AN AUTOMATED SOFTWARE TEAM FORMATION BASED ON BELBIN TEAM ROLE USING FUZZY TECHNIQUE

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Abstrak

Dalam kejuruteraan perisian (SE), pasukan memainkan peranan yang penting dalam menentukan kejayaan projek. Untuk memastikan hasil yang optimum projek pasukan bekerja pada, ia adalah penting untuk memastikan bahawa pasukan itu terdiri daripada ahli-ahli dengan ciri-ciri betul. Dalam satu pasukan memberikan peranan yang betul kepada setiap ahli pasukan untuk memastikan bahawa individu yang paling sesuai dipilih untuk tugas-tugas tertentu dan usaha mereka menyumbang maksimum kepada prestasi pasukan secara keseluruhan. Salah satu peranan pasukan lazim adalah Belbin peranan pasukan. Belbin dibangunkan teori ini untuk pembentukan pasukan yang berjaya. Teori ini tertumpu kepada peranan pasukan dan bagaimana mereka harus dipadankan untuk mengelakkan konflik dan membina pasukan bunyi yang diurus secara optimum. Oleh itu, matlamat utama kajian ini adalah untuk membangunkan satu pasukan perisian kaedah pembentukan automatik berdasarkan Belbin pasukan Peranan dengan menggunakan teknik kabur. Teknik kabur dipilih kerana ia membolehkan menganalisis data tidak tepat dan mengelaskan kriteria yang dipilih. Dalam kajian ini, dua peranan dalam peranan Belbin pasukan, yang Pembentuk (Sh) dan Plant (Pl) dipilih untuk memberikan peranan tertentu dalam pasukan perisian - ketua pasukan dan programmer, masing-masing. Peranan ini dipilih kerana gabungan peranan ini dapat menentukan ahli-ahli pasukan yang berkesan dalam pasukan SE. Pembentukan pasukan perisian automatik yang dicadangkan ketika itu dinilai dengan menggunakan kajian pakar. Para peserta terdiri daripada 12 pemaju perisian daripada Asiacell Syarikat Telekomunikasi di Kurdistan Rantau Kerajaan Iraq (KRG). Keputusan menunjukkan bahawa kaedah ini berguna untuk digunakan bagi membentuk pasukan SE dalam suasana industri. Pembentukan pasukan yang dicadangkan automatik perisian boleh menjadi alat yang berguna untuk pengurus apabila memberikan ahli pasukan baru untuk projek perisian. Selain itu, dengan menggunakan kaedah yang dicadangkan, ia boleh membantu pembuat keputusan khusus pengurus untuk membentuk pasukan yang berkesan dan sama rata. Pasukan yang berkesan dan sama boleh mempunyai peluang yang sama untuk mengalami kerja-kerja pasukan yang baik dan dengan itu, untuk menjadi pasukan yang berjaya.

Kata kunci: Pembentukan pasukan, Belbin peranan pasukan, Teknik kabur, Pembentukan pasukan Automasi, Kejuruteraan perisian.

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 comprises of the members with right characteristics. In a team assigning the right role to each team member in order to make certain that the most appropriate individuals are chosen for specific tasks and their efforts contribute maximum to the overall team performance. One of the prevalent team roles is Belbin team role. Belbin developed this theory for formation a successful team. This 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, the main aim of this study is to develop an automated software team formation method based on Belbin Team Role by using a Fuzzy technique. Fuzzy technique was chosen because it allows analyzing of imprecise data and classifying selected criteria. In this study, two roles in Belbin Team role, which are Shaper (Sh) and Plant (Pl) were chosen to assign the specific role in software team – team leader and programmer, respectively. These roles were chosen because the combination of these roles is able to determine effective team members in SE team. The proposed automated software team formation was then evaluated using an expert review. The participants consist of 12 software developers from Asiacell Telecommunication Company in Kurdistan Region Government of Iraq (KRG). The results demonstrate that the method is useful to be used for forming SE team in industrial setting. The proposed automated software team formation can serve as a useful tool for managers when assigning new team members to a software project. In addition, by using the proposed method, it can help decision makers specifically managers to form effective and equal teams. Effective and equal teams can have an equal chance to experience good team work and thus, to be a successful team.

Keywords: Team formation, Belbin team role, Fuzzy technique, Automated team formation, Software engineering.

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List of Abbreviations

SE	Software engineering
KRG	Kurdistan Region Government
ITRU	Industrial Training Research Unit
ME	Monitor Evaluator
CF	Completer-Finisher
CO	Coordinator
IMP	Implementer
PL	Plant
SH	Shaper
SP	Specialist
RI	Resource Investigator
TW	Team worker
MDT	Multi-Dimensional Trust
IS	Information System
BTRSPI	Belbin Team Role Self-Perception Inventory
FTSE-100	Financial Times Stock Exchange 100 Index
GBMs	Group Balance Metrics
MAUT	Multi-Attribute Utility Theory
AHP	Analytic Hierarchy Process
CBR	Case-Based Reasoning
DEA	Data Envelopment Analysis
SMART	Simple Multi-Attribute Rating Technique
GO	Goal Programming
SAW	Simple Additive Weighting
TOPSIS	Technique for Order Preferences by Similarity to Ideal Solutions
MCDM	Multi Criteria Decision Making
SPI	Self-Perception Inventory

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter introduces the background of study, followed by statement of the problem, research questions, and objectives of the research. The research scope, significance and contribution of the research are also presented.

1.2 Background of the Study

In software engineering (SE), team plays an important role in determining the project success (Ebert & Neve, 2001; Ralph & Kelly, 2014). To ensure the optimal outcome of the project the team is working on, it is essential to ensure that the team comprises of the members with right characteristics (Syed-Abdullah, Omar, & Idris, 2011). 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, Morris, Waite, Coates, & Veliquette, 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 (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-Abdullah, Omar, & Idris, 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 (Humphrey, Morgeson, & Mannor, 2009; Senior, 2005). 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 include skills, experience and characteristics (Belbin, 2014).

According to Syed-Abdullah et al. (2011), effective team provides all members equal opportunity to experience good teamwork, while also allowing them to work on tasks that would enhance their skills and career prospects, On the other hand, this also requires that all members possess characteristics that complement those of others and assist in forming a cohesive unit (Aritzeta, 2005). This aspect is usually the most challenging for the managers and team leaders. This issue has prompted researchers to investigate strategies or methods for identifying suitable members for specific roles and tasks. Several researchers have examined team formation and how groups progress into efficient teams through selection of group processes the accomplishment of assigned tasks (Kozlowski & Bell, 2001, Fisher, 1970; Poole & Roth, 1989; Tuckman, 1965).

For example, Tuckman's (1965) 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 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, Suriya, Won Yoon, Berrett, & Lafleur, 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 & Harris, 1999). Nowadays one of the popular team roles in most organization, for example (Education, Management, Commerce and Industry) is Belbin team role (Senaratne & Gunawardane, 2013, Smith, Polglase, & Parry, 2012, Schoenhoff, 2001), named after Dr. Meredith Belbin that, with his 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 (A. Aritzeta, Swailes, & Senior, 2007, Belbin, 2012).

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 (Belbin, 2012). 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) (Aritzeta, 2005).

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 (Aritzeta, 2005; Raymond, 2010). 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:- 1) Multi-Attribute Utility Theory, 2) Analytic Hierarchy Process, 3) Fuzzy Set Theory, 4) Case-based Reasoning, 5) Data Envelopment Analysis, 6) Simple Multi-Attribute Rating Technique, 7) Goal Programming (Velasquez & Hester, 2013). One of these techniques is fuzzy technique. According to Syed-Abdullah (2011) Fuzzy 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 and this technique can facilitate decision makers when forming highly productive project teams. Thus, this study aims to develop an automated software team formation method based on Belbin team role using fuzzy technique.

1.3 Problem Statement

In software organizations, human resources undertake a crucial role in the software project success or failure (Kr.Misra & Ray, 2012; Linberg, 1999). Hongyun, Xiaohong & Shunkun (2009) mentioned that in the mid-1970s, the American Department of Defense already started researching the reasons behind software development failures, as these were seen as critical to address even then, their findings indicate that around 70% of all failures were due to incorrect management practices. For that reason, software management is important to ensure that software project can be developed successfully. According to Kr.Misra & Ray (2012), human factor plays a major role in determining success of software project; thus, human behavior must be considered in forming team members.

Regarding to Liu, Joy, & Griffiths (2013), forming effective team members is essential for many software organizations, especially those of small and medium size, as they operate with tight budgets and have fewer individuals to consider when forming teams for specific projects. On the other hand in larger organizations, with many employees, it is much easier to ensure that the individuals possess diverse experience, which can be matched to the constraints and skill requirements of each project. Clearly, success or failure of software product mostly depends on the development team. Thus, when deciding on its composition, three major team formation methods— self-formation, random-formation, and instructor-formation—can be adopted (Cann et al., 2012; Hamilton, 2010).

However, in industrial settings, team formation is typically responsibility of the manager, who uses his/her experience and judgment when determining team composition, while this is a prevalent approach, empirical evidence has shown that it does not always yield optimal results (Kr.Misra & Ray, 2012) . Failures typically occur when time and cost are the main constraints and the available employee pool comprises of individuals with mixed types of expertise (Kr.Misra & Ray, 2012;Qureshi, Alshamat, & Sabir, 2014; Ezziane et al., 2012). Thus, in such circumstances, a systematic mechanism must be adopted and utilized in ensuring that the optimal team selection is consistently made.

The composition of a team significantly impacts the project and organizational performance. This is supported by studies which found that the failure of software development projects is often a result of inadequate human resource team planning (Cann, Jansen, & Brinkkemper, 2012; Qureshi et al., 2014). Therefore, issues concerning teamwork are unavoidable, and typically include lack of cooperation, inadequate rewards, and conflicting tasks, as noted previously. These problems may arise because skills and experiences are not equally distributed amongst team members (Syed-Abdullah et al., 2011). Thus, understanding teams and the environments in which they need to operate has become increasingly vital due to technological advances and globalization which are making organizations to consider moving toward employing added network structures and team-based functions (Lipnack, 1997; Sudhakar, Farooq, & Patnaik, 2011).

Gilley (2010) conclude that executing team formation stage correctly is crucial towards ensuring that the manager gains optimal understanding of the group functionality in order to take charge of the team. This also helps the team members, as they have the opportunity to know about other members of the team and find ways to cooperate with them. Besides, Whichard & Kees (2006) specified that during team formation stage, members may also form initial team interaction protocol, recognize available resources, identify those activities which advance their interaction, styles of working in maximal utilization of member's skill and knowledge.

It was further suggested by Spiegel and Torres (1994) that a team that will have a better chance of success at the forming phase if the above conditions are present. According to Gilley et al. (2010), such conditions involve specific and measurable objectives that are achievable by team effort; an organizational culture that facilitates the team concept; satisfactory time for suitable training, debate, and discussion; and knowledge and use of other problem solving techniques. These authors, and many others like Aritzeta (2005) and Syed-Abdullah et al. (2011), clearly confirm that the team formation stage is crucial in the team's success. Once the team has been formed, it is essential to assign the right role to each team member in order to make certain that the most appropriate individuals are chosen for specific tasks and their efforts contribute maximum to the overall team performance.

The formation of a new team offers an opening to go out of existing structures and bring together a group of people who probably may have not previously worked together. This is particularly valuable when the potential team members can provide the best range of roles that is in line with the requirements of the available task. In order to maximize team performance, there should exist a balanced representation of team within the teams (Aritzeta, 2005; Belbin, 2014).

The team role balance means that, if all team roles exist, the team will have better performance than if not all roles are present, or if they are not optimally balanced (Belbin, 2014). However, for most managers, this is a very challenging task, as they may not be able to find suitable candidates for all roles. This is particularly the case in small and medium sized organizations, with limited staff pool (Liu, Joy & Griffiths, 2013). During team formation, there are several team role for software team formation, such as Harmoniser, Initiator-contributor and Energiser (Partington & Harris, 1999).

One of the prevalent team roles is Belbin team role. Belbin developed this theory for formation a 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 (Belbin, 2012). With regard to the problem, it is essential to assign the right role to each team member in order to make certain that the most appropriate individuals are chosen for specific tasks and their efforts contribute maximum to the overall team performance. Assigning the roles correctly can further assist in preventing unproductivity and guide against interpersonal conflicts or inefficient management discreetly and without disrupting the hierarchical structures (Belbin, 2014). However the application of team roles in software engineering teams limited (Aritzeta, 2005; Raymond, 2010). This is due to difficulty to determine the roles that suited to the software engineering team.

During team formation, there are several techniques that can be considered to form teams, for instance Analytic Hierarchy Process, Case-based Reasoning, Multi-Attribute Utility Theory and Fuzzy technique (Velasquez & Hester, 2013). However, several researchers like (Ahn et al., 2008; Tseng et al., 2004; Venkatamuni & Rao, 2010) have provided other various techniques to team formation, such as the use of multi-dimensional trust revealed that the reliable evaluation has a considerable value in solving the problem of team formation. Nevertheless, Cann et al., (2012) opined that such techniques still require some other qualities, like the potential team members' proficiency, characteristics of project, and the team members' tasks.

Fuzzy technique has gained popularity, because it allows analyzing imprecise data and classifying selected criteria. Initial evaluation of this technique showed that it can indicate whether every team possesses equal distribution of the key criteria. By incorporating this technique into the chosen team formation method, each team can enhance its chances of performing effectively. In particular, this technique can facilitate decision makers when forming highly productive project teams. However, at present, studies that demonstrate the applicability of this technique in forming software team members are limited (Syed-Abdullah et al., 2011). In particular, there is a significant gap in the knowledge on the factors determining of team members based on Belbin roles. Thus, this study will fill this gap by providing a team formation method based on Belbin team roles by using a fuzzy technique.

1.4 Research Questions

Based on the problems statement, this research tries to answer this question:

i. What are the characteristics required to form software team members based on Belbin Team Role?

ii. How to develop an automated software team formation based on Belbin Team Role by using Fuzzy technique?

iii. How can the proposed automated software team formation be evaluated?

1.5 Research Objectives

The main reason of this study is to develop an automated software team formation method based on Belbin Team Role by using a Fuzzy technique. In an effort to attain that main aim, the following objectives were set out to achieve:

i. To identify the characteristics required to form efficient software team members based on Belbin Team role.

ii. To develop an automated software team formation based on Belbin Team Role by using Fuzzy technique.

iii. To evaluate the proposed automated software team formation using expert review.

1.6 Scope of Study

The primary concern of this research is on developing a software team based on Belbin Team Role using Fuzzy technique. Therefore, the scope of the study focus on the ability to form software engineering team based on Belbin Team Role— Implementer (IMP), Resource Investigator (RI), Completer-Finisher (CF), Coordinator (CO), Monitor Evaluator (ME), Plant (PL), Shaper (SH), Specialist (SP), and Team worker (TW).

These roles were determined its equality representation in software engineering team based on Fuzzy technique. Formation teams members is important as it can guarantee the ability of the team to have higher chances of performing effectively (Syed-Abdullah et al., 2011), and plays a vital role on the team's success or failure (Bradley & Hebert, 1997; Gondal & Khan, 2008 ; Gilley et al., 2010). In addition, the team size that used in this study was consist of 3—6 members as it is the ideal team size to perform better in a small or medium-scale software project size (Zarzu, 2011).

An expert review was used in order to evaluate the team formation method constructed. A software engineering team working in a private sector telecommunication company was selected because the company acts as service provider of high technology to the community. Due to this, this company needs to provide good services, with good technical advancement, and adopt modern management styles. Thus, having good software team members are crucial to cope with the changing environment demands.

1.7 Significant of Study

This study demonstrates the importance of Belbin Team Role to form software engineering team. A team with important 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 in 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.

1.8 Contributions of Study

The contributions of this study can be divided into theoretical and practical contributions.

1.8.1 Theoretical Contributions

This study successfully demonstrates that the two roles of Belbin team role, which are Shaper and Plant are significant role to form software engineering team. These roles are able to contribute to the higher satisfaction level of team work. By having this knowledge it contributes to the software engineering management field, in particular, that Belbin team role can be used to form team in software engineering industry.

1.8.2 Practical Contributions

The practical contribution of this study lies in the ability of the constructed method to form team in industrial setting. The result of this study is on the software team formation method that can assist decision makers to form team based on team roles. This method can serve as a useful tool for managers when assigning new team members to a software project. In addition, this study contributes to the SE literature regarding the significant roles that suited to the software engineering team.

1.9 Thesis Structure

This thesis consists of six chapters. An outline of the essential contents of the following chapters is expressed as follows:

Chapter 1: Introduction

As an starting to discuss in depth on the research topic, this chapter provides some background of the study, elaboration of issues that underline the foundation of the study, the research problem, research questions, research objective, research scope, and also the significant and contributions of the study.

