, Joy, and Griffiths, 2013), which are random-formation, self-formation, instructor-formation. Details of these methods are discussed as the follows:

1. Random-formation

Assigning team randomly can lead to newness and freshness in newly formed teams. Besides, it risks placing the best, or the worst, students in a single team, thereby limiting their abilities (Cann et al. 2012). Liu, Joy and Griffiths (2013), stated that using random formation method can increase the efficiency of the group formation process as well as the likelihood of heterogeneous groupings, but do not guarantee that students satisfy their individual needs. While Chapman et al. (2006), concluded that self-formation method in educational setting tend to work better than those groups formed by random assignment. Their study revealed that students in randomly assigned groups usually had more concerns about working in their groups, as well as had lower group outcome measures and slightly less positive group attitudes.

2. Self-formation

According to Hamilton (2010), one simple method for the instructor for defining teams is by letting the students choose themselves. It is usual for the groups to form on a natural flow, based on the connectivity between the group members, which definitely has minimal to do with the performance of each group member in the project. This criteria used by the students will not be the best to form a team which can be effective, but it avoids the waste in time for the students to form a group, as they already know each other's.

In educational settings, instructors usually either let students self-form their group partners or random formation into different groups. However, there are limitations for these methods, as well as student self-formed groups are usually formed based on friendship rather than for educational reasons (Liu et al. 2013).

3. Instructor-formation

When an instructor form a team, the objective is the enhance learning in the classroom. As such, teams are formed with the prime aim of enhanced learning experience and knowledge sharing. After surveying the students, the instructor chooses a method for developing groups. The method can be a random classification or specific criteria based classification. Certain criteria such as the grades of the students, proximity of their residences or timings of classes are used by instructors to develop effective teams (Hamilton 2010).

On the other hand, past reviews demonstrated that instructor method is able to encourage members to participate in teamwork and thus having equal chance to be successful (Deibel 2005), (Oakley et al. 2004).

CRITERIA TO FORM TEAM MEMBERS

Most information technology classes require students to work in team projects (Rutherford, 2006). One of the difficulties in forming students for these teams is in the criteria for formation. Therefore, several researchers determined different criteria in order to form team member such as personality, teamwork experience, gender, Grade Point Average. Table-1 depicted some criteria use to choose team members.

Table-1. Summary of criteria to form team member.

Authors (year)	Criteria to form team member
Humphrey (2000)	Skills, aptitudes, and interests
Paris et al. (2000)	Age, gender, race, intelligence, aptitude, training, experience, personality
Tsai et al. (2003)	Knowledge, experience and technical skills
Gibson and Cohen (2003)	Unique knowledge, skills, and experience
Chen and Lin (2004)	Teamwork experience, communication skill, flexibility in job assignment.
Rutherford (2006)	Personality, country of origin, gender, work experience, and ethnic background
Kozanoglu and Fahri (2009)	Knowledge, skills, personality characteristics
Hamilton (2010)	Gender, Grade Point Average, class schedule, student housing location
Antoniadis (2012)	Experience, technical skills, management skills and personal profile.



Accumulating evidence has shown that most of the criteria used in the research are more focusing on cognitive ability which are team member's knowledge. In addition, there are recent studies that tend to focus on soft skills such as personality and communication skills. Therefore, this study focuses on four criteria which are personality type, academic achievement, teamwork experience and previous academic achievement (GPA) because the combination of these criteria is able to determine effective team members in educational group project.

INTRODUCTION OF AHP APPROACH

The Analytic Hierarchy Process (AHP) is a multiple criteria decision making method which was developed in the 1970's by Thomas L. Saaty. It is simply the most common and widely used approach in the process of decision making (Bouhana et al. 2011). According to Dalalah et al. (2010), AHP's popular use as a multiple criteria decision making approach is because of the pairwise comparisons used by AHP which enables the verbal judgment and increases the result's precision.

AHP has diverse applications, Vaidya and Kumar (2006), provided a detailed literature review on AHP applications, over 150 applications were categorized in their study. Categories were identified on the basis of themes as well as the areas of applications. Ho (2008), reviewed the applications of integrated AHP in a similar way, use of AHP combined with other techniques including SWOT, Quality Function Deployment, Mathematical Programming and Data Envelopment Analysis between the years 1996-2007. All of these show how versatile and capable AHP is in the decision making process (Gurumurthy and Kodali 2012).

