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An Analysis of Belbin Team Roles in Software Engineering Team

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Abstract: In Software Engineering (SE), team plays an important role in determining the project success. To ensure the optimal outcome of the project the team is working on, it is essential to ensure that the team members are assigned to the right team role. One of the prevalent team roles is Belbin team role. This role theory is centered on the team roles and how they should be matched in order to avoid conflicts and build sound teams that are optimally managed. Therefore, this study is aims to propose a software team formation method based on Belbin team role. In order to realize it, fuzzy technique will be chosen because it allows analyzing of imprecise data and classifying selected criteria. The method will be designed to form a balance of software development team. It is hoped that the proposed method can serve as a useful tool for managers when assigning new team members to a software project.

Key words: Team formation, balance team, Belbin team role, fuzzy technique, software engineering, optimally

INTRODUCTION

According to the prevalent definition, team is any group of small number of individuals with matching skills and other characteristics, all of whom are dedicated to a common resolution, performing objectives as well as approach for which the responsibilities they are jointly accountable (Gilley *et al*., 2010). When the team members are able to cooperate, the entire unit can accomplish greater heights of thought as well as preserve information better and longer than individuals that work quietly and lonely.

Gibson *et al*. (2009) also noted that the importance of a team lies in the ability of participation in group endeavors to improve leadership skills and boost the morale of the team members. This also facilitates efficiency in the processes and procedures, thus enhancing organizational productivity. While these and many other benefits of teamwork are well known, some issues are unavoidable. In particular, when team members are not chosen well this can result in lack of cooperation and some members may feel that they are not treated equally or that rewards for their individual contribution are inadequate. Finally, if teamwork is not managed properly this can lead to conflicting tasks which jeopardize the execution of the project and can become major threats that can affect team performance (Qureshi *et al*., 2014). These issues typically arise when wrong individuals are assigned to a team or when team members are given incorrect role or a task (Syed *et al*., 2011).

Assigning correct role to correct team members can be challenging for project managers. The difficulty in executing this in correct way usually stems from the manager's inexperience in assigning the roles to team members (Senior, 1997; Humphrey *et al*., 2009).

In software projects, team leaders and managers usually attain this position due to their superior performance as developers, rather than managers. Thus, many are ill prepared for the aspects of their role that require personnel handling. This can lead to inconsistency in decision making to form the group. Therefore, to ensure that the team is effective, it must have a balance of skills, experience and characteristics.

Several researchers have examined team formation and how groups progress into efficient teams through selection of group processes the accomplishment of assigned tasks (Fisher, 1970; Poole and Roth, 1989).

Tuckman (1965)'s team formation model highlights the four sequential phases to include: forming, storming, norming and performing. In this context, the first phase of forming denotes a period at which members of a team determine their positions, procedures to follow and the rules to be guiding the group. The next phase called storming commences when conflict occurs as a team member resists the influence of the group and rebels against accomplishment of the task.

Norming phase commences as the group forms cohesiveness and commitment to its responsibilities, decides fresh ways to work together to accomplish the

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common goals and sets norms for suitable behaviors. Performing as the final phase occurs when the team achieves proficiency in working together to attain its goals and attains more flexibility in applying the procedures for working together. It can be inferred that each stage of Tuckman's model represents critical step in formation of a team. Thus, in line with other linear models, the first step determines the success of the second and so on.

In other words, if any of the preceding phases are unaccomplished, the latter phases will not be successful (Johnson *et al*., 2002). Since, the success of the task depends on all the stages in the sequence, the first stage is the most important as it is a precondition for all subsequent ones. For this reason this study only focuses on the forming phase. In this first stage, team members are assigned to a specific role based on specific characteristic using a specific technique.

The concept of team roles is not new. Early researchers such as Benne and Sheats in 1940-1950, identified some roles such as Harmoniser, Initiator-contributor and Energiser (Partington and Harris, 1999).

Now a days one of the popular team roles is Belbin team role, named after Dr. Meredith Belbin that with her collaborators from the Industrial Training Research Unit (ITRU) of Cambridge, UK, developed a theory for the formation of successful teams. The theory is centered on the team roles and how they should be matched in order to avoid conflicts and build sound teams that are optimally managed, team role defined as the predisposition to behave, contribute and interrelate with others in a specific way.