Chapter 2: Literature Review

This chapter provides a systematic review which target to analyze the literature for the purpose of looking for concept and an approach related to the study. It is intended to present reviews related studies on team formation, method to form team, related works on team formation, Belbin team role, Belbin team role in software engineering team, and techniques for team formation and specifically fuzzy technique.

Chapter 3: Research Methodology

This chapter elaborates the process involved in this study from the beginning to the end in order to achieve all the research objectives, and discussion for the research methodology phases.

Chapter 4: The Development of an Automated Software Team Formation Method using Fuzzy Technique

This chapter presents the meta-analyses to identify the most suitable Belbin team role in software engineering team, the steps taken to form teams by using fuzzy technique, and present implementation for the prototype of team formation method using fuzzy technique, and also discussion of the results.

Chapter 5: Evaluation Results and Discussion

This chapter describes the evaluation of the usability of the prototype and expert satisfaction on the method by discusses the result of the quantitative approach.

Chapter 6: Conclusion and Future Work

Finally, this chapter discusses the finding of this study by answering all the research questions and research objectives. This chapter also discusses theoretical and practical contributions of this research and recommendations for future research.

1.10 Summary

This chapter provides a background of study, problem statements, questions, objectives, significant, contributions, the scope of study, and thesis structure. The following chapter will discuss the literature review of this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter consists of nine sections. The first section has the definitions of team. Second discusses the benefits of team, while the third and fourth sections explain the related literature on formation of team and the approach that can be used to form team member respectively. The fifth section, described the software engineering teams and the sixth section discussed the Belbin theory, Belbin team roles, and the importance of Belbin team role and application of Belbin team role. The seventh section discussed Belbin team role and software engineering team. The eighth section explains the techniques to form team. The final section illustrates Fuzzy technique and concept of the techniques.

2.2 Definition of Teams

There are different definitions of teams and the components of team by various authors. Clutterbuck (2006) maintained that team is the group of small people with matching skills that are dedicated to achieve a collective purpose, performing goals, and method, which they considered themselves jointly responsible. In the same way, Gilley et al. (2010) believed that a proficient team composed of small group of people that have related skills and are devoted to a shared resolution, established concerted goals as well as method.

Sinclair (1992) in his own definition describe team as unique set of group which is more tasks focused than any other groups with a clearly stated guidelines and recompenses for the members. A simple definition of teams related it to a distinctive form of work group, comprising of two and/or more people, committed to achieving a particular goal or objective. Gibson (2009) proclaimed that team comprises of individuals with shared identity and principles, common tasks, drive for success, recognition of individual contributions, clear definition of team membership and balanced roles.

Others like Gilley et al. (2010) assumed that a team comprises of a common vision, member involvement, joint teamwork, clearly defined goals, team identity, open and honest communication, individual-team accountability and positive team culture, however, the most distinguishingly characteristic of any team lies in the accomplishment of team goals as the highest priority their members, further explained that teams should be employed in a situation where complex problem needs workers with various talents and practical expertise as well as when task involves the use of division of labor.

West (2012) maintained that teams can take advantage of a fast-changing environment, enable learning, offer financial advantage and enable effective change efficiently more than the collection of people who in any way are not sharing a common resolution in the organization. Consequently, leaders of the organization should consider the following features before enlisting employees in teams; (a) if the task can be executed effectively by more than one person, (b) does the task offer itself to certain shared set of goals for the team members, (c) are members of the team interdependent and (d) do the members of the team possess the suitable skill mix to excel (Gibson, 2009). In conclusion, based on studies above, team refers to software engineering team possessing complementary skills and experience with commitment to a common purpose, performance objectives, and method with which team members are mutually accountable, Software development depends significantly on team as does any process that involves human interaction.

2.3 The benefit of team

According to previous study there are many benefit for team work, the following table 2.1 shows the summarized some of these benefit:

Table 2.1

Summary of benefit of team work

Author	Benefits
West (2012)	Can improve employees abilities of problem-solving, isolating and eliminating barriers that hinder creativity, maintaining team participation that can advance cooperation, communication, efficiency, quality, optimum use of resources, decision-making, commitment, solution identification, employee self-confidence, and quality.
Gilley (2010)	Team participation assists the employees to clearly attain set goals and objectives that need to be accomplished while offering an opportunity for members of the team to exhibit their strengths and weaknesses
Gibson (2009)	Significantly improves team participation, confidence and leadership abilities of members of the team, processes, procedures as well as organizational productivity.
Albanese 1994	Minimize unhealthy competitive relationships through broad problem-solving approaches facilitate by the need to achieve common goals.

As shown in table above there are a lot of benefits for team work to help team members to achieve the common goals and objectives. The most benefit of team work is to improve team member's ability of problem solving, increase communication and cooperation, among team members which lead to enhance team performance and organization productivity.

2.4 Related works on team formation

Related works in team formation can be summarized as indicated in table 2.2.

Table 2.2

Summary of related work about team formation

Author	Techniques	Finding	Limitation
Tavana, Azizi, Azizi, & Behzadian, (2013)	Fuzzy technique	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.
Syed-Abdullah et al., (2011)	Fuzzy Rule-based	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.
Tseng, Huang, Chu, & Gung, (2004)	Grey decision theory and fuzzy sets theory	They proposed a conceptual framework for project team formation	They focus on relationship between project characteristics and customers' requirements in forming team; there is a lack of including the characteristics of team fitting the assignment of members' roles.
Deibel, (2005)	Latent jigsaw method and grouping students by Felder-Silverman learning styles	This paper considers that greater student interaction and learning can take place by using instructor-formed teams. Two group formation techniques for in-class group work are presented.	Only focus on learning style and Personality types
Ahn,	Multi-	In this paper, a method is proposed	This method only discusses

DeAngelis, & Barber, (2008)	Dimensional Trust (MDT)	to build a multi-dimensional trust model using agents' attitudes to give priority to a subset of the three dimensions which are reliability, quality, and availability during the teammate formation process.	three dimensions, this method lacks a number of attributes, such as the experience or expertise of potential team members as well as the functions of the team members
Kozanoglu & Fahri, (2009)	Goal programming model	The goal programming model was suggested to lessen the extent of team's deviations from the required diversity and elevation levels regarding the personality traits and technical skills.	In this paper, there is no testing for the validity of proposed model.
Venkatamuni & Rao, (2010)	Mathematical programming model	The mathematical model is developed to determine the team members in product design with constraints of number of projects, time and budget.	The process of team members' formation depends only on the ordered matrixes that afford them the most crucial functions of team; there is a lack of including team characteristic fitting into the role assignment to the members.
Gilley et al., (2010)	This paper proposed integrated theoretical model for building effective team	There is a combination of various theories that are independent and disconnected (like: the change curve, theory of charge and charter, synergistic relationship theory, and the theory of performance curve) into a single inclusive model.	Theoretical paper, there is no empirical data to validate the model
Marcolino, Jiang, & Tambe, (2013)	Multi-agent team formation	They introduced a modern technique for the formation of multi-agent team. Contrary to the current study, they examined formation of team in relation to the agents' context that vote together at each point of problem.	Regarding the desire of the best team, this causes a new conflict that is whether to focus on the team members' strength or the team's diversity.

Based on table 2.2 it has shown that most studies are focused on criteria to form team member. However studies on team work behaviors that consider roles in a team is still limited.

2.5 Method for team formation

There exist three different methods for team formation which are random-formation, self-formation, Intelligent-formation (Cann et al., 2012; Hamilton, 2010; Liu, Joy, & Griffiths, 2013). These methods details explain as following:

2.5.1 Random-formation

This involved assigning teams members randomly on the basis of newness and freshness in the team formed. The use of random formation method will likely increase the effectiveness of the group formation procedure and the possibility of unrelated groupings which may or not give the assurance that the students individual needs are satisfied (Liu et al., 2013). However van Cann, Jansen, and Brinkkemper (2012) noted that the Random-formation method risks placing in a team with all the best or the worst, member in a single team which can limit the team abilities.

2.5.2 Self-formation

Self-formation according to Hamilton (2010) is when team is formed naturally based on the resemblance among member. This does not considered the perception of team members on one another as regards to the ability to perform the task on which the group is created. It is the commonest group formation method. This method is premised on the principle that time taken to form a team and get to know one another due to previous affiliation is reduced. However, the team so formed may not be the best team. Although it's easy and simple way to form a team, but there is higher chance of the probability that teams to be formed will be based on prior memberships or proximity either of which may not possibly to guarantee optimal performance and total group understanding (Hamilton, 2010).

2.5.3 Intelligent-formation (Instructor- formation)

It is selection of members of a team through in a manner that leads to most effective teams for learning. For instance, if a project wants to enhance the learning and experience of a team comprising of student members in a class, the teacher selects teams in a manner that will allows this improved experience among students. While adopting this method of selection, the professor can use randomly select student based on their specific ability through surveying of the students. With access to student data like grade point average, class schedule, or even student housing location the professor may have more information to help facilitate creation of productive teams (Hamilton, 2010).

Under this method, the instructor would not allow students to do self-selection to avoid tendency of active students in class being in the same team and leaving the weaker students to form team among themselves which will not be to any ones favor. Thus, those teams with weak students may likely fail and consolidate the misconception of one another, while the teams that is made up of totally active students frequently adopt a distinguishing and divide opinion in implementing different portion of the task individually thereby putting the product together without discussion (Oakley, Felder, & Brent, 2004).

There is a lack of sufficient evidence supporting the members' self-selection vs. manager's groups' selection. This is basically resulted from that the group formation is performed on the basis of different standards for both managers and members. Occasionally, those standards may overlap causing a difficulty in having empirical collection of data for both sides (Hamilton, 2010). However, previous studies verified that intelligent method could inspire members' participation in teamwork and therefore having success opportunity (Deibel, 2005; Oakley et al., 2004). Thus this study will utilize a team formation method based on intelligent method, which require the manager to form effective team.

2.6 Automated Team Formation

Many approaches to the success of tasks rely upon members working in groups. Research in many disciplines has shown that learning within groups improves the members experience by enabling peers to learn from each other. To form teams, members can be either allocated to teams randomly, self-select each other, or be appointed to a team by the managers based on some criteria related to the collaboration goals. These criteria are usually expressed as a set of conditions, typically referred to as constraints, such as restricting the groups to be mixed in gender or skills (Asma Ounnas, Davis, & Millard, 2007).

Team formation has been a well-studied field in numerous contexts, (i.e. business teams, project teams, educational teams etc.). Formation groups in traditional often occurs in an ad-hoc fashion where members are assigned to groups mostly without any particular constraints or regard to the group composition that is most likely to lead to optimal outcomes. It's important consider an approach to automated group formation that continuously analyses group performance and uses this to build rules regarding optimal group composition. These rules can be subsequently used to allocate members to groups that are more likely to have higher performance (Mujkanovic, Lowe, Guetl, & Kostulski, 2011).

For the responsible, forming teams manually can be both difficult and time consuming. For this, researchers have been investigating several techniques for automating this process through the use of computer-supported group formation (CSGF). Similar to manual group formation, the challenges of CSGF lie in modeling the members' data, the responsible constraints; and negotiating the allocation of members to groups to satisfy these constraints (Asma Ounnas, Davis, & Millard, 2009).

In addition, automated team formation dramatically decreases the managers time required to assign teams, making it possible for instructors to assign teams based on many criteria and studies presented that automated team is already an effective and efficient means of assigning members to effective teams (Layton, Loughry, Ohland, & Ricco, 2010).

2.7 Software Engineering Teams

The growth of software development as the field of study has been described to be very rapid. People has also been said to be fundamental and important to the success and failure of software development. Software development requires teamwork and communication to a very greater extent. The need for teamwork in information system (IS) practice has been highly recognized by many organizations. Thus, they are looking for devices for online cooperation in order to trim down the production costs and to quickly make the product available in the market.

There have been several attempts by various software project managers to put together effective and highly productive teams but the result was not successful. This is because software projects look very distinct from the traditional projects due to the fact that they are invisible, compounded and flexible to develop and integrate. Hence, software projects remain restricted by money and time as well as are executed by team that is brought together for the particular purpose of creating a product or application which does not exist before (Sudhakar, Farooq, & Patnaik, 2011).

About 75% of American companies have subcontracted their work to many other countries, and this makes it more complex to comprehend team performance and business partner's processes and management practices, therefore, in complex onsite-offshore and global delivery models of software development, it is challenging to differentiate and evaluate the customer plus performing organization's teams' performances (Na, Simpson, Li, Singh, & Kim, 2007).

The team productivity and performance is the major concern in the team orientation, most especially in the software engineering teams. Features of software development jobs are changing due to the mergers and acquisitions. They are diverging toward being more globally distributed to many locations which leads to increase in creativeness of prevailing teams, enhances new markets, products and engineers (Ebert & Neve, 2001).

Trendowicz, Ochs, & Wickenkamp (2008) proved that team proficiency is more essential than technical skills like the use of software tools, knowledge of programming languages, and the experience on particular applications. Human relations are very vital and necessary than the technical abilities in software engineering teams, the teams for software project are quite distinct to another project teams, this is due to the fact that software development entails human centric activities and as to do with addressing greatly unpredictable thing, software projects also dissimilar from any other projects in the area of cost estimation during the early phases of the software project, this is very difficult with software applications new products with very few of it in upgraded version of the existing ones.

2.8 Belbin Theory

Belbin theory on team role establishes that when the behavior of people engaged in team is unlimited, the extent of useful behaviors that effectively contribute to the performance of team is equally limited. Belbin role theory congregated these behaviors into eight groups with each one describing behavioral features of the manner wherein a member of team is related to another. He further stated that team role behavior is not related to individuals' traits only, but it might be altered by conditional factors as well as individuals' learning pattern, also categorized team roles as Action-oriented roles (SH, IMP, CF), People-oriented roles (CO, TW, RI) and Cerebral or Thinking roles (PL, ME, SP) (Senaratne & Gunawardane, 2013).

Belbin cautions 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’ (Belbin, 2014). Based on conclusion of 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. Contrarily, it is argued from a certain quarter that some specific roles are more required for the task of construction on the basis of its requirements (Senaratne & Gunawardane, 2013).

2.7.1 Belbin Team Roles

For most organizations effective team work has become a basic concern. Significant interest has been set on the influence of diversity in team member in terms of roles played in a team among several factors influencing a team’s performance. Aritzeta (2005) noted that Meredith Belbin made the model of team role popular by Belbin Team Role Self-Perception Inventory (BTRSPI) which is developed to measure the behavioral features displayed by individuals when working in teams. Due to the studies carried out by Meredith Belbin in the seventies, Belbin Team Role Theory was developed.

According to Aritzeta (2005) BTRSPI is not seen as a psychometric test (i.e measures of personality attributes) since it measures behavior rather than personality, however, personality is among several factors that can impact behavior including internalized values, motivations as well as the external environment of working or “Field Constraints”, whilst it was acknowledge that nearly all personality traits are fairly constant, behavior can change more consistently, adjusting to the variations in any of the factors that influence it. Due to this, Belbin (2013) believed that there might be change in the preferences of Team Role with time passage. Although it remains doubtful that

Team Roles of an individual would be intensely changed or upturned totally, as certain adjustments could take place according to the job role change or the environment of work, or because of key changes in life.

The BTRSPI examine behavior which Belbin (2013) expects that will make available as the most valuable and supportable information concerning an individual to an employer, manager or consultant, and the person concerned. Though it is possible to contend that the individual's personality is recognized by himself only, behavior is apparent and could be construed and utilized to forecast probable reactions and manner.