Some applications of AHP in selecting of alternatives for various purposes such as, AHP used in dean selection process in academic field (Gibney and Shang 2007). Deniz and Metin (2009), describe an application of AHP for selection of an appropriate host country for further English language education abroad. AHP was also employed for Selecting the Suitable leadership Style (Zendeh and Aali 2011).

Generally, AHP consisting of three key principles, firstly, hierarchy framework, secondly, priority analysis and finally, consistency verification (Saaty 1980), Adhikaril et al. 2006), (Cheng et al. 2007). In the beginning of AHP should formulate the decision problem into suitable form of the hierarchical framework, with the top level which represent the overall objective or goal, the middle level which represents the criteria and the final level representing the alternatives. Figure-1 illustrates the three level of hierarchy for decision process for this study.

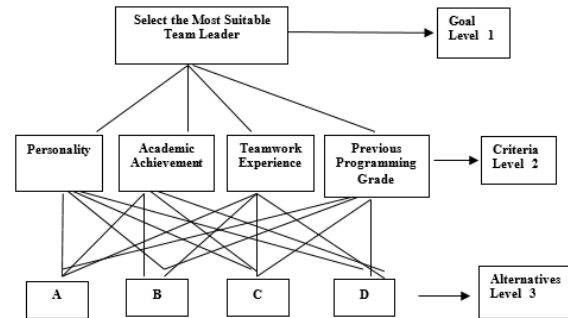


Figure-1. A hierarchy model for selecting team leader.

In the beginning, the goal or overall objective of the decision is showing at the first level (the top) of the hierarchy. In particular, the overall goal for this study is to select the most suitable team leader based on specified criteria. The second level represents the main decision criteria that have been considered in making selection decision of team leader which are (Personality, Academic Achievement, Teamwork Experience, and Previous Programming Grade). The final level of the hierarchy represents the alternatives which are the decision option. In this study, the alternatives are the team members in educational group project teamwork. Thus, the letters (A, B, C and D) refers to the alternatives (candidates) of team members as shown in Figure-1.

Once a hierarchical framework is constructed, the users are requested to create a pair wise matrix at each level of hierarchy and then compare each element with the other by using the fundamental scale for pair wise comparisons as shown in Table-2. The nine point scale developed by (Saaty 1980) has been accepted by most experts as a very scientific and reasonable basis for comparing two alternatives (Taylor 2010).

Table-2. Scale for pair-wise comparisons (saaty 1980).

The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another, its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

The scale translates the pairwise comparative judgements into intensity of relative importance represented by numbers to assess the intensity of preference between two elements (Saaty 1980). The judgements are entered using the numbers 1, 3, 5, 7, and 9 which correspond to the verbal judgements. The values of 2, 4, 6 and 8 are intermediate values that can be used to



indicate compromise values of importance between the five basic assessments.

In order to determine the relative importance of criteria to form team members specifically team leader in educational group project teamwork, data was obtained from direct questions by experts who are effectively involved in the decision problem. In this study, questionnaire for pairwise comparison proposed by Lee and Kim (2013) was adapted Questionnaire, it was helpful to collect data in order to assign weight to the element of the decision hierarchy.

According to Cheng and Li (2001), it was observed that AHP approach is subjective methodology and that do not necessary involve large number of expert to participate in AHP process. While Saravanan and Mahendran (2014), pointed out that consulting more experts will avoid bias that may be present when the judgments are considered from a single expert.

Therefore, in this study five instructors in School of Computing (SOC), Universiti Utara Malaysia (UUM) were selected as the experts for the decision-making; the experts are responsible to evaluate four criteria which are (1) personality type, (2) academic achievement, (3) team work experience, and (4) previous programming grade, with respect to their importance in achieving the overall goal.

The pair wise questionnaires were given to the experts and requested to fill up by identify relative importance between those four decision criteria that which considered in making formation decision of team leader by using the fundamental scale for pair wise comparisons as shown in Table-2. All responses were collected and recorded. The expert's opinion data is depicted in Table-3.

Table-3. Pair wise comparison of criteria.