The value of Belbin's team role theory for practice as to do with assisting an individual or team to take advantage from self-knowledge and modify it to meet the demands of a particular external situation. In this model, nine roles are recognized as these are believed to represent "useful people to have in teams". They comprise of Monitor Evaluator (ME), Completer-Finisher (CF), Coordinator (CO), Implementer (IMP), Plant (PL), Shaper (SH), Specialist (SP), Resource Investigator (RI) and Team Worker (TW).

Although, Belbin team role model is claimed to be effective in increasing performance of team members, very little is known about its application in forming software engineering teams as research on this topic is scarce. Therefore, a systematic method is urgently needed in order to assist mangers in selecting the right members for the team as well as assigning them right team roles based on the Belbin team role model. When the team is correctly assigned, it can help the organization to deliver software on time and within budget.

There are several techniques for team formation such as: multi-attribute utility theory, analytic hierarchy process, fuzzy set theory, case-based reasoning, data envelopment analysis, simple multi-attribute rating technique, goal programming (Velasquez and Hester, 2013).

One of these techniques is fuzzy technique. This technique allows analyzing of imprecise data and classifying selected criteria. Initial evaluation of this technique showed that it can indicate whether every team has equal distribution of criteria. By incorporating this technique in a team formation model, each team can be guaranteed to have equal chances to perform effectively. This technique can facilitate decision makers when forming highly productive project teams (Odoherty, 2005).

Literature review: Literature related to team formation has created increasing interest among researchers. They have developed different kinds of techniques to form team members as depicted in Table 1.

Table 1: Summary of literature review

Techniques	Findings	Limitations
Fuzzy technique (Tavana *et al*., 2013)	Uses a meaningful and robust multi-criteria model to aggregate both qualitative judgments and quantitative data and it addresses the gaps in the literature on the effective and efficient team formation	The proposed framework does not imply a higher-level of 'accuracy' in selection and team formation
Multi-agent team formation (Marcolino *et al*., 2013)	They opens new way for multi-agent team formation Not similar to the existing work, they study team formation in the context of agents that vote together at each point of problem	This offers a new conflict between focusing on the strength of each individual member or on the diversity of. a team when aspire to the best team
Fuzzy rule-based (Syed *et al*., 2011)	Able to form team with equal prior academic achievements because this will add validity and reliability of team formation. The technique can be improved to accommodate more members for each team	Further improvement is required to incorporate this technique in team formation
Mathematical programming model (Venkatamuni and Rao, 2010)	The mathematical model is developed to determine the team members in product design with constraints of number of projects, time and budget	Formation process of team members based only on the ordered matrixes which provides them with the most critical team functions, there lacking to include on team characteristic that fit into the role assignment to the members

Table 1: Continue

Techniques	Findings	Limitations
This study proposed integrated theoretical model for building effective team (Gilley *et al*., 2010)	Several disconnected and independent theories such as (charge and charter theory, the change curve, the performance curve theory, synergistic relationship theory), have been combined into one comprehensive model	Theoretical study, there is no empirical data to validate the model
Grey decision theory and fuzzy sets theory (Tseng *et al*., 2004)	They proposed a conceptual framework for project team formation	They focus on the relationship between project characteristics and customer's requirements in forming team. This study is lacking to include on team characteristic that fit into the role assignment to the members
Role balance and team development (Chong, 2007)	This study supports the link between team role balance and team performance. They established the link between role balance and successful project teams	There was no significant relationship between the more 'balanced', teams measured by the number of roles represented and their performance

The approaches that show above have lack in certain aspects such as they do not take into account any information with regard to past experience or knowledge of potential team members. Therefore, there is a need to apply the techniques that can consider behaviors characteristics for forming effective team members.

MATERIALS AND METHODS

Belbin team role: Belbin theory on team role establishes that while the behaviors of people engaged in team are unlimited. The range of useful behaviors that lead to an effective contribution to team performance is equally limited. Belbin role theory congregated these behaviors into eight groups with each one describing behavioral characteristic of the manner in which a team member related with another. He further stated that team role behavior is not fixed by individual traits but could be altered by situational factors as well as learning pattern of individual (Senaratne and Gunawardane, 2013).

Belbin explained that for a team of people to be successful and effective, nine necessary diverse roles needs to be present without duplication so that the team can be called to be a 'balanced team'. Based on conclusion by Senior (1997) the central principle of Belbin's theory is that a more balanced team is in terms of the spread of naturally occurring team roles and thus, the greater the propensity for high performance. Table 2 shows the nine Belbin team roles with descriptions.