In this questionnaire, it has 8- team roles and a team role was defined as a form of behavioral characteristic of the way in which a team member relates with another in order to enhance the performance of the team entirely. Also included are the names and descriptions of all the eight team roles. However, in 1993 some of the team roles were renamed and an additional one role was added to make it nine. The nine team roles are as follows; Co-ordinator (CO), Implementer (IMP), Resource Investigator (RI), Monitor Evaluator (ME), Plant (PL), Shaper (SH), Completer-Finisher (CF), Specialist (SP) and Team worker (TW) (Aritzeta, 2005). Table 2.3 below shows the descriptions of each role:

Table 2.3

Summary of Belbin Team Role adapted from Belbin (2013)

Team Role	Descriptor	Strong point	Weaknesses
Co-ordinator (CO)	Dominant, trusting, extrovert, mature, positive, self-controlled, self-disciplined and stable.	Mature, confident, a good chairperson, clarifies goals, promotes decision making, delegates well.	Can be seen as manipulative. Offloads personal work.
Completer Finisher (CF)	Anxious, conscientious, introvert, self-controlled, self-disciplined, submissive and worrisome.	Painstaking, conscientious, searches out errors and omissions, delivers on time.	Inclined to worry unduly. Reluctant to delegate.
Plant (PL)	Dominant, imaginative, introvert, original, radical-minded, trustful and uninhibited.	Creative, unorthodox, solves difficult problems.	Too preoccupied to communicate effectively
Shaper (SH)	Abrasive, anxious, competitive, dominant, edgy, emotional, extrovert, impatient, impulsive, outgoing and self-confident.	Challenging, dynamic, thrives on pressure, has driven and courage to overcome obstacles.	Prone to provocation. Offends people's feelings.
Resource Investigator (RI)	Diplomatic, dominant, enthusiastic, extrovert, flexible, inquisitive, optimistic, persuasive, relaxed, social and stable.	Extrovert, communicative, explores opportunities, develops contacts.	Over-optimistic, loses interest after initial enthusiasm.
Monitor Evaluator (ME)	Dependable, fair-minded, introvert, low drive, opens change, serious, stable and unambitious.	Sober, strategic and discerning, sees all options, judges accurately.	Lacks drive and ability to inspire others.
Team Worker (TW)	Extrovert, likeable, loyal, stable, submissive, supportive, unassertive, and uncompetitive.	Co-operative, mild, perceptive and diplomatic, listens, builds, averts friction, and calms the waters.	Indecisive in crunch situations.
Specialist (SP)	Expert, defendant, not interested in others, serious, self-disciplined, efficient.	Single-minded, self-starting dedicated; provides skills in rare supply and knowledge	Contributes on a narrow front only. Dwells on technicalities.
Implementer (IMP)	Conservative, controlled, disciplined, efficient, inflexible, methodical, sincere, stable and systematic.	Disciplined, reliable, conservative and efficient, turns ideas into practical actions.	Somewhat inflexible. Slow to respond to new possibilities.

Table 2.3, indicate the nine Belbin team role with the description, strong and weakness point for each role, these nine roles measured the behavior behavioral characteristic of the way in which a team member relates with another in order to enhance the performance of the team entirely.

2.7.2 Importance of Belbin team role

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 (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. There is a general acknowledgement that the Belbin scheme's intuitive appeal, ease of application, empirical support and widespread use in numerous organizations including government bodies, Financial Times Stock Exchange 100 Index (FTSE-100) and multinational organizations render it a useful tool for managers (A. Aritzeta et al., 2007).

The central claim of the Belbin team role theory is that a balance 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 (Harris, 1999; Senior, 1997). The Belbin theory also recognizes that behaviors are contextual and will change over time in response to new circumstances.

2.7.3 Application of Belbin Team Role

Most of the organizations become basically focused on effective team working. It is a fact that there are several factors that impact the performance of team; however, the team member diversity influence has been given a considerable attention in respect to the played roles in a team. Meredith Belbin made the model of team role popular concerning teams of management and commercially accessible via Belbin Associates. It is extensively practiced and featured in the studies of teams at work. many organizations have utilized this model, including: companies of FTSE-100, multinational agencies, bodies and consultants of government, as well as has been translated into sixteen languages (A. Aritzeta et al., 2007), example of application:

2.7.3.1 Belbin Team Role in education

The usefulness of the Belbin scheme is to encourage students to focus explicitly on group work skills and to encourage a greater understanding of individual strengths and weaknesses. Since the increase in high-performing groups appears unrelated to their balance of team roles, the use of Belbin as a teaching tool to expose students to the expected problems of group work may be a more appropriate focus of investigation (Todd Jr et al., 1998& Smith et al., 2012).

2.7.3.2 Belbin Team Role in industry

Eclipse (2009) advocates that in aligning a team consideration should not only focus on technical skills of individuals, experience and knowledge but also their ability to coordinate actions, behaviors and interpersonal traits. The team roles concept is greatly associated with those factors considered significant for team roles of construction teams to become evident.

Regarding to construction teams, Sommerville & Dalziel (1998) emphasized that the achievement of a construction projects encompasses examining the conduct of each of the team member and monitoring them with respect to how individuals relate. Besides, Elizabeth Yeh, Charlene Smith (2006) recommended that members of construction need to identify what their team roles are so as to understand how to operate as a team. Further findings from the literature show that team role concept is important in the construction industry for improved team performance (Todd Jr et al., 1998& Senaratne & Gunawardane, 2013).

2.9 Belbin Team Role 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. Though certain applications of software engineering domain are dedicated to specific teams, other teams concentrate on a special division of the identical project or application (Schoenhoff, 2001).

While software engineering adopts the tactic of team-based, analyses related to the perspectives of psychology, personality or managing are required and Belbin's team role theory depicts a real world choice for such a perspective, however Belbin likened varied plant combinations which are more appropriate for computer science: combining a Plant with a Chairman, a Plant together with Resource Investigator, or a Plant with a Monitor-Evaluator, Both principals of Plants, namely creativity and intelligence, are more germane to the design and development of software, and the example about these, the Chairman owns the potentials to enhance the direction free of abrasion, Consequently, the Resource Investigator is capable to acquire external ideas whereas the Plant delivers inside inventions and the Monitor-Evaluator can efficiently evaluate and highlight problematic cases in the formulated models of Plant. Thus, selecting a correct pairing strategy among the above-listed ones can help solving problems experienced by Plant in a certain circumstance (Todd Jr et al., 1998).

In spite of Belbin's effort to cover a large extent of industries, Henry and Todd 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: 1) the Shaper, 2) the Plant, besides 3) the Monitor-Evaluator. Those above listed roles are given attention 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 other unconventional problems and a rational decisions foundation for points that trapped the team or could select among several choices are essential. Those qualities represent the Shaper, Plant, and Monitor-Evaluator respectively (Todd Jr et al., 1998).

Two leadership roles were defined by Belbin in the work of Steven on team leadership, that is, the Chairmen and the Shaper. Concerning the software, Shapers appear as more established than Chairmen do, the work of Stevens indicated that single recognizable leader (Shaper) teams exhibit well performance than other teams without leader or those having many leaders; the second focus of the Stevens' study is the Plant. His study conclusion was on the Plants' amount in a particular team besides that the team's achievement is dependent. Stevens concluded that teams which composed mainly of Plants exhibit better performance than teams with few Plants or without Plants do. Finally, an unexpected result was produced in the Steven's study of the influences of Monitor-Evaluators (Henry & Todd Stevens, 1999).

Monitor-Evaluator was referred to as the role of "decision maker" assuming that a team of software engineering needed decision-making ability that could be granted by the Monitor-Evaluator, Stevens resolved that, in the his sample limits, the Monitor-Evaluator's effect on the software engineering team cannot be verified to be statistically important, and then asserted that the Monitor- Evaluator could not be useful or vital for software engineering, and regarding to an early observation, it is exciting noting the lack of Resource Investigators. Prior research appears to recommend that software engineering teams did not basically need Resource Investigators, because the role in the practical scenario did not occur amongst the community of computer science (Todd Jr et al., 1998).

In addition other researcher confirm that the role of plant in more suitable to software developer , since the Plant role is linked to ‘genius, imagination, intellect, and knowledge’ personality traits, individuals occupying this role might be capable of generating rapid and innovative solutions to software problems, making them most suitable as programmers (Licorish, Philpott, & MacDonell, 2009& O’Doherty, 2005), and Belbin Shaper role is playing leader role (Beranek, Zuser, & Grechenig, 2005).

Moreover, based on the research an experiment that different researcher made in the field of software engineering with Belbin team role. The roles of Shaper and Plant in Belbin team role are more convenient to the software engineering team, hence Shaper role for leader while Plant role for programmer (Rajendran, 2005, Ounnas, Davis, & Millard, 2008 & Wasiak & Newnes, 2008).

Regarding to Partington & Harris (2011) the concept of team roles is not new. Early researchers, for instance Benne and Sheats in (1940-1950), identified some roles such as Harmoniser, Initiator-contributor and Energizer. In the late eighties and nineties, teams attracted the increased attention of researchers as well as becoming a useful guidance in the team roles field. Consequently, many researchers suggested various numbers of roles, including: in 1989s, Woodcock suggested twelve, while in 1990s Margerison and McCann recognized 9, then in 1992s Davis offered 5 roles of team divided into fifteen. Most of these studies need to be based on a specific theoretic basis. Based on this literature, it is clear that the team roles knowledge becomes a common case having an apparent impact on the performance of team. The derivation of the most widely practiced method to identify the roles of team is based on Belbin's work (Partington & Harris, 1999).

2.10 Comparing Belbin's Team Role with Others Team Role

The three theories which compared are Belbin's team role theory, Margerison and McCann's team role theory and the Myers-Briggs Type Indicator. Though the latter is it also identifies personality types and is used for similar purposes in enterprises. Table 2.4 compares these three contemporary approaches to understanding teams (Margerison & McCann, 1990).

Table 2.4

The different approaches to understanding team roles

Belbin's Team Role	**Margerison-McCann**	**Myer-Briggs Type Indicator**
Sociological approach (i.e. social relations among organized groups/teams)	Socio-psychological approach	Psychological approach (i.e. the human mind/soul)
Role differences within a team	Individual role preferences	Individual differences
What behavioral, role do I have?	What do I wish to do?	Who am I?

For more understanding about these teams roles Table 2.5 shows a comparison of the terminology used by Belbin, Myers-Briggs and Margerison & McCann and the associated skill involved.

Table 2.5

Compares the terminology used in the theories (Botha, 1994).

SKILL	BELBIN	MYERS-BRIGGS	MARGERISON & MCCANN
People	Coordinator: Holds the process together	ESTJ	Linker : Holds the process together
People	Resource Investigator	ESTJ or ESFJ	Explorers: Explorer/Promoter
Doing	Implementer	ISTJ	Assessor Developer
Doing	Shaper	ISTJ or ESTJ	Organisers: Thruster/Organiser
Doing	Completer Finisher	ISTJ	Concluder/Producer
Thinking	Monitor Evaluator	ISTJ	Controllers: Controller/Inspector
People	Teamworker	ESTJ or ISTJ	Upholder/Maintainer
Thinking	Specialist (¢)	ISTJ	Advisers: Reporter/Advisor
Thinking	Plant	INTP or INTJ	Creator/Innovator

Myers-Briggs abbreviations: E=Extrovert; I=Introvert; S=Sensing; N =Intuition; T=Thinking; F=Feeling; J=Judging; P=Perceiving.

Each one of these models emphases its own unique differences. Which one is best will depend on what is required within a particular context. Belbin's team roles appear to have a popular appeal, Margerison and McCann focus on the ongoing nature of activities and Myers-Briggs focuses on the inherent qualities of the individual. It will also depend on the resources available and which software package is preferred, Belbin appears to have the competitive advantage here as his Inter-place software package has multiple possibilities such as personal profiles, counseling profiles, team profiles and the possibility to search for the ideal candidate to participate in a particular project, and an important reason for Belbin having the 'competitive edge' with regard to the team role theories is the fact that he is a researcher turned businessman, he has founded Belbin Associates and his products are marketed internationally and are tailored and updated to suit the needs of the market, in conclusion these are reasons of the uniqueness of Belbin's team role theory when compared to other similar theories (Van, 1999).

Finally, Partington (1999) argued that, on the basis of ten years investigation, Belbin has developed a team roles theory combined with several types of personality and behavioral in the stable setting of a management game employed as part of an executive development programmer. For a number of years, eight team roles have been recognized by Belbin and his trained observers, and then they developed a device to quantify the preferences of individuals' team role. This device, identified as the Belbin Team Role Self-Perception Inventory (SPI), produces a quantified summary of its respondent's affinity with each team role. Several refinements have been practiced on the SPI since its early development, including:

- Re-labeling roles that have labels of undesirable connotations.
- The addition of a ninth role and recognizing that technical expertise is necessary for the performance of some team tasks.
- Packaging the instrument in computer-based form with a more refined scoring mechanism.

2.11 Techniques to form team

Based on the literature review, many techniques can be considering for team formation. Table 2.6 below shows some of these techniques and summarized of the advantages and disadvantages observed, and areas of application for each technique.

Table 2.6

Summary of team formation technique adapted from Velasquez & Hester (2013)

Technique	Advantages	Disadvantages	Areas of Application
Multi-Attribute Utility Theory (MAUT) by Fishburn(1967)	It considers the uncertainty aspect, and the preferences can be incorporated.	Many inputs are required; there is a need of precise preferences.	Economics, finance, agriculture, actuarial, management of water, management of energy.
Analytic Hierarchy Process (AHP) by Thomas L Saaty (1988)	Easily used; accessible; it is easy to adjust the hierarchy structure so as to be proper for various sized problems; no intensive data.	Problems because of criteria and alternatives interdependence; contradictions may be caused between judgment and criteria of ranking; reversal of rank.	Problems of performance-type, management of resource, public policy, corporate policy and strategy, planning, and political strategy.
Case-Based Reasoning (CBR) by Stephen Slade (1991)	No intensive data; a little maintenance is required; it could be improved with time passage; moreover, it can be adapted to environment changes.	It is sensitive to varying data; many cases are required.	Businesses, insurance of vehicle, engineering design, and medicine.
Data Envelopment Analysis (DEA)	Capable of handling multiple inputs and outputs; efficiency can be analyzed and quantified.	Does not deal with imprecise data; assumes that all input and output are exactly known.	Economics, medicine, utilities, road safety, agriculture, retail, and business problems.
Fuzzy Set Theory by Zadeh (1965)	Imprecise input is allowed; insufficient information is considered.	The development is difficult; Numerous simulations could be required before use.	Environment, social and medical fields, engineering, management, besides economics.
Simple Multi-Attribute Rating	Simple; types of weight assignment technique is allowed; decision	Regarding the framework, th procedure could be inconvenient.	Environment, construction, transportation and

Technique (SMART)	makers' less effort.		logistics, problems of manufacturing and assembly, and military.
Goal Programming (GP) by Charnes, cooper (1955)	It is capable to treat large-scale problems; infinite alternatives can be produced.	Its ability to coefficients of weight; typically it needs to be combined with other methods of MCDM to coefficients of weight.	Planning of production, scheduling, health care, selection of portfolio, distribution systems, energy planning, management of water reservoir, and management of wildlife.
ELECTRE by Bernard Roy mid(1960)	Uncertainty and vagueness are considered.	It could be difficult to explain its process and result in layman's terms; the alternatives' strengths and weaknesses cannot be directly identified because of the outranking.	Energy, environment, economics, management of water, and problems of transportation.
PROMETHEE by Jean-Pierre Brans (1982)	Use easiness; the assumption that criteria are proportionate is not required.	There is no clear method to allocate weights.	Environment, hydrology, water management, business and finance, chemistry, logistics and transportation, energy, manufacturing and assembly, and agriculture.
Simple Additive Weighting (SAW)	Criteria can compensate it; innate for makers of decision; simple calculation without requiring programs of complex computer.	The revealed estimates do not always denote the real situation; the obtained result could be illogical.	Management of water, business, as well as management of finance.
Technique for Order Preferences by Similarity to Ideal Solutions (TOPSIS) by Yoon (1987)	Has a simple process; use and program easiness; regardless of the attributes number, the steps number remains identical.	The use of Euclidean Distance does not take in consideration the attributes correlation; weight and keeping of judgment consistency are difficult.	Supply chain management and logistics, engineering, manufacturing systems, business and marketing, environment, human resources, and water resources management.

As indicate in above table there are many technique for team formation, In this study, fuzzy technique was used because, fuzzy technique allows analyzing of imprecise data, classifying selected criteria, and it can indicate whether every team has equal distribution of criteria, However other techniques needs a lot of inputs, sensitive to inconsistent data, does not deal with imprecise data, does not provide a clear method by which to assign weights, estimates revealed do not always reflect the real situation and difficult to weight and keep consistency of judgment.

Finally Koksal & Ozmutaf (2009), showed that selection of the best model is based on the issue in hand and it may be to certain extent dependent on which model the decision maker is best comfortable with. Different methods were developed for standardizing the decision making process. Selecting a proper method 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 (Saeed & Trab, 2012).

2.12 Overview and Comparison of Team Formation Techniques

Different techniques were developed for team formation, Selecting a proper technique for team formation is based on the kinds of issue being dealt with, the attributes of the method of team formation and the aims of the teams (Saeed & Trab, 2012). According to (Mukherjee & Bera, 1995), the common team formation technique are, fuzzy, DEA, ELECTRE, Goal Programing and TOPSIS. The following sections address some techniques with an overview about each technique:

1- Fuzzy

Fuzzy is an extension of classical set theory that allows solving a lot of problems related to dealing the imprecise and uncertain data, it has many advantages, it takes into account the insufficient information and the evolution of available knowledge and it allows imprecise input, also it allows for a few rules to encompass problems with great complexity, on the other hand for disadvantages, fuzzy systems can sometimes be difficult to develop, in many cases, they can require numerous simulations before being able to be used in the real world (Balmat, Lafont, Maifret, & Pessel, 2011).