Criteria	Personality	Academic Achievement	Teamwork Experience	Previous Programming Grade
Personality	1.00	4.00	3.00	7.00
Academic Achievement	0.25	1.00	0.33	3.00
Teamwork Experience	0.33	3.03	1.00	5.00
Previous Programming Grade	0.14	0.33	0.20	1.00

The experts believed that a personality type is four time more important than academic achievement, and three time more important than teamwork experience, as well as seven time more important than previous programming grade respectively, due to extrovert team leader can improve performance of team in group work project. In regards to this, Omar and Syed-Abdullah (2010), pointed out that an effective team needs to have more extrovert members.

Furthermore, experts thought that teamwork experience is three time more important than academic

achievement, in contrast to this, they thought academic achievement is three time more important than previous programming grade. Finally, experts believed that teamwork experience is five time more important than previous programming grade in selecting suitable team leader for group project in educational setting.

The data collected from alternatives by using questionnaire, so as to evaluate alternatives with respect to their strengths in achieving each of criteria. The respondents of the study are targeted for undergraduate students, School of Computing (SOC), Universiti Utara Malaysia (UUM).

Saaty (1980), demonstrated mathematically that the eigenvector method was the best approach to determine the priorities from each pair wise matrix in order to get importance of criteria and alternative performance. The three main principles of AHP can be elaborated by organizing them in a more comprehensive nine steps as described in Figure-2 (Ariff et al. 2012).

To ensure the judgment are consistent, the last process called consistency verification, which is considered as one of the significant task of AHP, is included to measure the degree of consistency among the pair wise comparisons by computing the consistency ratio (Ho, 2008). According to Saaty (1980), if the CR is greater than 0.1 the judgments are untrustworthy because they are too close for comfort to randomness and the exercise is therefore valueless or must be repeated. However, in practice, consistency ratios of more than 0.1 sometimes have to be accepted. For instance, an inconsistency of 10% or less must sometimes be accepted even though the adjustment is small as compared to the actual values of the eigenvector entries (Asamoah, Annan, and Nyarko, 2012).

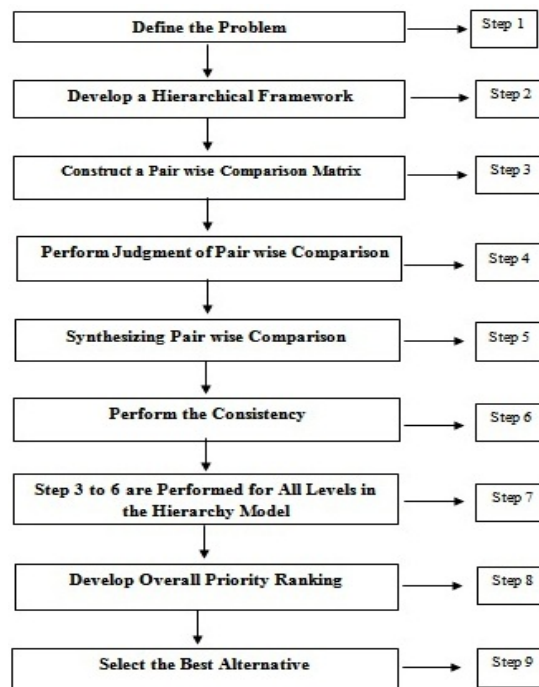


Figure-2. Steps of AHP adopted from (Ariff et al. 2012).



EXPERIMENTAL STUDY

To assess the validity of the prototype, an experimental study carried in Universiti Utara Malaysia (UUM) was conducted. In this study, there were 24 undergraduate participant whereby students from System Analysis and Design (SAD) class. This experimental study was carried out by giving (lab assignment) to 24 participant that formed randomly by using the prototype into six groups, each group consist of 4 students.

According to Luna-Reyes and Andersen (2003), the experimentation toward a real project can be carried out in order to measure the practical aspect, as well as in assisting for validating of the proposed model. In particular, this study was used pre-test, post-test design, where only the experimental group (random assignment) was selected as the study subjects to compare level performance of participants (students group), it includes a pre-test of participants on a dependent measure before the introduction of a treatment, followed by a post-test after the introduction of the treatment.