It has long been recognized that the performance of a group as a mix of individuals is influenced by the combination of personality styles within that group and attempts to design ideal teams through categorization of individuals into team roles date back over 60 years. In recent decades, the team role categorization scheme of Belbin has built up considerable momentum with management development professionals (Partington and Harris, 1999). Based on extensive observations of the behavior of managers during training courses during the 1970s, Belbin hypothesized that team balance was more important for success than combined intellect, focusing on the emergence of informal, functional roles during training exercises. Rather than considering collective team behavior, Belbin categorized individual behavior within the team into eight types, later expanded to nine, since different people interact in different ways; successful teams are characterized by the compatibility of the preferred roles of their members. An individual's natural team role preferences are rapidly identified through the Belbin self-perception index (Aritzeta *et al*., 2005).

Table 2: Belbin team roles

Team role	Descriptor
Co-Ordinator (CO)	Dominant, mature, self-controlled, trusting, extrovert, positive, stable and self-disciplined
Completer Finisher (CF)	Anxious, conscientious, introvert, self-controlled, self-disciplined, submissive and worrisome
Plant (PL)	Dominant, imaginative, introvert original, radical-minded, trustful and uninhibited
Shaper (SH)	Abrasive, anxious, competitive, dominant, edgy, emotional, extrovert, impatient, impulsive, outgoing and self-confident
Resource Investigator (RI)	Diplomatic, dominant, enthusiastic, extrovert, flexible, inquisitive, optimistic, persuasive, relaxed, social and stable
Monitor Evaluator (ME)	Dependable, fair-minded, introvert, low drive, opens change, serious, stable and unambitious
Team Worker (TW)	Extrovert, likeable, loyal, stable, submissive, supportive, unassertive and uncompetitive
Specialist (SP)	Expert, defendant, not interested in others, serious, self-disciplined, efficient
Implementer (IMP)	Conservative, controlled, disciplined, efficient, inflexible, methodical, sincere, stable and systematic

The central claim of the Belbin team role theory is that a 'balanced' team as judged by a spread of high-scoring individuals in each team role has a greater propensity to perform highly. However, a variety of different Group Balance Metrics (GBMs) have been reported previously (Partington and Harris, 1999; Aritzeta *et al*., 2007). The Belbin theory also recognizes that behaviors are contextual and will change over time in response to new circumstances.

RESULTS AND DISCUSSION

Belbin team roles and software engineering team: Belbin team role has revealed that team role is affected by dynamics of team, team success and individual propensity on numerous software engineering activities. Thus, team role can be seen to have broader implications. There are different phases of software engineering as well as numerous intents of programming projects. While, some software engineering teams are devoted to specific domain applications, others focus on a special division of the same application or project (Schoenhoff, 2001).

While adopting team-based tactic to software engineering, analyses are required from the standpoints of psychology, personality or management. Belbin's team role theory depicts a real world choice for such a perspective. Belbin likens varied Plant (PL) combinations as more suited to computer science: combining a Plant (PL) with a Chairman (CO), a Plant (PL) together with Resource Investigator (RI) or a Plant (PL) with a Monitor-Evaluator (ME). Both the creativeness and intellect underlying of the Plant (PL) are more germane to software design and development. For example, the Chairman (CO) has the potentials to enhance direction without abrasion. So is the Resource Investigator (RI) capable to bring in external ideas while the Plant (PL) delivers inside innovations while the Monitor-Evaluator (ME) can effectively evaluates and points out problematic issues within the plant's formulated models, Thus, selecting a correct pairing strategy among the above-listed can help solving problems experienced by Plant (PL) in a certain circumstance (Todd *et al*., 1998).

In spite of Belbin's attempt to cover a broad range of industries, Henry and Stevens (1999) pointed out that his theory narrowed down to management groups in particular with no attempt to foray into team's role and formation in other disciplines. The roles specifically chosen for this study consist of: the Shaper (SH) the Plant (PL) and the Monitor-Evaluator (ME). These above roles listed are of interest in team formed for software engineering as a resort of their implications and characteristics. The field of software engineering as a discipline which entails that creative and workable solution is applied towards understanding the problems. Therefore some elements such as: leadership and direction of team; intelligence as well as creativity with which ideas will evolve so as to resolve more unorthodox problems and a foundation of rational decisions for points where the team gets trapped or can choose between several options are essential. These qualities represent the Shaper (SH), Plant (PL) and Monitor-Evaluator (ME), respectively (Deibel, 2005).