Fuzzy is established and has been used in applications such as engineering, economic, environmental, social, medical, and management. Many of these types of problems take advantage of the availability of imprecise input. These types of applications favor a method that embraces vagueness and can be tested numerous times before real-world application (Velasquez & Hester, 2013).

2- DEA

DEA uses a linear programming technique to measure the relative efficiencies of alternatives (Thanassoulis, Kortelainen, & Allen, 2012). It rates the efficiencies of alternatives against each other, with the most efficient alternative having a rating of 1.0, with all other alternatives being a fraction of 1.0, it has a number of advantages. It is capable of handling multiple inputs and outputs; efficiency can be analyzed and quantified, it can uncover relationships that may be in hidden with other technique, an important disadvantage is that does not deal with imprecise data and assumes that all input and output data are exactly known, In real world situations, however, this assumption may not always be true (Wang, Greatbanks, & Yang, 2005). The results can be sensitive depending on the inputs and outputs. DEA is used wherever efficiencies need to be compared, this is commonly used in economic, medical, utilities, road safety, agriculture, retail, and business problems, these categories are especially useful because they have precise data that could be utilized for input, which bypasses one of the method's major deficiencies (Velasquez & Hester, 2013).

3- ELECTRE

ELECTRE, along with its much iteration, is an outranking technique based on concordance analysis. Its major advantage is that it takes into account uncertainty and vagueness. One disadvantage is that its process and outcomes can be hard to explain in layman's terms, further, due to the way preferences are incorporated, the lowest performances under certain criteria are not displayed, the outranking method causes the strengths and weaknesses of the alternatives to not be directly identified, nor results and impacts to be verified (Konidari & Mavrakis, 2007). ELECTRE has been used in energy, economics, environmental, water management, and transportation problems. Like other methods, it also takes uncertainty and vagueness into account, which many of the mentioned applications appear to need (Velasquez & Hester, 2013).

4- Goal Programming

Goal Programming is a pragmatic programming technique that is able to choose from an infinite number of alternatives. One of its advantages is that it has the capacity to handle large-scale problems, its ability to produce infinite alternatives provides a significant advantage over some methods, depending on the situation, a major disadvantage is its inability to weight coefficients, Goal programming has seen applications in production planning, scheduling, health care, portfolio selection, distribution system design, energy planning, water reservoir management, timber harvest scheduling, and wildlife management problems, many of these applications have been used in combination with other methods to accommodate proper weighting, finally, by doing so, it eliminates one of its weaknesses while still being able to choose from infinite alternatives (Velasquez & Hester, 2013).

5- TOPSIS

TOPSIS is an approach to identify an alternative which is closest to the ideal solution and farthest to the negative ideal solution in a multi-dimensional computing space (Qin, Huang, Chakma, Nie, & Lin, 2008). It has numerous advantages. It has a simple process. It is easy to use and programmable, the number of steps remains the same regardless of the number of attributes (İç, 2012). A disadvantage is that its use of Euclidean Distance does not consider the correlation of attributes, it is difficult to weight attributes and keep consistency of judgment, especially with additional attributes, TOPSIS has been used in supply chain management and logistics, design, engineering and manufacturing systems, business and marketing management, environmental management, human resources management, and water resources management, this is another method where its ease of use has kept its application popular, the advantage of its simplicity and its ability to maintain the same amount of steps regardless of problem size has allowed it to be utilized quickly to review other methods or to stand on its own as a decision-making tool (Velasquez & Hester, 2013).

2.13 Fuzzy technique

Prof. Lotfi Zadeh introduced Fuzzy logic in the 1960's as a means of resembling human reasoning, specifically the vagueness feature of human reasoning. It was precisely designed to produce a mathematical decision based on approximate information and uncertainties (Chen, 2003). Research in this area has expanded so that now there are journals devoted to fuzzy. Also, the applications of fuzzy cover a broad range, such as artificial intelligence, linguistics, economics, decision- making, and consumer products (Young, 1993).

Study by Cheng & Leung (2001) considered fuzzy logic based on methodology and reasoning of human on decision making. Mostly, fuzzy is relevant to ill-defined and complex processes, and fuzzy has been accepted among authors as the right technique to describe unclear personnel competences as well as project requirements, when combined with other optimization techniques, fuzzy will be effectively applied to the problem of automated team formation.

In view of this, Tseng, Huang, Chu, and Gung (2004) recommended fuzzy decision theory as most appropriate for assignment of engineers with different specializations to projects with specified characteristics. After initial classifying of the engineers according to their specializations, they would therefore be appraised on a division of skills. Using this technique by Tseng et al. (2004), the project requirements need to have been specified in terms of specific job characteristics. this is seldom needed as it can result to nearly best solutions when there is existence of a better specification of the project activities with more comprehensive skills. However, Strnad and Guid (2010) noted there may be problems when employees' capabilities are assessed in relation to fuzzy levels which are not on the basis of quantitative data by department supervisors. He argued further that doing such will necessitate manual and periodical re-evaluation with subjective attitude.

The reason for employing fuzzy to define ambiguous inputs in context of team performance and also used in a number of ways to explain project requirements, establishment of team based on fuzzy compatibility measures the each employee to project was required for multi-phase projects, thus, Fuzzy models can generally be used as a reliable approach for human resource management(Strnad & Guid, 2010).

Finally, according to Velasquez & Hester (2013), fuzzy is an extension of classical set theory that allows solving a lot of problems related to dealing the imprecise and uncertain data, it has many advantages, Fuzzy takes into account the insufficient information and the evolution of available knowledge, also it allows imprecise input, and allows for a few rules to encompass problems with great complexity, on the other hand, for disadvantages, fuzzy systems can sometimes be difficult to develop, and in many cases, they can require numerous simulations before being able to be used in the real world, Fuzzy is established and has been used in applications such as engineering, economic, environmental, social, medical, and management, thus many of these types of problems take advantage of the availability of imprecise input, these types of applications favor a method that embraces vagueness and can be tested numerous times before real-world application.

Based on classical Boolean logic, there are two values or states regularly expressed as "true" or "false". Nevertheless, in real world there occur many circumstances where events are not simply "true" or "false", but rather somewhere in between, For illustration, if someone is asked to describe one's own feeling at a specific moment, hardly would the reply be only "good" or "bad", it is possible to fall somewhere in between the two. Fuzzy logic is a continuous type of logic that permits the description of this vagueness.

Most of the practical methods are non-linear. Orthodox design methods utilize different approximation approaches to resolve non-linearity. Some usual choices are: piecewise linear, forced linear, lookup table approximations to trade off factors of cost, complexity, and system performance. Finally fuzzy offers an alternate solution to non-linear control because it is almost the same to real physical systems. Non-linearity is handled by membership tasks, rules, and the inference procedure (Chen, 2003).

Applying fuzzy technique involves three steps which are fuzzification, Fuzzy Inference and Defuzzification as describe below:

1 - Fuzzification

Fuzzy processing involves a domain transformation called fuzzification (Figure 2.1). Crisp inputs are transformed into fuzzy inputs. To transform crisp input into fuzzy input, membership functions must first be defined for each input. Once membership functions are defined, fuzzification takes a real input value, such as roles value, and compares it with the stored membership function information to produce fuzzy input values (Mathworks, 2015).

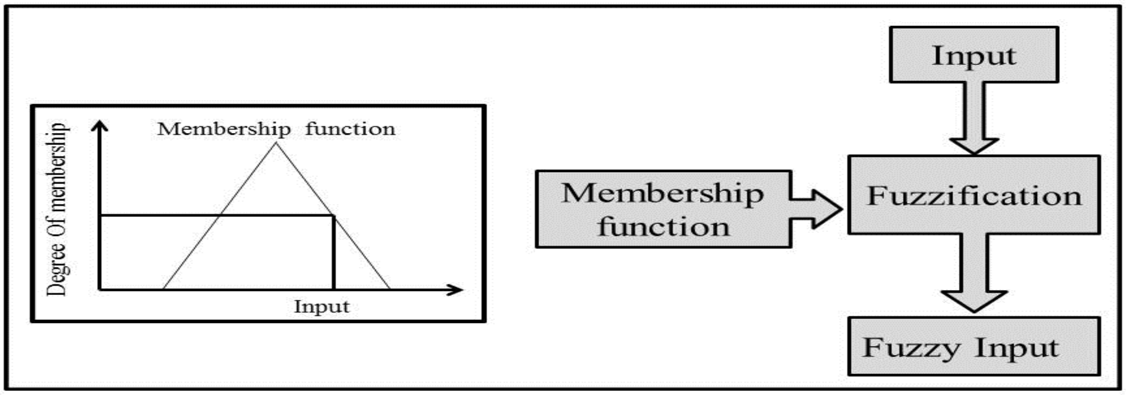

Figure 2.1. Fuzzification process

The first step in fuzzification is to assign fuzzy labels in the Universe of discourse of each of the crisp inputs. So for roles value, the range of labels assigned like those shown in Figure 2.2.

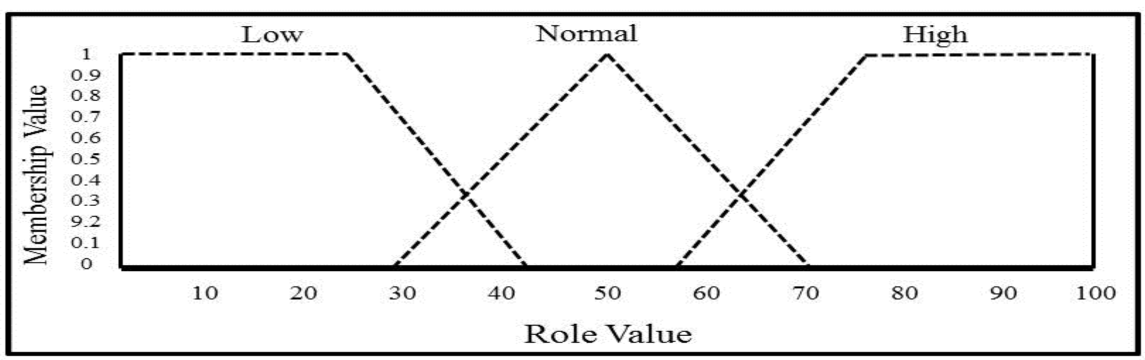

Figure 2.2. Roles Membership Functions

The variable of role divided to three fuzzy regions which are Low membership, Normal membership and High membership. Next, membership functions are defined to give numerical meaning to each label. Each membership function identifies the range of inputs values that corresponds to a label (Rodjito, 2006).

Membership functions can have several different shapes, like those shown to the Figure 2.3. Trapezoidal, bell, and triangular are the most frequently used. Although other shapes may be more representative of natural occurring phenomena, they require more complicated equations or large look-up tables to be represented accurately (Rodjito, 2006).

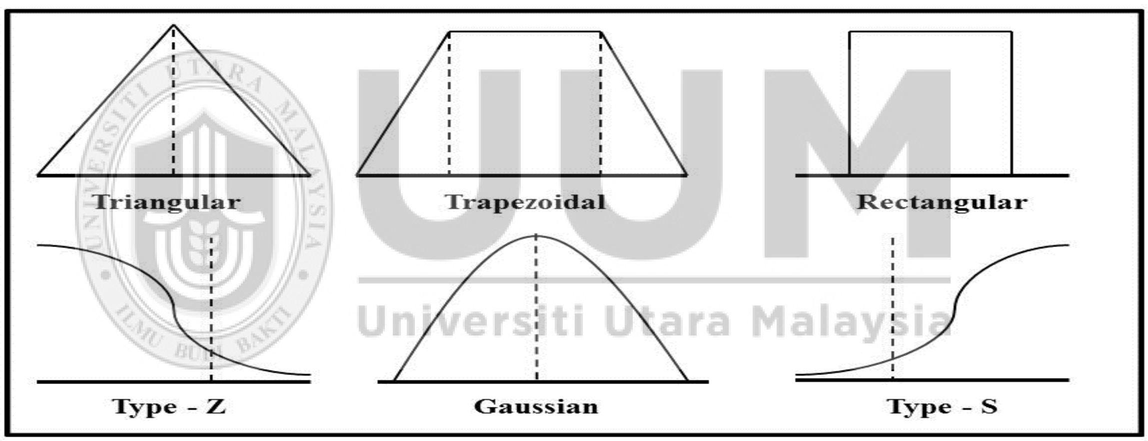

Figure 2.3. Different Types of Fuzzy Set Membership Functions

2 - Fuzzy Inference

Fuzzy logic based systems use rules to represent the relationship between observations and actions. These rules consist of a precondition (IF-part) and a consequence (THEN-part). The precondition can consist of multiple conditions linked together with AND or OR conjunctions. Conditions may be negated with a NOT. The computation of fuzzy rules is called Fuzzy Inference (Mathworks, 2015).

IF-THEN rules are a common way of representing and communicating knowledge in everyday conversation. Anyone who has written a program or machine code knows how complicated (and difficult to debug, read, and maintain) the if-then lines can get. Fuzzy rules offer a way of getting around that by trading the precise representation of the values that variable must assume with much more intuitive fuzzy representations (Rodjito, 2006).

3 - Defuzzification

This stage is used to convert the fuzzy output set to a crisp number. Two of the more common techniques are the Centroid and Maximum methods. In the Centroid method, the crisp value of the output variable is computed by finding the value of the center of gravity of the membership function. In the Maximum method, the crisp value of the output variable is the maximum membership weight of the fuzzy subset (Varun, Govindarajan, & Nayak, 2012). Figure 2.4 illustrates the complete process of applying Fuzzy.

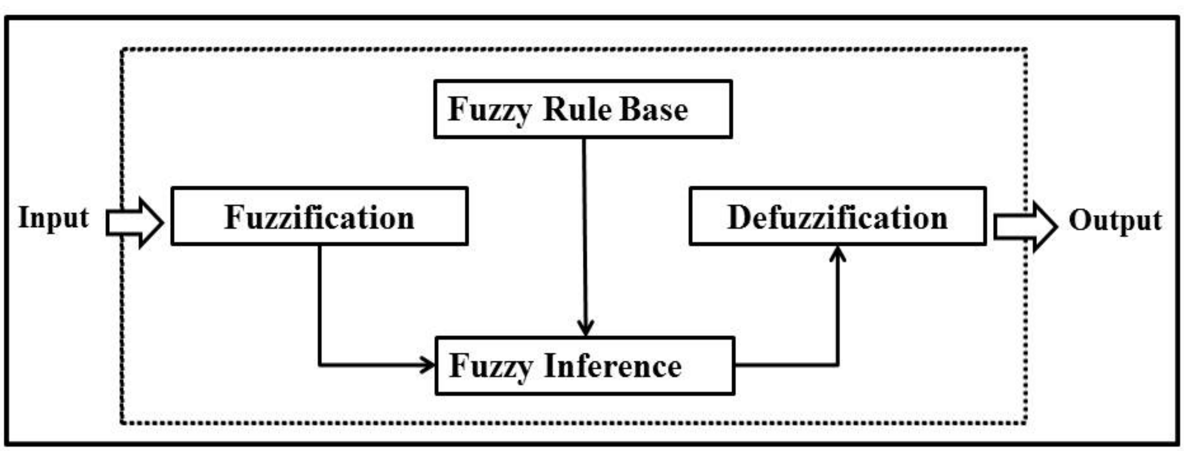

Figure 2.4. Process of applying Fuzzy

2.14 Summary

This chapter has reviewed a definition of team, the benefit of team and related works on team formation. Also, methods for team formation, Software Engineering Teams, Belbin Theory, Belbin Team Roles, and importance of Belbin team role, application of Belbin Team Role, Belbin Team Role and Software Engineering Team and compares between team role theories. Finally, Techniques to Form Team, Overview and Comparison of Team Formation Techniques and Fuzzy technique.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The major objective of the present research is to develop an automated software team formation method based on Belbin team role by using Fuzzy method as explained in chapter one. The three objectives outlined for this study are to identify the characteristics to form team members based on Belbin Team Role, to develop automated software team formation method based on Belbin Team Role by employing Fuzzy technique, and to evaluation the proposed method. In an attempt to accomplish the objective, this research effort would be in 3 main phases as follows:

a) Conceptual Study.
b) Constructing an automated software team formation method.
c) Evaluation of the proposed automated software team formation.

In addition, the three phases in the methodology are adapted from the research design of Peffers, Tuunanen, Rothenberger, & Chatterjee (2007) which are al linked with comprehensive activities in accomplishing the objectives.