This is supported by Bordens and Abbott (2011), who pointed out that by using a one-group pre-test, post-test experimental design, can compare levels of performance before the introduction of change to levels of performance after the introduction of the change, as well as it help in assessing the effect of changes in an educational environment.

One hypothesis has been formulated:

H1: Team using AHP of team leader selection will experience higher level of team satisfaction compared to team with self-selection team leader.

To test the hypothesis (H1), a self-evaluation questionnaire adapted from (Tseng et al. 2009), (Ku et al. 2013) was used for assessing members' satisfaction on teamwork learning environment and perceptions on peer interaction, this questionnaire containing 10 items and all questions were measured on a five-point Likert-type scale, ranging from 'Strongly disagree', 'Disagree', 'Do not agree neither disagree', 'Agree' and 'Strongly agree'. Wilcoxon Signed-Rank Statistical Test was used to test the hypothesis.

Ku et al. (2013), argued that teamwork satisfaction involves understanding the team's interaction and process from the perspective of the team participants themselves. In addition, the teamwork satisfaction scale has been shown to demonstrate desirable factorial validity and internal consistency with the selected student population (Tseng et al. 2009).

RESULTS AND DISCUSSION

The results of this study showed that the team using AHP technique to select team leader experienced significantly higher level of satisfaction compared to team with self-selection team leader ($Z=-2.967$, $p=0.003$). Accumulating evidence has demonstrated that team formation has an impact on team performance. Detail of results for each items in the teamwork satisfaction questionnaire such as the mean scores and standard

deviations and the associated significance levels of the teamwork and satisfaction scale collected from 24 participants are ranked and tabulated as shown in Table-4.

Table-4. Teamwork satisfaction scale.

No	Questions	Mean (Std. Deviation)		P-value
		Pre-Test (N=24)	Post-Test (N=24)	
1	My team members are sharing knowledge during the teamwork processes	4.42 (504)	4.67 (482)	.109
2	Interacting with the other members can increase my motivation to learn	4.46 (658)	4.58 (584)	.366
3	I like solving problems with my teammates in group projects	4.67 (482)	4.92 (282)	.580
4	Working with my team helps me produce better project quality than working individually	4.46 (509)	4.50 (511)	.808
5	I gained expertise and skills from the teamwork processes	4.50 (511)	4.75 (442)	.083
6	Communicating between team leader and team members regularly helps me to understand the team project better	4.29 (464)	4.75 (442)	.005
7	My team leader was supportive and considerate to other team members	4.38 (495)	4.71 (464)	.033
8	My team leader consider suggestion made by team member	4.50 (511)	4.38 (495)	.405
9	I like team leader that acts as a referee when our members cannot seem to resolve differences	4.38 (495)	4.83 (381)	.002
10	I have benefited from team leader guidance on the group project	4.33 (482)	4.71 (464)	.013

Note: Responses ranged from 1 (strongly disagree) to 5 (strongly agree)

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Omar and Syed-Abdullah (2010) demonstrated that an effective team needs to have more extrovert members. Therefore, application of AHP for selecting the most suitable extrovert team leader can improve performance of team in group work project in educational field due to the team leader plays an important role in the success or failure of the team (Gilley et al., 2010) (Humphrey, 2000a), (Rong and Shao, 2012).

In the current study, the results from the two highest-rated items from the Teamwork satisfaction questionnaire also indicated that participants communicated with their team leader regularly helped them to understand the team project better. Lancellotti and Boyd (2008), pointed out that through communication, team members can find better ways to work with each other, increase team effectiveness, and lead to greater teamwork satisfaction.

CONCLUSIONS

The results shown that AHP approach can be used to help decision maker to evaluate and select the best alternative based on the certain criteria of a decision. Application of AHP for selecting the most suitable team leader can improve performance of team in group work project in educational field due to the team leader plays an

important role in the success or failure of the team (Rong and Shao 2012), (Gilley et al. 2010), (Humphrey 2000).

Knowledge in identifying and understanding significant criteria to form team members in are beneficial, particularly for SE community. In addition, by using the proposed model, it can help decision makers specifically instructor to form effective team members. This study can be improved by integrating a hybrid technique to improve the accuracy of model. In addition, the proposed model can be extended and evaluated in industrial setting.

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