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QUALITY OF SCRUM TEAM MANAGEMENT USING FUZZY NUMBERS

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Purpose: This paper is a continuation and development of the same authors two papers which have been published recently, and have been devoted to the Quality of Project Team in classical – in the project management methodology sense – approach. The presented paper pertains to the notion of quality of project team in Scrum project management framework. A paradox is observed in the state of art of the project team quality in project management. All specialists recognize the exceptional importance of the parameter "quality" for the final result of the project. On the one hand, one can easily find definitions of project quality, quality of product of the project, quality of the project management processes, and so on. On the other hand, a huge majority of bibliographical sources consider the project team functioning, as a *sine qua non* condition of the project success. The notion "Scrum Team Quality" appears seldom in the literature. In this paper an approach is proposed to fill in this gap.
Design/methodology/approach: In this paper an approach is proposed, by the proposal of the model, based on fuzzy numbers, which defines the Scrum Team Quality, its measure, and the processes of such quality management. The process of Scrum Team Quality Management building consists of: Scrum Team Quality definition, methods of such quality measurement, and three phases of Scrum Team members selection: processes of MBTI – first pre-selection, Belbin – second pre-selection, and Scrum Team Quality standards complying as a final selection of the Scrum Team, insuring its optimal content.
Findings: The appropriate model of Scrum Team quality management using fuzzy numbers is developed.
Originality/value: The originality of the paper consists in: defining the Scrum Team management quality, the manner of its measurement using fuzzy numbers, and exemplary simulations of Scrum Team members selection using Belbin method, equipped with fuzzy numbers apparatus.

Keywords: Scrum Team, model of Scrum Team Quality Management, Scrum Team Quality measure, fuzzy numbers.

Category of the paper: research paper, conceptual paper.

1. Introduction

We are witnesses of an interesting phenomenon in the project management science. All experts recognize and claim the exceptional importance of the parameter "quality" for the final result of the project. On the one hand, one can easily find numerous definitions of project quality, product of the project quality, or quality of the project management processes, managing quality in project and project quality management. On the other hand, a large number of bibliographical sources consider the human factor – project team functioning especially – as a sine qua non condition of the project success. Favourite subjects are: leadership, team work, relations, cooperation, synergy effect, team climate, project team structures, motivation, psychological abilities of the team members, and so on. Extremely seldom appears the term "quality" with reference to the project team. In the literature of the subject, in relation to the team, the concept of the quality appears only as "relationship quality among team members" or "teamwork quality". This phenomenon is incomprehensible in juxtaposition with the statements above.

This paper is a continuation – development, of two recent papers of the authors, in which an attempt has been made to fill in this gap – at least partially – in the form of a proposal of the process, which define the project team quality and allows to measure this quality, for projects managed according a traditional methodology, like PMBok or Prince2 (Betta and Iwko, 2019a; 2019b). Two mentioned papers have a conceptual character. Their objectives consist in show the possibility to define the project team quality process, which ensures not only the optimal level of the team quality, but also undertake valuable managerial decisions during the project life cycle, using fuzzy numbers apparatus.

It is evident the interest and necessity to propose and analyse the analogous model of team quality management for projects managed according to agile philosophy (Manifesto, 2001), whose the notion, role, working and responsibility system, as well as the culture of the project team are different from these in classical approach. In the present article let us limit to Scrum Framework, being absolutely the leader of agile methodologies family (Agile247, 2017). The development of previously elaborated model (Betta and Iwko, 2019a; 2019b) should take into account not only the commonly recognized methods like Myers-Briggs Test Indicator (MBTI) (Frame, 1995; MBTI Basics) or Belbin (Belbin, 2008), universal for every team building and management, but also the specific requirements recommended by Scrum's fathers (Schwaber and Sutherland, 2017). This specificity of Scrum Team requires new definition of its quality. This quality must be measured; use of classical, quality measure methods could not be based on real numbers. The quality of team depends of many parameters of psychological nature, which are not representing by ordinary numbers, but require the fuzzy approach (numbers) (Zadeh, 1965; Kuchta, 2001).

In respective sections are presented:

Section 2 – main results of earlier articles (Betta and Iwko, 2019a, 2019b), Section 3 – Scrum, Section 4 – Scrum Team Quality Measurement, Section 5 (central one) – Quality of Scrum Team Management Model, Section 6 – Discussion, Conclusions, Section 7 – Recommendations.

2. Background for the Project Team Quality Model Development

In two previous papers (Betta and Iwko, 2019a; 2019b), the Guidelines for the Quality Model of the Project Team are presented: general assumptions, quality of project team definition, quality of team measure – classical and with use of fuzzy numbers, based on Myers-Briggs method and Belbin test, and finally, an impact of the quality required of the project team on team management are discussed (Betta and Iwko, 2019a; 2019b). The Guidelines are briefly presented (cited below). It is necessary to show and understand the development of the model, being the goal of this article.