Figure 3.1, depicts the entire research activities designed to achieve the research objectives of the study. The figure reveals the linkages between the different stages, activities and the main outcome of the study. Firstly, the review of literature that related to formation of software team method based on Belbin team role has been conducted to define the problem clearly as well as the characteristics to form the team was known from the discussion of literature review. Secondly, automated software team formation method was carried out using fuzzy technique. Finally, evaluation of the constructed automated software team formation method was conducted.

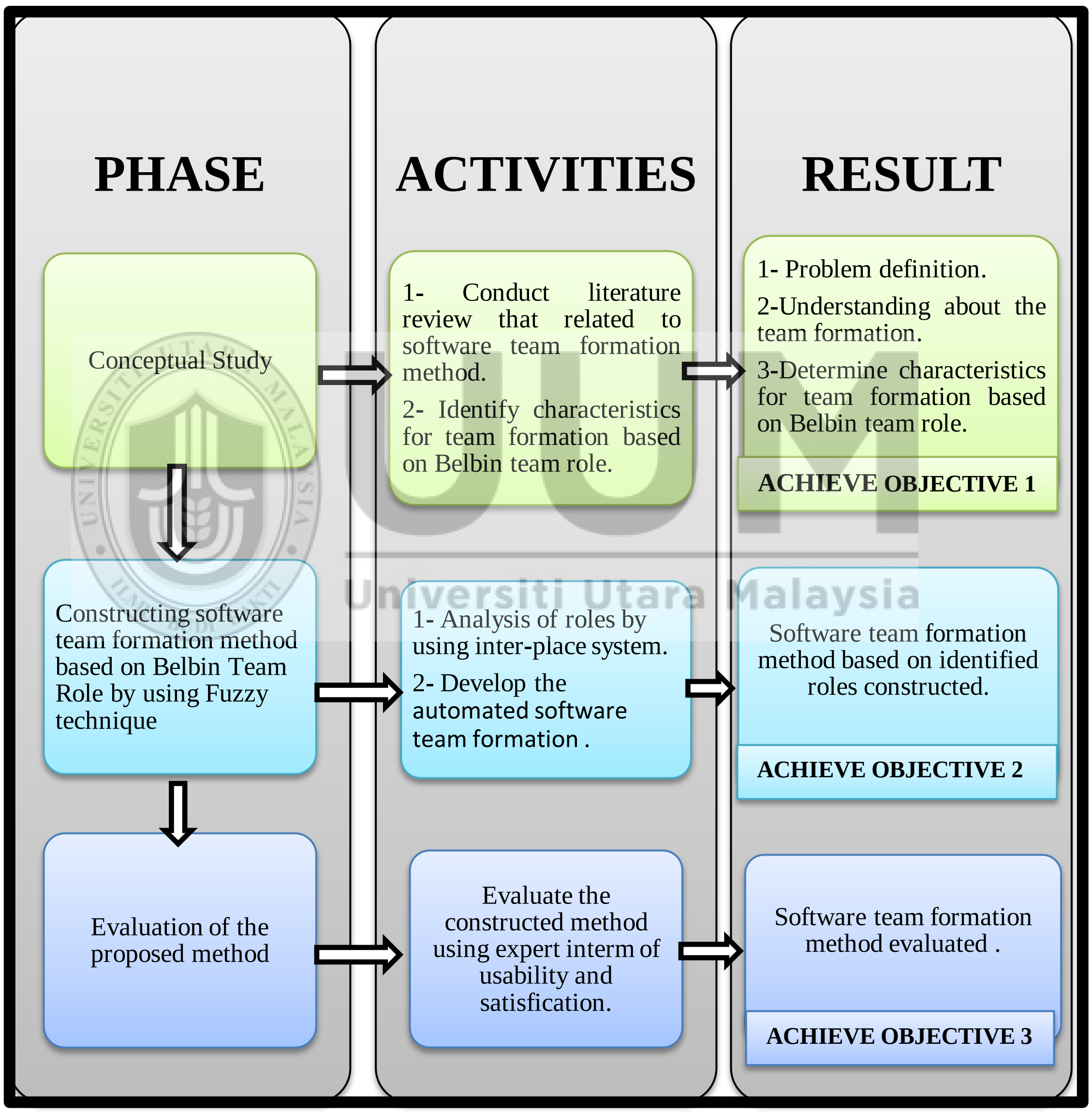

Figure 3.1. Research procedure

The detailed discussion for each phase involved will be discussed in the next section.

3.2 Phase 1 - Conceptual Study

This phase is to help the researcher in understanding the research study by conducting literature review, explain related terminologies and identify the characteristics required in forming team members based on Belbin Team Role. Based on the literature review, the study carefully defines the problem of this research study. Besides the review of existing techniques of team formation has been conducted so as to gain deeper understanding of possible techniques that can be used. Also, once the information is obtained, the next step was critically analyze existing techniques that lead to use of improved technique which can be embedded with the known team formation technique in software engineering team.

During software team formation, there are several criteria for team formations based on Belbin Team Role have been considered for decision makers to select which roles that suitable to form software team. Belbin Team Role was defined as a predisposition to behave, contribute and interrelate with others in a particular way (Belbin, 2012) and the roles represents Resource Investigator (RI), Completer-Finisher (CF), Co-ordinator (CO), Monitor Evaluator (ME), Implementer (IMP), Shaper (SH), Plant (PL), Team worker (TW) and Specialist (SP) (Aritzeta, 2005).

In this study the main characteristics based on Belbin team role to be chosen is Shaper or Chairman for leader role and plant for other team members as argued by Todd Jr. et al., (1998),, because Shaper and Plant roles they are consider necessary roles for a software engineering team as illustrated in section 2.8.

In this study, fuzzy technique was chosen because 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 method, each team can be guaranteed to have equal chances to perform effectively. This technique can facilitate decision makers when forming highly productive project teams (Syed-Abdullah et al., 2011). Finally the result of this phase is significant role for choosing team members for software team creation.

3.3 Phase 2 – Constructing automated software team formation method

The second stage in the study is the construction of an automated software team formation method Based on Belbin Team role by using fuzzy technique. This forms the most important part of this study. To build this model, it consists of two steps, this include:

i. Analysis of role characteristics.
ii. Construct automated software team formation method based on Belbin Team Role by using Fuzzy technique.

The detailed discussion for each step will be explained in the next sub section.

3.3.1 Analysis of role characteristics.

The characteristics for each member is identified based on data collection, through Belbin Self-Perception Inventory (SPI) questionnaire after obtaining the appropriate roles for the teams from the literature, that the most suitable roles to forming the team in software engineering are Shaper role, that include criteria like dynamic, challenging, thrives on pressure, driven and courage to overcome difficulties. And Plant role that include criteria like Creative, unorthodox, solves difficult problems, generates idea and imaginative. These two roles are most important role for forming software engineering team (Schoenhoff, 2001; Henry & Todd Stevens, 1999; Todd Jr et al., 1998) .

Fuzzy technique has been employed in order to prioritize the team role to choose team members. Fuzzy is appropriate in this study because Fuzzy is conceptually easy to understand, the mathematical concepts behind fuzzy reasoning are very simple. Fuzzy is a more intuitive approach without the far-reaching complexity. Fuzzy is flexible with any given system, it is easy to layer on more functionality without starting again from scratch, and Fuzzy is tolerant of imprecise data (Mathworks, 2014).

According to Zhao and Bose, 2002 there are numerous shapes for fuzzy (triangular, trapezoidal, Gaussian, bell), In this study triangular was used, because the membership degree calculations is linear, thereby facilitating high computational efficiency, in additional it is more visually understandable, due to the triangle simple to comprehend and computationally easy to calculate. This is significant since the purpose of the fuzzy is to help decision makers to form the teams (Miao, Hammell II, Hanratty, & Tang,2013)

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 mean that the teams have a important role. This technique can facilitate decision makers when forming highly productive project teams (Syed-Abdullah et al., 2011).

In order to analyze the role characteristics using Fuzzy technique, the steps involved can be organized as following:-

1. **Belbin Team Role questionnaire for team members.**

   The Belbin Self-Perception Inventory (SPI) is a behavior-based questionnaire. The responses, through the SPI, are evaluated by the Belbin Team Role system Inter-place. The outcome brings feedback in scripted and graphical form. The roles have been determined for each member based on Belbin Team Role and data collection using Belbin questionnaire. Appendix A shows Belbin Self-Perception Inventory (SPI) questionnaire. In this study, respondents for the questionnaire were software engineers that work in organization and work as a software engineering team. The validity and reliability of this questionnaire has been demonstrated in other studies such Todd Jr et al., (1998) , Schoenhoff, (2001) and Prescott & El-sakran, (2014).

2. **Identify the team roles from the previous study.**

   Belbin Team Role includes nine roles for software engineering team based on previous works. The roles are; Implementer (IMP), Plant (PL), Co-ordinator (CO), Specialist (SP), Monitor Evaluator (ME), Resource Investigator (RI), Team worker (TW), Shaper (SH) and Completer-Finisher (CF). In this study, the roles of shaper and planet are of particular interest to software engineering teams as a result of the effects of their characteristics (Todd Jr et al., 1998). Software engineering as a field of study entails the application of creative working solution to understand issues. The leadership and direction are involved for the team; creativity and intelligence by which concepts and ideas can be developed to solve more unconventional problems. These qualities embody in the Shaper and Plant, respectively.

3. **Applying fuzzy technique.**

The idea of using fuzzy logic in explaining vague or imprecise inputs was introduced in resemblance to human reasoning particularly the vagueness aspect of human reasoning (Strnad & Guid, 2010). It was precisely designed to generate a mathematical decision based on approximate information and uncertainties; fuzzy provides an alternative solution because of its closeness to real physical systems. According to Syed-Abdullah et al. (2011) explained that Fuzzy technique is suitable for team formation because this technique allow analyzing of imprecise data and classifying selected criteria. In this study MATLAB was used, because MATLAB provides functions, apps, and a Simulink block for analyzing, designing, and simulating systems based on fuzzy logic, also MATLAB are provided for many common methods, including fuzzy clustering and adaptive neurofuzzy learning, finally MATLAB lets you model complex system behaviors using simple logic rules, and then implement these rules in a fuzzy inference system (Mathworks, 2015).

3.3.2 Construct an automated software team formation method

At this phase, the fuzzy steps that were described in the above section was transformed to a method that can gather the data of team members by Belbin (SPI) questionnaire and form equal team based on the roles by using fuzzy technique, and identified characteristics based on Belbin team role. This method was deliver a decision making, assessing the data, and provides the user with the final result.

This method was serving as tools for team formation on random technique depending on the answering of Belbin questionnaire .Then using Fuzzy technique to form equal teams in industry group project based on Belbin Team Role. The following figure 3.2 illustrates the steps process.

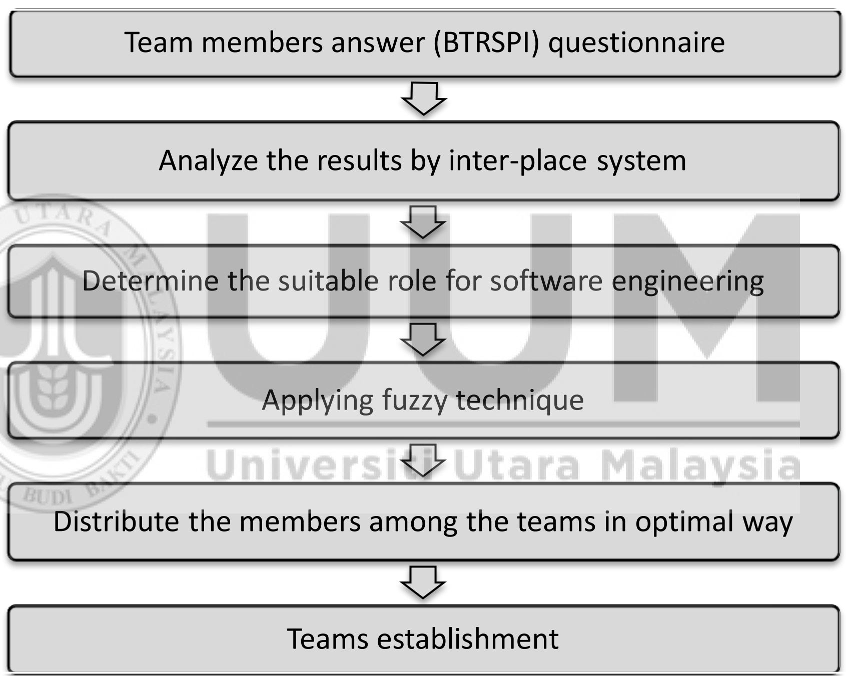

Figure 3.2. Steps of constructing method

3.4 Phase 3 – Evaluate the constructed method

This stage focuses on the assessment of the constructed automated software team formation method by using an expert review. Expert review is chosen because, it is an extremely useful tool to offer independent advice quickly and easily on a product or service, and as this method is quick to conduct it requires fewer budgets than others. Therefore it can be used multiple times throughout a project life-cycle (Nielsen, 2000). Expert review allows researcher to closely observe the data in a precise context; it can also be considered to be a good and strong research technique mostly when a holistic and comprehensive investigation is necessary (Yin, 2009; Zaidah & Zainal, 2007).

The usability questionnaire was designed using seven point likert scale from strongly agree to strongly disagree. On the other hands, the questionnaire for measuring the satisfaction of expert on the designed prototype was designed using 5 point likert scale and ranges from strongly disagree to strongly agree. The chosen likert scales were to measure the psychological attitudes of the users on the functionality of the prototype in a scientific way. Moreover, the designed questionnaires for both satisfaction of expert and the usability of the prototype contained two different sections; demographic questions and the questions on satisfactions and usability of the prototype respectively.

In this study, a software engineering in Asiacell Telecommunication Company in Kurdistan of Iraq was used. The company is selected because Telecommunication business is considered as one of the most dynamic and capital intensive industry, due to the fact that the Iraqi telecommunications sector is the most successful sectors open for investment (Ahmed & Doski, 2014). In this study, ten experts was chosen from the company, to evaluate the proposed automated software team formation method and the prototype usability. Previous works have demonstrated that five experts are enough to evaluate the prototype (Nielsen, 2000& Omar, Syed-Abdullah, & Hussin, 2012).

There are two types of evaluation were carried out, which are:

i) Prototype usability

As discussed in Section 3.3, the proposed method was transformed into a working prototype. This prototype was developed in order to verify the method. Expert review was carried out to evaluate the method, with regards to automated software team formation method based on Belbin Team Role By using Fuzzy technique. The first evaluation involved in this study is to evaluate the prototype usability, Usability questionnaire adapted from (Lewis, 1995) was used. This questionnaire can be seen in Appendix B. The following figure 3.3 explains the steps involved for prototype usability evaluation.

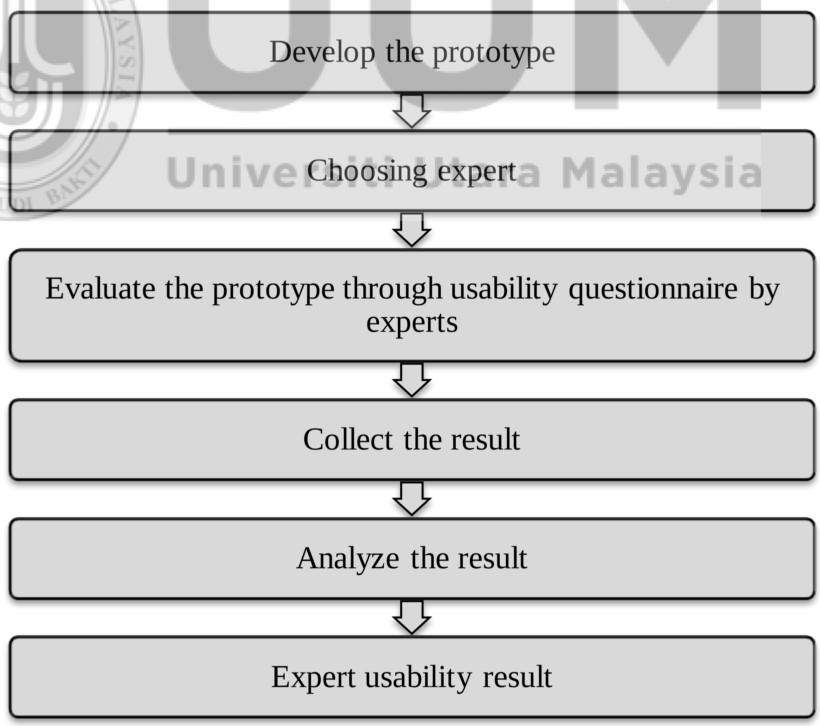

Figure 3.3. Steps of expert review for Prototype usability activities

ii) Expert review for evaluation of the proposed automated software team formation.