Two leadership roles were defined by Belbin in the work of Steven on team leadership that is the Chairman (CO) and the Shaper (SH). Shapers (SH) appear to be more established in software than are Chairman (CO). Steven's work indicated that teams with single recognizable leader (Shaper) exhibit better performance than other teams without leader or those having multiple leaders; the second focus of the Steven's study is the Plant (PL). His study conclusion was on the amount of Plants (PL) in a particular team and that the achievement of the team is not independent. Stevens concluded that teams which composed mainly of Plants exhibit better performance than would by teams with few Plants or without Plants. Finally, an unexpected result was produced in the Steven's study of the influences of Monitor-Evaluators (ME) (Henry and Stevens, 1999).

Monitor-Evaluator (ME) was referred to as "decision maker" role and the assumption made that a software development team needed decision-making ability that could be granted by the Monitor-Evaluator (ME). Stevens resolved that in the limits of his sample, the effect of a Monitor-Evaluator (ME) on the team of software engineering could not be proven to be statistically significant and then asserted that the Monitor-Evaluator (ME) may not be useful or vital for software engineering and regarding to an early observation, it is exciting noting the lack of Resource Investigators (RI).

Prior research appears to recommend that software engineering teams did not basically need resource investigators because in the practical scenario, the role did not exist amongst the computer science community (Todd *et al*., 1998).

On the average, the effectiveness of the teams that have Company Workers (CW) could not be seen to have significantly different from the teams that did not have Company Workers (CW). The Completer-Finisher (CF) appears to be of petite value to a team but the results show that this role is completely out of the requirements in team activity (Schoenhoff, 2001).

Many researchers have argued that for the team roles formation to be achieved in software development, nine roles have to be taken into consideration including Shaper (SH), Plant (PL), Resource Investigator (RI), Monitor Evaluator (ME) and Coordinator (CO) (Schoenhoff, 2001; Beranek *et al*., 2005; Ounnas *et al*., 2008).

Others are Complete Finisher (CF), Team Worker, Specialist (TW) and Implementer (IMP) (Henry and Stevens, 1999; Beranek *et al*., 2005; Ounnas *et al*., 2008; Fatahi and Lorestani, 2010). However, previous studies have revealed that the Shaper (SH) and Plant (PL) team roles as shown in Table 3 are the most important

Table 3: Analysis of belbin team roles in software engineering team

Researchers	SH	PL	RI	ME	CO	CF	TW	SP	IMP
Todd *et al.* (1998)	√	√	×	×	×	×	×	×	×
Henry and Stevens (1999)	√	√	×	×	×	×	×	×	×
Schoenhoff (2011)	√	√	×	×	×	×	×	×	×
Rajendran (2005)	√	√	×	×	×	×	×	×	×
Doherty	√	√	×	×	×	×	×	×	×
Beranek *et al.* (2005)	√	×	×	×	×	×	×	×	×
Ounnas *et al.* (2008)	√	√	×	×	×	×	×	×	×
Wasiak and Newnes	√	√	×	×	×	×	×	×	×
Licorish *et al.* (2009)	√	√	×	×	×	×	×	×	×
Fatahi and Lorestani (2010)	√	√	×	×	×	×	×	×	×

and useful among the Belbin team roles in software engineering (Henry and Stevens, 1999; Beranek *et al*., 2005; Ounnas *et al*., 2008; Fatahi and Lorestani, 2010).

Table 3 represents meta-analysis of nine Belbin team roles in software engineering team. The yellow color represents the argument of the previous studies that support the use of both Shaper (SH) and Plant (PL) as the useful roles in Belbin team roles in software engineering team.

In this study, Shaper (SH) and Plant (PL) in Belbin team role are chosen based on the research and experiment that different researcher made in the field of software engineering with Belbin team role. The roles of Shaper (SH) and Plant (PL) in Belbin team role are more convenient to the software engineering team, hence Shaper (SH) role for leader while Plant (PL) role for programmer (Rajendran, 2005; Ounnas *et al*., 2008).

CONCLUSION

This study presented the importance of Belbin team role in SE team. The proposed method will prove the importance of Belbin team role to form a balance software engineering team. A team with balance characteristics might have an opportunity to exhibit good team work as well as being a successful team. In addition, the significant of this study lies on the ability to make available approach to put together team members based on Belbin team role by using fuzzy technique in industrial setting. Thus, the knowledge of identifying and understanding significant roles and the technique used for team formation is valuable in SE field. Moreover, by employing of the proposed team formation method, it can assist decision makers particularly managers to put together effective team members.

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