The second evaluation is to measure expert's satisfactions about applying Belbin Team Role to helping the managers to form equal and effective teams. The expert satisfaction questionnaire adapted from Tseng, Wang, Ku, & Sun, (2009). The questionnaire can be seen in Appendix C. The following figure 3.4 explains the steps involved for Expert satisfaction for proposed software team formation prototype.

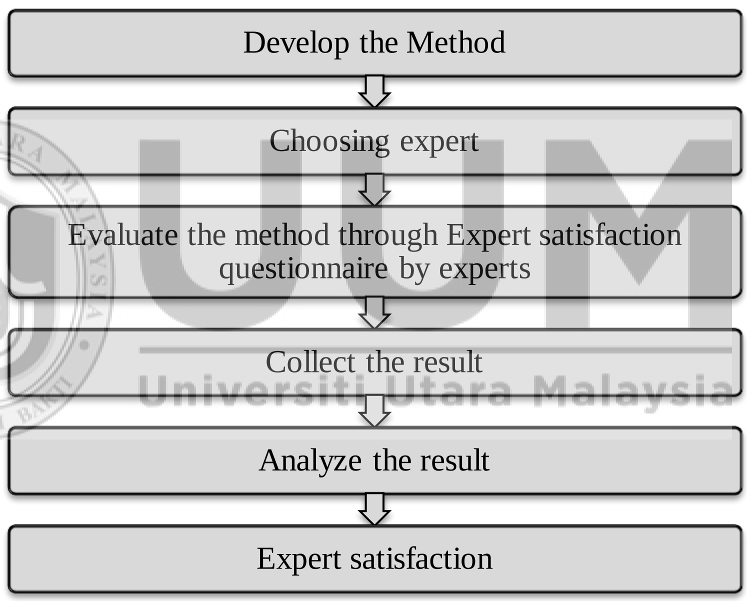

Figure 3.4. Steps of expert review activities

3.5 Sampling Technique

This study uses non probability sampling, particularly purposive sampling. Purposive sampling technique is a method of sampling where the researcher has criteria or particular purpose of the sample to be studied. It helped a lot because the selection of subjects was made based on the needs of this study and it represents the population in this study well (Lavrakads, 2008).On that basis, the targeted population of this study are the software engineer from Asiacell telecommunication company in (KRG).

Expert review was applied to evaluate the automated software team formation method. The automated software team formation method was applied through system prototype at Asiacell Telecommunication Company. The selected company had experience in software developing projects for about 10 years. The researcher initiated contact with human resource department managers for this research purpose and was granted permission to conduct case study accordingly.

To start, a group of software engineer was identified to participate in the case study. A total of 12 software engineer were selected based on their current job scope, role, and contribution in previous software development projects completed for the company. The researcher then applied automated software team formation method. A briefing was then conducted for the selected software engineer to explain about the research, the research objectives, the automated software team formation method, the Belbin team role, the outcomes expected. And BTRSPI was introduced and highlighted; this step was required to ensure the participants understand the BTRSPI concept and how to answer the SPI questioner. Data gathering information activity was completed in one week time.

The researcher also communicated to the company's software engineering manager to select software development projects, in same level with one was completed by manually selected team, on the second week the automated software team formation method was filled with the selected software development project chosen from the previous week. Also based on the input from the company software engineering department manager, a total teams members and project completion estimated to complete in three weeks. The software engineering department Manager then made the final judgment on the teams to deliver the project. The software development project then was given to the all teams by the software engineering department manager. A two week of ten days working days was also given to the teams to complete the project.

The researcher observed and noted the team process, team effectiveness, and the performance level of all teams with advised from the software engineering department manager. Performance level of team was measured based on managers' satisfaction during one week. All in all, a total of one month was taken to complete the case study activity. The results of this activity are to be discussed in the chapter five Evaluation Results and Discussion.

3.6 Summary

This chapter provides the stages of methodology, beginning with the conceptual study and the constructing software team formation for software engineering based on Belbin Team Role by using fuzzy technique, evaluation of constructed prototype and finally sampling technique.

CHAPTER FOUR

DEVELOPMENT OF AN AUTOMATED SOFTWARE TEAM FORMATION USING FUZZY TECHNIQUE

4.1 Overview

This chapter discusses Belbin Team Roles in software engineering and software team formation using a fuzzy technique. The chapter describes the steps involved in a fuzzy algorithm for team formation based on Belbin Team Roles in software engineering. Hence, the method development is also explained in detail in regards to studying the team formation of Belbin Team Roles using a fuzzy technique.

4.2 Belbin Team Roles in Software Engineering

The Belbin Team Role method has been described as an approach towards achieving the collective success or failure of a software engineering team (Fatahi & Lorestani, 2010). The Belbin Team Role Self-Perception Inventory (SPI) provides an effective means to assess how individuals behave in a team environment (Rajendran, 2005). Thus, Belbin's (SPI) identifies individual tendencies towards multiple roles. On the other hand, there are no 'good' or 'bad' roles, and team roles are not equivalent to personality types (Beranek et al., 2005). In the context of this study, an automated software team formation method based on Belbin Team Roles using a fuzzy technique was designed to mitigate the problem of team formation.

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, Plant, Resource Investigator, Evaluation Monitor and Coordinator (Schoenhoff, 2001; Beranek et al., 2005; Ounnas et al., 2008). Others are Complete Finisher, Team Worker, Specialist and Implementer (Fatahi & Lorestani, 2010; Beranek et al., 2005; Ounnas et al., 2008; Henry & Todd Stevens, 1999). However, previous studies have revealed that the Shaper and Plant Team Roles, as shown in Table 4.1, are the most important and useful among the Belbin Team Roles in software engineering (Fatahi & Lorestani, 2010; Beranek et al., 2005; Ounnas et al., 2008; Henry & Todd Stevens, 1999).

Table 4.1

Analysis of Belbin Team Roles in Software Engineering

Author	**SH**	**PL**	**RI**	**ME**	**CO**	**CF**	**TW**	**SP**	**IMP**
Todd (1998)	Yes	yes	No	No	No	No	No	No	No
Henry & Todd Stevens (1999)	Yes	Yes	No	No	No	No	No	No	No
Schoenhoff (2001)	Yes	yes	No	No	No	No	No	No	No
Rajendran (2005)	Yes	Yes	No	No	No	No	No	No	No
Doherty (2005)	Yes	Yes	No	No	No	No	No	No	No
Beranek, Zuser & Grechenig,(2005)	Yes	No	No	No	No	No	No	No	No
Ounnas, Davis & Millard (2008)	Yes	Yes	No	No	No	No	No	No	No
Wasiak & Newnes (2008)	Yes	Yes	No	No	No	No	No	No	No
Licorish, Philpott, & MacDonell (2009)	Yes	Yes	No	No	No	No	No	No	No
Fatahi & Lorestani (2010)	Yes	Yes	No	No	No	No	No	No	No

Table 4.1 represents a meta-analysis of nine Belbin Team Roles on a software engineering team, while the Shaper and Plant have been discussed in Section 2.8 of this dissertation. The yellow color represents the argument of the previous studies that support the use of both Shaper and Plant as significant roles in a software engineering team based on Belbin Team Roles.

In this study, the Shaper and Plant in Belbin Team Roles were chosen based on the research and experiments that different researchers made in the field of software engineering with Belbin Team Roles. The roles of Shaper and Plant in Belbin Team Roles are significant to the software engineering team; hence the Shaper role is used for the leader while the Plant role is used for the programmer (Rajendran, 2005; Ounnas, Davis, & Millard 2008; Wasiak & Newnes, 2008).

The Shaper role is a type of leader but has a completely different personality and managerial style than a Chairman. A Shaper is a slave driver, questioning members to find the best approaches to problems. This role leads the team by stimulating the members to challenge inertia, ineffectiveness, and complacency (Henry & Todd Stevens, 1999, P.25).

Shapers tend to be nervous, extroverted, competitive and argumentative, just to name a few of their stronger characteristics (Henry & Todd Stevens, 1999). In addition, other researchers confirm that the role of a Plant is more suitable to the job of a software engineer, Since the Plant role is linked to ‘genius, imagination, intellect, and knowledge’ (Licorish et al., 2009, P.4), personality traits, individuals occupying this role might be capable of generating rapid and innovative solutions to software problems, making them most suitable as programmers (Licorish et al., 2009; O'Doherty, 2005), and the Belbin Shaper role is a leadership role (Beranek et al., 2005).

4.3 Belbin Team Role Self Perception Inventory (BTRSPI)

This study using Belbin team role to determine the member's behavior preference. During studies on team roles Belbin developed a psychometric test called Self Perception Inventory (SPI). The (SPI) is a questionnaire used as indicator for determining an individual's behaviour preference. The test consists of eight sections with ten questions for each section. For each section individuals allocate a total of ten point based on how they fell about questions as can be seen in Appendix A. There are several studies in software engineering context that have considered the validity of Belbin work (Beranek, Zuser, & Grechenig, 2005; Jones, 1999; Rajendran, 2005), have all lent confirmation of Belbin finding.

According to previous section, the most important roles in Belbin team role for software engineering team are Shaper and Plant roles; all respondents' reports that received from inter-place system shows the roles value for each members as a bar graph, The bar graph in the report shows the team roles in order from highest to lowest, and shows the team roles in order of preference. Some members have an even spread of team roles whilst others may have one or two very high and very low team roles. An individual does not necessarily show all nine team role behaviors. All 12 respondents reports for the respondent shows in appendix D.

4.4 Automated Software Team Formation Method Using Fuzzy Technique

As discussed in Chapter 3, this research aims to develop a software engineering team formation method based on Belbin Team Roles using a fuzzy technique. In doing so, several steps are involved, as shown in Figure 4.1.

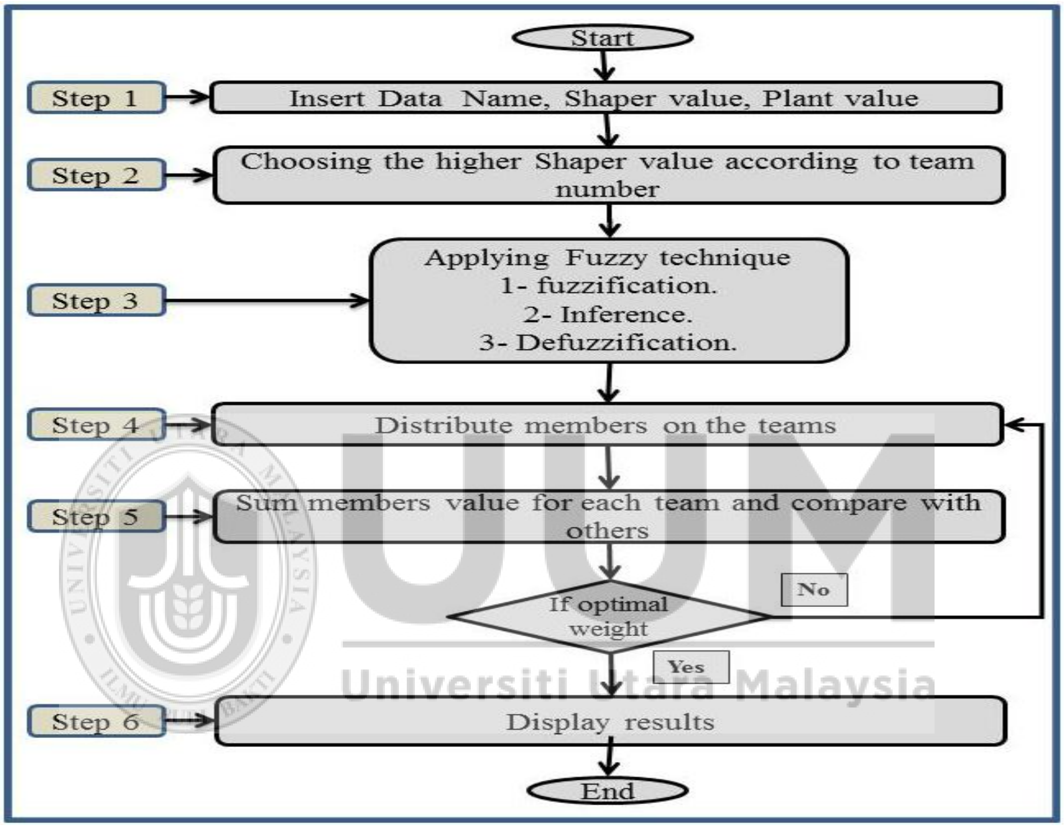

Figure 4.1. Steps for software engineering team formation method by fuzzy technique

The systematic steps involved in this method are as follows:

Step 1:

Several data are required to use this method, which include the member's name and Shaper and Plant values, as recommended by the literature. The value is a numeric value between 0 and 100. These two roles' values are obtained from the BTRSPI report. An example of the reports is shown in Appendix D.

Step 2:

Based on the Shaper value, choose the individual with the higher Shaper value to appoint as a leader in the team.

Step 3:

Applying fuzzy technique involves three steps which are fuzzification, Inference Engine and Defuzzification. Figure 4.2 shows the diagram depicting inputs, rule base and outputs.

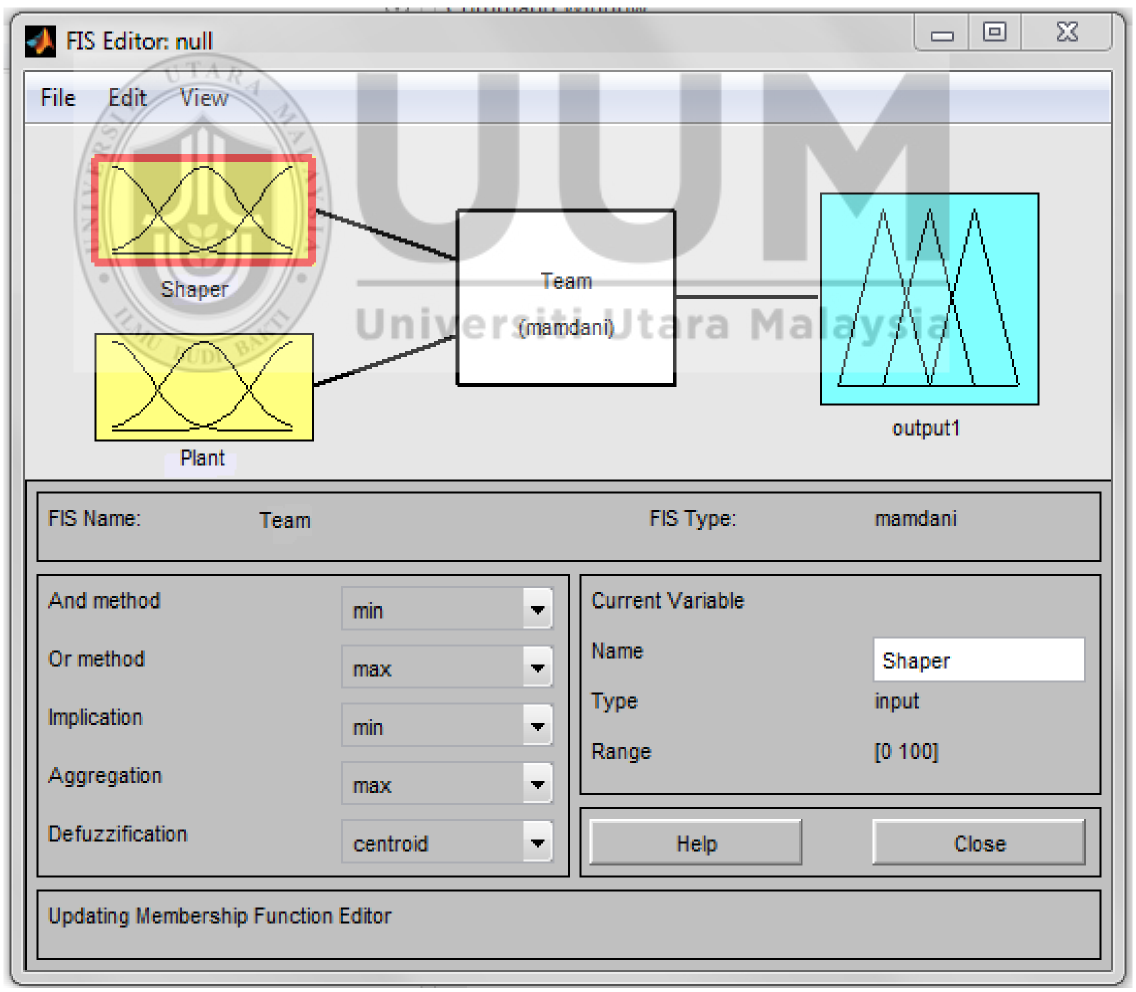

Figure 4.2. Team diagram depicting two inputs, rule base, one outputs.

i) Fuzzification

During fuzzification, the major slopes are converted from numerical values into degrees of membership according to the input membership functions, as shown in figure 4.3. The range of membership is between (0-100), if the input between (0-40) the degree membership of inputs is Low, and when the input between (20-80) the degree membership of input is Normal, otherwise the degree membership of input is High when the range between(60-100).

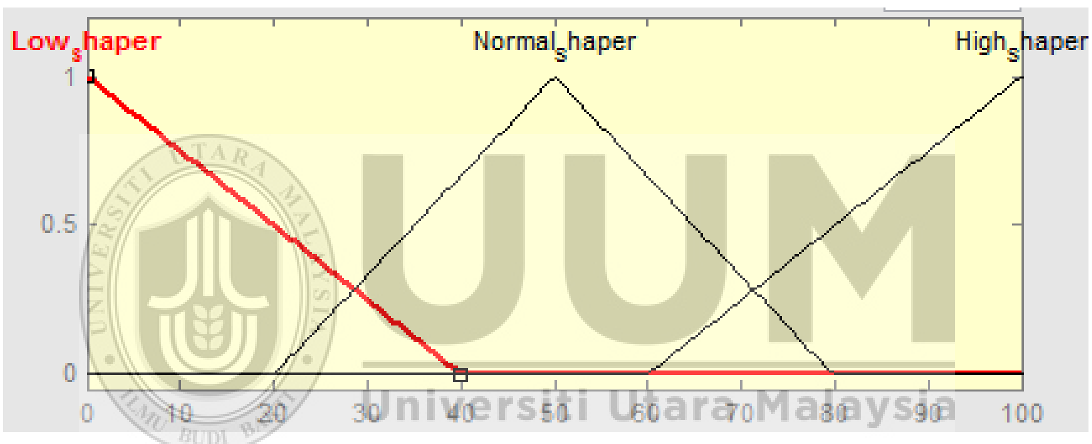

Figure 4.3. Membership functions for input fuzzification

According to Zhao and Bose (2002) there are numerous shapes for fuzzy which are, triangular, trapezoidal, Gaussian and bell, in this study, triangular was used, because the membership degree calculations is linear, thereby facilitating high computational efficiency, in additional it is more visually understandable, due to the triangle simple to comprehend and computationally easy to calculate. This is significant since the purpose of the fuzzy is to help decision makers to form the teams (Miao, Hammell , Hanratty, & Tang,2013)

ii) Inference Engine

After the inputs are fuzzified for automated software team formation rules are constructed. There are 14 rules applied as follows:

1- If (Shaper is Low-Shaper) and (Plant is Low-Plant) then (Output1 is Low membership) (1).

2- If (Shaper is Low-Shaper) and (Plant is Normal-Plant) then (Output1 is Low membership) (1).

3- If (Shaper is Low-Shaper) and (Plant is High-Plant) then (Output1 is Normal membership) (1).

4- If (Shaper is Normal-Shaper) and (Plant is Low-Plant) then (Output1 is Low membership) (1).

5- If (Shaper is Normal -Shaper) and (Plant is Normal -Plant) then (Output1 is Normal membership) (1).

6- If (Shaper is Normal-Shaper) and (Plant is High -Plant) then (Output1 is High membership) (1).

7- If (Shaper is High-Shaper) and (Plant is Low -Plant) then (Output1 is Normal membership) (1).

8- If (Shaper is High -Shaper) and (Plant is Normal -Plant) then (Output1 is High membership) (1).

9- If (Shaper is High-Shaper) and (Plant is High -Plant) then (Output1 is High membership) (1).

10- If (Shaper is Normal -Shaper) or (Plant is Normal -Plant) then (Output1 is Normal membership) (1).

11- If (Shaper is Normal -Shaper) or (Plant is High -Plant) then (Output1 is High membership) (1).

12- If (Shaper is High -Shaper) or (Plant is Normal -Plant) then (Output1 is High membership) (1).

13- If (Shaper is High -Shaper) or (Plant is High -Plant) then (Output1 is High membership) (1).

14- If (Shaper is High -Shaper) or (Plant is not High -Plant) then (Output1 is High membership) (1).

The figure 4.4 shows an example of inputs and outputs according to the rules.

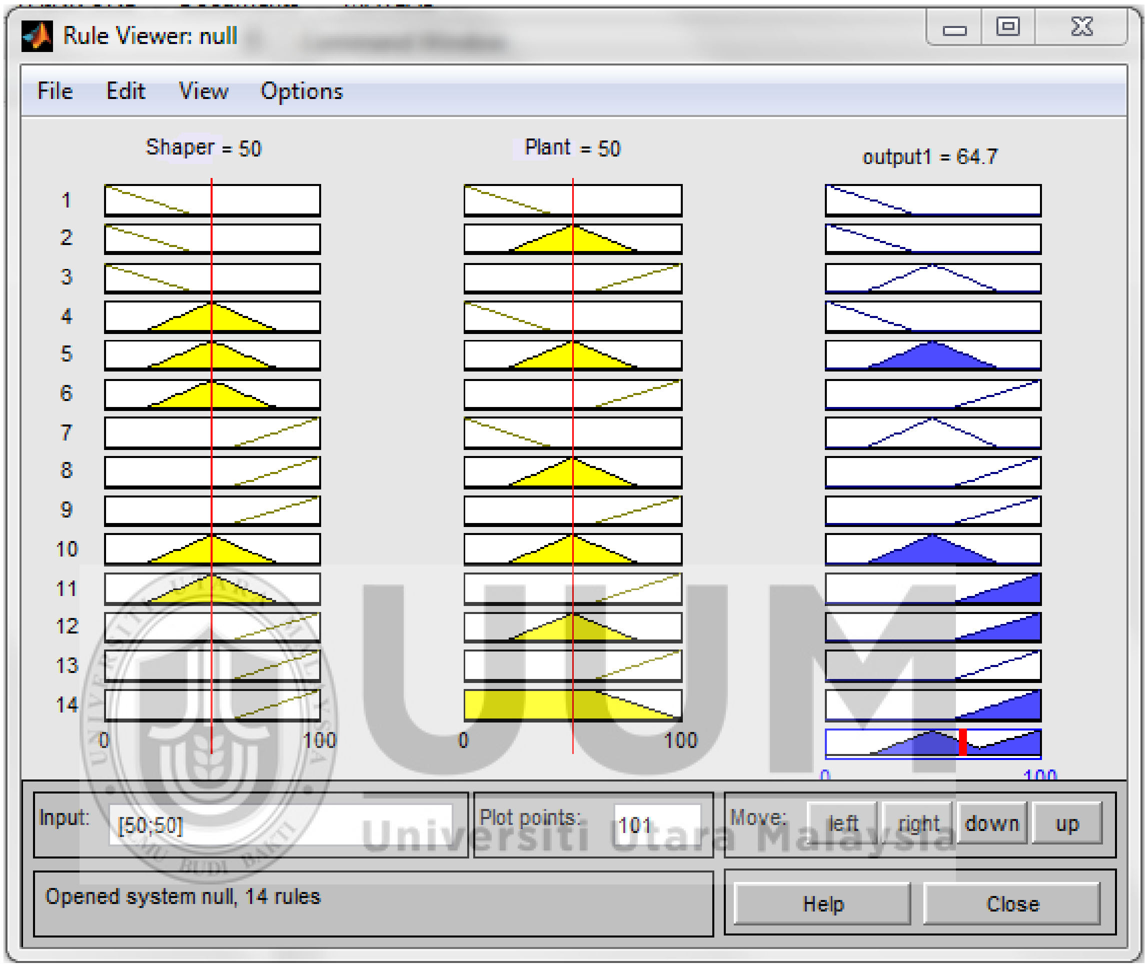

Figure 4.4. Represent of team rule

iii) Defuzzification

The final part of applying fuzzy is converts the fuzzy result into crisp value, crisp value refer to real number. This step focuses on the membership functions used. The output will be converted to crisp values in accordance with the three triangular membership functions, “low”, “normal” and “high” in Figure 4.5.

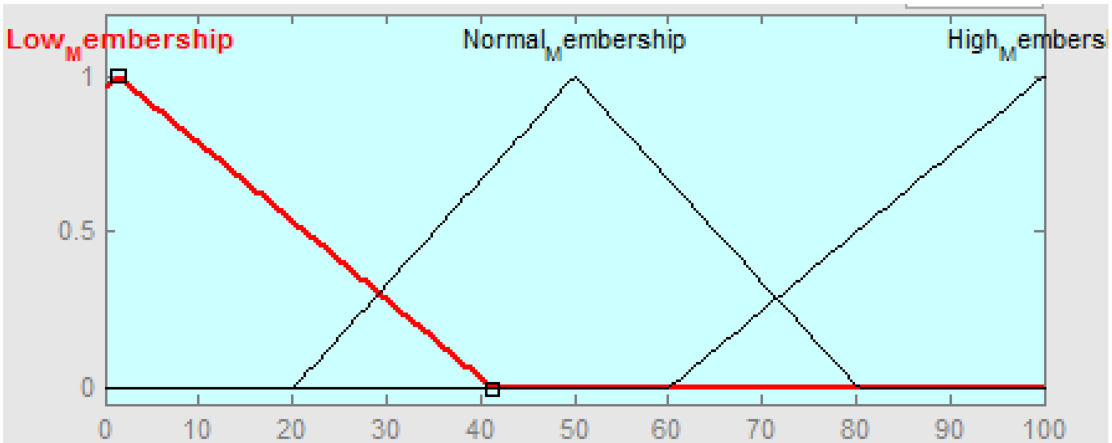

Figure 4.5. Membership functions for output defuzzification

There are many Defuzzification strategies such as centroid, Bisector, Mean of maximum, smallest of minimum and largest of maximum. This study used centroid strategy because the centroid method is usually essential for the systems (Rodjito, 2006).

Step 4:

The decision would be made by distributing members on the teams. Hence, each team has a leader that is determined from Step 2.

Step 5:

The members in each of the teams would be added together and compared to each another. If the total weight for the teams equal, the process moves to the next step. Otherwise, the process returns to the previous step. The process of distributing the leader and members among the teams is shown in Figure 4.6.

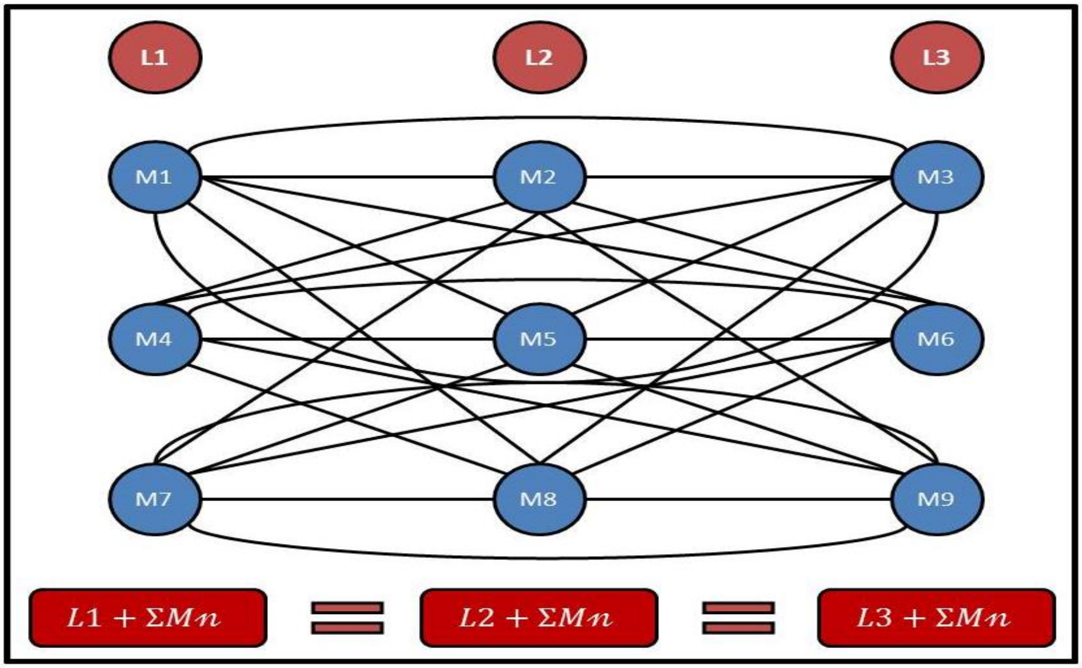

Figure 4.6. Distributing member's process

For example, there are three teams, and each team consists of four members. In the figure above, the team leader according to the Shaper value is represented by L1, L2 and L3, and the members according to Plant value is represented by M1 to M9. The weight of each leader was chosen depending on higher shaper value with three member's weights gathers for every team. The summation weight for each team is compared with the weight other teams to check the difference between them. If there is a big difference between them, teams change the members around in and out of different weight, and so on. Otherwise, the prototype displays the results.

Step 6:

In this step, the teams that have the optimal equal weights will be formed, and the team members' names and each leader will be displayed.

4.5 Prototype Development and their Operations

In order to verify the method, a prototype was developed by using a Visual Studio package and C# programming language towards developing an automated software team formation method based on the Belbin team role using a fuzzy technique. Figure 4.7 shows the first page of the prototype. On the first page, the user (manager) will enter the team size and team number. In addition, the team size that was used in this study was three to six members, as this is the ideal team size to perform better in a small or medium-scale software project size (Zarzu, 2011).

Figure 4.7. Homepage of the prototype

Next, the user needs to insert the team members' names, Shaper and Plant values. After completing entering the information, user can click 'Run' button. The Shaper and Plant values are based on the result of BTRSPI reports as explained in Section 4.4. This process is shown in Figure 4.8.

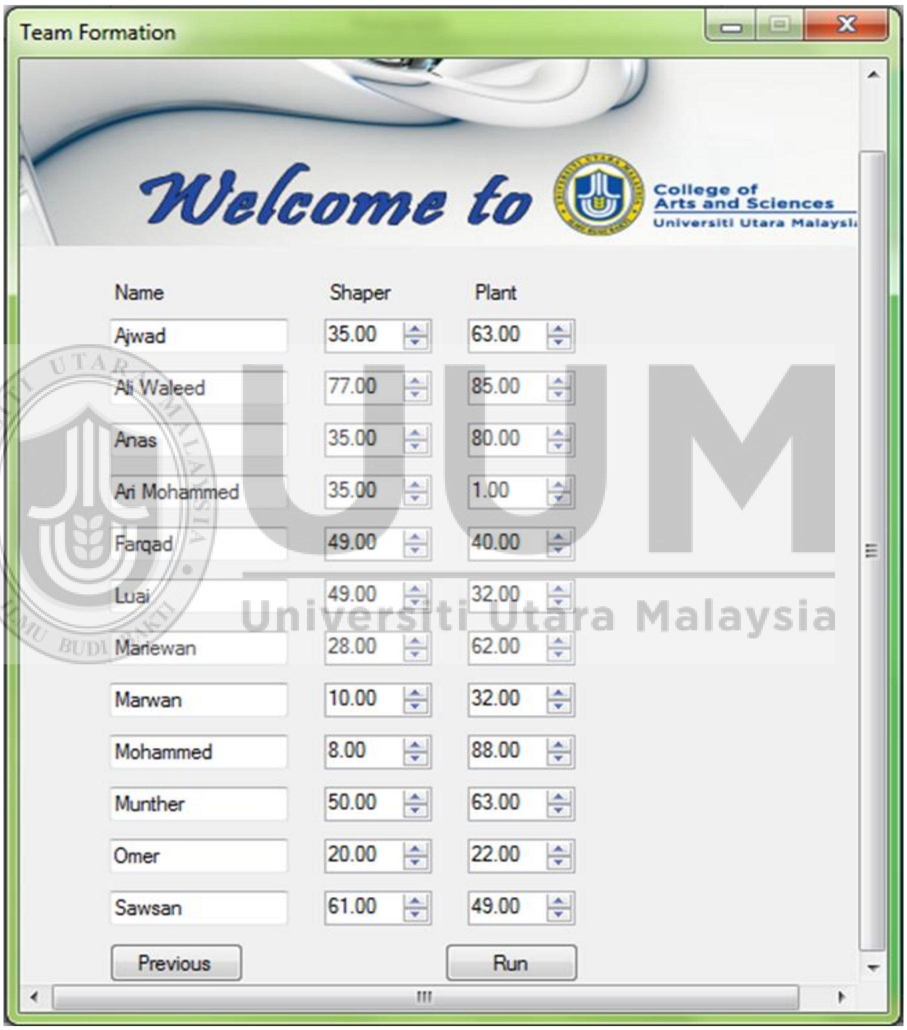

Figure 4.8. Shaper and Plant Team Roles Values

If there is any missing information, the error message is displayed to inform the user to complete the information. Therefore, the prototype displayed the total weight of the perspectives of all the participants on the interface, as revealed in Figure 4.9.

Figure 4.9. Generated Total Weight of the Participants

Based on Figure 4.9, the prototype will display the team member's name, leader and the total weight for each team. In order to validate the method used, an expert review was carried out in the industry setting, and a discussion of the result is explained in Chapter 5.

4.6 Summary

This chapter has discussed the argument of previous researchers in the domain of Team Roles formation in software development. The study reveals that of all the nine Team Roles in software industries, only Shaper and Plant are important for the study on Belbin Team Roles for software engineering. Besides that, the study comes up with the method for the software team formation by using a fuzzy technique and the approach for developing the prototype. The subsequent chapter gives a detailed discussion on the evaluation of the result of an analysis on the expert evaluation of the developed prototype.

CHAPTER FIVE

EVALUATION RESULT AND DISCUSSION

5.1 Overview

This chapter discusses the evaluation results and discussion that has been carried out among the experts from the industrial setting. Two set of questionnaires were designed to evaluate the team formation method constructed as discussed in Chapter Four. At the first stage, the experts which are project managers were asked to evaluate the prototype usability to ensure that the constructed team formation method is usable. After that, the experts were used the proposed method to form their team and asked whether they satisfy with the team proposed by the prototype.

5.2 Evaluation Technique

The evaluation of the system was achieved after the prototype has been developed so as to verify the level of the usability of the prototype and satisfaction of the team formation method constructed to the users. This was done by deploying the prototype to ten selected experts in the field of software engineering. The evaluation of the prototype and the method were done through the two set of questionnaires which were distributed to the experts in the software industries. All the participants were given a brief description of the prototype and were allowed to explore the system with the expectation of measuring their level of usability of the prototype and their satisfaction for the team formation method.

5.3 Data Analysis

The two set of questionnaires (usability and satisfaction) that were given to each of the experts were returned to the researcher after the system had been extensively explored and subject to the analysis using the SPSS version 20. The analysis was carried out purposely to measure the level of usability of the prototype and the satisfaction of the expert to the method as revealed in the subsequent sections.

5.3.1 Result of Usability of the Prototype

The results of the automated software team formation based on Belbin team role using fuzzy technique prototype usability are carried out using descriptive statistics. The details are discussed in the next sub section.

5.3.1.1 Demographic Profile for usability

This section describes the demographic profile of the ten experts that took part in this study. The profiles consist of age, gender, educational background and teamwork experience. The frequency distribution of respondents that took part in the usability evaluation of the developed prototype on the teamwork formation shows that there are no missing data while collecting and key-in the dataset in to the statistical package as shown in Table 5.1.

Table 5.1

Data Preparation during Usability Test of Prototype

	Age	Gender	Educational Background	year of teamwork experience
Valid	10	10	10	10
Missing	0	0	0	0
Mean	3.20	1.00	2.00	2.00
Std. Deviation	1.033	.000	.000	.667
Minimum	2	1	2	1
Maximum	5	1	2	3

Moreover, the results of the analysis during the usability test considers the frequency distribution of demographic variable and shows that 20% of the respondents falls in the age range of 26-30 years as shown in Table 5.2.

Table 5.2

Descriptive Statistics of Participants' Demographic Profiles for Usability Testing

Variable/ Factors	Frequency	Percent	Valid Percent	Cumulative Percent
Age				
26-30	2	20.0	20.0	20.0
31-35	6	60.0	60.0	80.0
41-45	2	20.0	20.0	100.0
Total	10	100	100	
Gender				
Male	10	100.0	100.0	100.0
Female	0	0	0	0

Total	10	100	100	
Educational Background				
Bachelor degree	10	100.0	100.0	100.0
Total	10	100	100	
Year of Experience				
below 5 years	2	20.0	20.0	20.0
5-10 years	6	60.0	60.0	80.0
above 10 years	2	20.0	20.0	100.0
Total	10	100	100	

Besides, 60% of the respondents have their age ranges between 31-35 years and 20% have their age ranges from 41-45years. This implies that the experts that took part in the usability testing of the designed prototype are young, agile and helpful in determining the usability of the designed prototype for team formation in software development. In addition, the analysis as shown in Table 5.2 implies that the entire ten experts that took part in the analysis of usability testing were male. Considering the educational background of the expert that were engaged during the usability testing of the prototype, the entire participants have degree as their educational background as revealed in Table 5.2.

Lastly, the analysis considered the year of teamwork experience of the respondents and found that 20% of the respondents possess less than 5 years' experience as shown in Table 5.2. Indeed, 60% of the respondents have 5-10 years of experience in the software development and 20% of the respondents have more than 10 years of experience in software team formation in the software development as shown in Table 5.2.

5.3.1.2 Instrument Reliability

As discussed in Chapter Three, the usability questionnaire was adapted from (Lewis, 1995). The reliability and validity of the questionnaire was demonstrated in other studies (Ryu, 2005; Tullis & Stetson, 2004; Kingori, 2011; Viitanen et al., 2011) . In this study the reliability of this questionnaire with Cronbach Alpha is 0.9. this demonstrate that the questionnaire is reliable which is greater than 0.7 (Andrew, Pedersen, & McEvoy, 2011)

Table 5.3 describes the number of the respondent, the mean and the STD deviation of the usability of the designed prototype for the teamwork formation in software engineering as shown in section B of the questionnaire.

Table 5.3

Descriptive Statistic of Usability of the Prototype

	Question	N	Mean	Std. Deviation
1	Overall, I am satisfied with how easy it is to use this system.	10	3.30	2.003
2	It is simple to use this system.	10	3.10	2.378
3	I can effectively complete my work using this system.	10	3.40	2.271
4	I am able to complete my work quickly using this system.	10	3.30	2.214
5	I am able to efficiently complete my work using this system.	10	3.50	2.068
6	I feel comfortable using this system.	10	3.80	2.098
7	It was easy to learn to use this system.	10	3.10	2.378
8	I believe I became productive quickly using this system.	10	3.50	1.958

9	The system gives error messages that clearly tell me how to fix problems.	10	4.10	1.729
10	Whenever I make a mistake using the system, I recover easily and quickly.	10	3.30	1.636
11	The information provided with this system is clear.	10	3.60	1.713
12	It is easy to find the information I need.	10	3.50	2.415
13	The information provided with the system is easy to understand.	10	3.40	2.171
14	The information is effective in helping me complete my work.	10	3.60	1.647
15	The organization of information on the system screens is clear.	10	3.50	2.321
16	The interface of this system is pleasant.	10	3.50	2.173
17	I like using the interface of this system.	10	3.30	1.703
18	This system has all the functions and capabilities I expect it to have.	10	3.70	1.889
19	Overall, I am satisfied with this system.	10	3.40	2.591

The total number of 19 questions was as during the expert evaluation of the usability of the designed prototype for the software team formation in the software industry. Therefore, the summation of the all the means (65.9) are divided by the 19 to arrive at 3.47 which is almost equal to 57.8. This implies that the measure of usability of the designed prototype for the team formation of software engineering is agreed altitude, indicated that the level of interaction of the prototype is high.

In conclusion the questionnaire result showed that most of the managers agreed that the prototype was easy to use and applied in their company and the process to apply also is not complicated. They also approved that the team formation method can help them to complete team formation based on Belbin team role. They feel comfortable to use the method because it was easy to learn. Majority of the managers. Overall, they are satisfied with the proposed automated software team formation.

5.3.2 Result of Satisfaction of the Respondent to the Proposed Method

The expert satisfaction to the designed method for software team formation in telecommunication industry was done as following.

5.3.2.1 Demographic Profile

The frequency distribution of respondents that took part in testing the satisfaction of the respondents on the designed prototype for the team formation in software engineering reveals that there are no missing data while collecting and key-in the dataset in to the statistical package and shown in Table 5.4.

Table 5.4

Data Preparation Satisfaction of Respondent on the Designed method

		Age	Gender	Educational Background	year of teamwork experience
Valid		10	10	10	10
Missing		0	0	0	0
Mean		3.50	1.00	1.80	2.00
Median		3.00	1.00	2.00	2.00
Mode		3	1	2	2
	25	2.75	1.00	1.75	1.75
Percentiles	50	3.00	1.00	2.00	2.00
	75	5.00	1.00	2.00	2.25

Considering the age of respondent during the evaluation of satisfaction of expert on the designed prototype revealed that 20% of the respondents have their age ranges between 26-30 years as shown in Table 5.5.

Table 5.5

Descriptive Statistics of Participants' Demographic Profiles.

Variable/ Factors	Frequency	Percent	Valid Percent	Cumulative Percent
Age				
26-30	2	20.0	20.0	20.0
31-35	4	40.0	40.0	60.0
36-40	1	10.0	10.0	70.0
41-45	3	30.0	30.0	100.0
Total	10	100	100	
Gender				
Male	10	100.0	100.0	100.0
Female	0	0	0	0
Total	10	100	100	
Educational Background				
diploma	2	20.0	20.0	20.0
Bachelor degree	8	80.0	80.0	100.0
Total	10	100	100	
Year of Experience				
below 5 years	2	20.0	20.0	20.0
5-10 years	6	60.0	60.0	80.0
above 10 years	2	20.0	20.0	100.0
Total	10	100	100	

It shows in Table 5.5 that 40% of the respondents on the satisfaction of the method are in the age range of 31-35 years, while only 10% has their age range between 36-40 years and 30% of the respondents are in the range of 41-45 years. Besides that, the entire ten experts that took part in the analysis of satisfaction of the designed method were male.

Regarding to the educational background, 20% of the respondents possess diploma and 80% of the respondents have educational background at the Bachelor degree, while evaluating the educational background of the respondent towards satisfaction of the designed method as shown in Table 5.5. Furthermore 20% of the respondents in the user satisfaction testing have teamwork experience below 5 years while 60% of the respondents claimed to have teamwork experience between 5-6years. Conclusively, 20% of the respondents in the user satisfaction testing have teamwork experience above 10 years.

5.3.2.2 Expert Satisfaction Results

In this study, to measure whether the automated software team formation method developed using fuzzy technique can satisfy the experts from industry; an expert review was carried in Asiacell Telecommunication Company. There were 12 software engineers involved in this study. They were required to follow the steps given:

1. The 12 software engineers from Asiacell Telecommunication Company asked to fill the (SPI). (SPI) can reach through the website (www.belbin.com), the test take amount 15 to 20 minute, and all respondents reports can be seen in Appendix D. The

management of the company supported that 12 software engineer from the software engineering department was filled the (SPI) questionnaire as shown in Appendix E.

2. After entering the result of the team members SPI to the method, and the teams formed based on the method, the experts from the company, asked to review about the ability of the method to form a team through a satisfaction questionnaire for applying the method in telecommunication industry.

3. Ten experts from the company after reviewing the method, answer the questionnaire of team work satisfaction, and table 5.6 describe about the results.

Table 5.6 describes the number of the respondent, the mean and the standard deviation of the expert satisfaction of the designed method for an automated team formation in software engineering as shown in section B of the user satisfaction's questionnaire.

Table 5.6

Descriptive Statistic of Expert Satisfaction of the Prototype

	Question	N	Mean	Std. Deviation
1	The members like working in collaborative group with them teammates.	10	4.10	.316
2	The members like solving problems with them teammates in group projects.	10	4.30	.675
3	Interacting with the other members can increase member's motivation to learn.	10	3.90	.738

4	The members have benefited from interacting with them teammates.	10	4.30	.483
5	The members have benefited from them teammates' feedback.	10	4.20	.789
6	The members enjoy the experience of collaborative learning with them teammates.	10	3.90	.738
7	Work within a balanced group encourages creativity.	10	3.80	1.135
8	Working with the team has better project quality than working in individual.	10	4.30	.675
9	Team members are sharing knowledge during the teamwork processes.	10	4.10	.568
10	The members gain collaboration skills from the teamwork processes.	10	4.40	.516

The total number of 10 questions was asked during the expert satisfaction of the designed method for the teamwork formation in the software industry. Therefore, the summation of the all the means (41.3) are divided by the 10 to arrive at 4.13 which is almost equal to 82.6. This shows that the expert satisfaction of the designed prototype for the team formation of software engineering is agreed altitude and indicated that the level of expert satisfaction is high.

Based on the results, the managers have highest confidence that the team formation method developed can increase collaboration skills among team members; this can be seen that the mean achieved is 4.40, In addition, the team members can have benefited each other as seen the mean reached 4.30. Moreover the manager satisfy with applying the method, which lead to the ability of team members to solve the problem within group project, thus, driving the team to have a better project quality, as the result of the means gathered 4.30. This indicated that an automated software team formation method developed, can help to increase the collaboration and interaction among team members, and encourages creativity, which leads to better software quality, as noted by the experts. In conclusion based on the expert satisfaction questionnaire result, working within a team leads to better performance rather than individual.

5.4 Summary

This chapter has discussed the evaluation of the automated software team formation. The evaluation was examined by considered both usability of the prototype and the user satisfaction on the method. The analysis showed that the method fulfills the requirements needed by the users for adoption in the software industry where teamwork formation is required for decision making.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Overview

This chapter focuses on the study summarization and reviewing the findings that were found from the study and presenting research contribution to achieve goals according to the problem statements and objectives. Also, the chapter shows the limitations and the direction of the future works.

6.2 Revisit the Research Objectives

The main aim of the research was to develop an automated software team formation method based on Belbin team role using fuzzy technique. In order to achieve the main objective, this section presents how this research successfully achieved its objectives.

Objective 1: To identify the characteristics required to form efficient software team members based on Belbin Team role.

The first objective was to identify the significant roles for team formation in software engineering based on Belbin team role in industrial setting. The results obtaining from the discussion of literature review was identified the important roles. In this study, two Belbin team roles was identify as an important roles for software engineering team as recommended by the previous work, these two roles are Shaper and Plant, This is because the availability of these two roles is able to determine effective teams in software organization. Since the Belbin shaper role related to challenging, dynamic, thrives on pressure, has driven and courage to overcome obstacles is playing leader role, and the plant role in Belbin team role is the designer, problem solving and innovator, therefor it is suitable for programmers in the software engineering team.

Objective 2: To develop an automated software team formation based on Belbin Team Role by using Fuzzy technique.

This objective is the main of this study due to leads to the major contribution of this research; this objective was achieved in Chapter 4 by developing a method of an automated software team formation based on Belbin team role using fuzzy technique. The method is able to collect team members' data and selecting software team leader based on the fuzzy technique. In addition, this method is able to distribute a team members based on Shaper and Plant value. It also provides the users with a reliable and flexible tool to assist manager to form effective team.

Objective 3: To evaluate the proposed method using quantitative approach.

The third objective was achieved in Chapter 5. This study employed a quantitative approach and the sample comprised of 10 experts enrolled in software engineering team from Asiacell Telecommunication Company. This study was conducted to determine the usability of the prototype and the expert satisfaction on the proposed automated software team formation. The results have shown that team using fuzzy technique to form team experienced significantly higher level of satisfaction.

6.3 Study Contribution

This study has contributed in the following directions:

i. The proposed automated software team formation method can help determining the useful Belbin team roles for team formation in the software development. In this study, the roles of Shaper and Plant provide significant role in software engineering team.

ii. This study also provides a systematic mechanism to form a team based on Belbin team role that can serve as advantage to software industry.

iii. By having the method using fuzzy technique, it can ease the task of manager or even instructor in academic to distribute the members among the team in equal way.

iv. The automated software team formation can also contribute to select the suitable team leader in software industry, this is important because good team leader play important role in software engineering team's effectiveness. Thus, this method can help managers to form team with suitable team leader based on Belbin team role.

6.4 Limitation of the Study

Despite the fact that the proposed method can help identifying the team roles formationin the software development, this study encountered the following bottleneck during the research:

i. The proposed method was developed using a stand-alone prototype, thus, the prototype can be accessed through local setup only. Due to the researcher need to meet participants to test the prototype which is time consuming.

ii. The automated software team formation is not integrated with the (BTRSPI), because of the Belbin policy for using and analyzes the questionnaire.

iii. The case study is limited only telecommunication industry.

iv. The method is only focused on team role not others criteria such as skills and personality.

6.5 Recommendation and Future Work

The proposed method can facilitate decision makers to form team. However, there is still need for improvement of this study for future enhancement such as:

i. The prototype can be upgraded to a web-based system; this can be done by uuploading the system to the server so that other software industry that located in other cities or countries can access the system and participate for testing the system.

ii. Applying other team roles that have ability to extract directly to the method or combining with the method for easy using.

iii. The case study can be extended to other software engineering industries.

iv. Integrate more criteria such as personality, skills and experience in the proposed method.

6.6 Summary

This chapter has discussed the study contribution and its limitation which could be addressed in the future work. The system has been evaluated with ten experts that had long experience in the team formation in software development, thus calling for the recommendation of the outcome of the research.

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