The standards of the project management have some reference to quality management systems, but much less attention is given to this issue than to processes in the project life cycle. The reason for this is largely in the uniqueness of project management (Wawak, 2018). „Quality" is of the exceptional importance for the final result of the project. In the literature there are many definitions of project quality, quality management in projects, managing quality in project and project quality management (Heisler, 1990; Anderson, 1992; Chang, and Ishii, 2013; Basu, 2014). Secondly, many publications are devoted to the human factor (a project team) as a necessary condition for the project success. In publications from the area of the project team, quality appears e.g. in issues as teamwork quality and relationship quality among team members (Ling et al., 2013; Lindsjørn et al., 2016). From the very beginning, the quality management gurus emphasized the importance of the human factor as a quality dimension (also for the manufacturing and service sectors) (Feigenbaum, 1983; Deming, 1986; Juran 1989; Bank, 1992; Crosby, 1992). In ISO 9000:2015 standard quality is defined as "the degree to which a set of inherent characteristics of an object fulfils requirements" (ISO, 2015). The definitions of quality used in project management literature are often also based on this definition. For example PRINCE2 uses the ISO definition of quality that sounds like: "the totality of features and inherent or assigned characteristics of a product, person, process, service and/or system that bear on its ability to show that it meets expectations or satisfies stated needs, requirements or specification" (Prince2, 2009). Project management uses the philosophy of Total Quality Management, which can be defined as:

- a holistic management philosophy which strives for continuous organizational improvement (Kaynak, 2003),
- a management approach for improving organizational performance that encompasses a variety of both technical and behavioral topics (Rahman and Bullock, 2005),
- the application of tools and techniques to understand, manage and meet customer expectations (Darnall, 1996).

The special characteristics of projects require special tools and techniques or applications of those tools adapted to projects. To be able to successfully implement Total Quality Management in project management, a project must be client-focused, goal-directed, and people-oriented.

The differences between applying TQM to projects and applying TQM to the manufacturing reflect the differences between project management and general management. Management skills are very important and necessary in both the manufacturing and project environment. A good project manager (PM) can adopt quality management approaches and techniques to project. Projects offer some challenges that require different skills, tools and techniques. There are many differences between quality in project management and in manufacturing. According to Darnall they are related to customer, time (improvement process and team building), focus, measurement, roles and responsibilities (Darnall, 1996).

The project team doesn't have the structure and organization of a plant and this is why it needs to develop a way to focus the project. It is very important to define very clearly what the project team wants to achieve, who is responsible for the various parts, and track progress toward goals so the project manager knows if the project team is making the right kind of progress. Defining what the project team wants to achieve is focus and tracking progress toward goals is measurement.

One of the basic assumptions of an ideal agile team – see sec. 3 – is that the team is to be self-organizing, multidisciplinary and not have so many named roles: business analyst, developer, tester, etc. In addition, **agile** teams should not constantly ask for outside help, remaining self-sufficiency. The Development Team should have a dual function, i.e. implement requirements and ensure quality at the level it will be able to. The team structure is to be diverse and include all skills that allow for effective repetition of product backlog elements in working increment. Quality assurance and testing activities become the responsibility of all team members thanks to the uniqueness of design roles and sharing of skills. The diversity of the team enables building mutual respect and supports a sense of stability (Zmitrowicz and Stańczak 2018).

Using the definition of quality contained in the ISO 9000:2015 standard (ISO, 2015), the quality of project team can be defined as "the degree of adaptation of the quality level of psychological profiles of the members of the project team to the requirements of particular phases of the project and requirements of Project Manager (PM), taking into account the nature

of the project", (Betta and Iwko, 2019b). This is a refinement of the definition of quality taken from the ISO 9000 standards (Betta and Iwko, 2019a).

In (Betta and Iwko, 2019b), requirements for the project team are primarily the responsibility of the project manager, who is responsible for the level of project management quality, which is affected by the level of quality of the project team and the level of quality of relations between the project manager and the team. The requirements for the project team are also defined in cooperation with a psychologist and PR expert. Together with PM, they decide on the optimal proportions of roles at each stage of the project.

It is worth adding that if the quality cannot be defined, it cannot be measured, and if it cannot be measured, it cannot be controlled and improved. The quality of project team measurement in traditional approach to project management has been proposed as a process, described below as the sequence of two steps. First of them is based on Myers-Briggs Test Indicator (MBTI), which allows find optimal personal quality level for each of sixteen psychological types (Frame, 1995; Kopczewski and Szwarc, 2009). In this step, the quality is measured classically, with real numbers (Betta and Iwko, 2019b). This step makes possible three main applications of MBTI in development of the project team (Frame, 1995; Betta and Iwko, 2019b). It is used for the personnel recruitment independently for five stages of classical project's phases, diagnosis of the psychological sources of conflicts and improvement of interpersonal relations PM - project team (Betta and Iwko, 2019b). The second, final step relays on Belbin method, and quality parameters are measured using fuzzy numbers apparatus. The nine roles of Belbin are: Leader, Practical Organiser, Locomotive, Plant (strategist, visionary), External Coordinator, Judge-Evaluator, Team-worker, Completer Finisher, Specialist. Every role is described by different psychological characteristics (Betta and Iwko, 2019b) Belbin team roles can be assigned to persons as a result of special Test Belbin (Pracownia Talentów). Belbin method recommends the equal distribution of the roles among the team members. However, not all are always required at the same time, e.g. in consecutive phases of the project team lifetime. The decision about the optimal proportions of the roles in respective stages of the project is undertaken by PM, Psychologist and HR expert (Betta and Iwko, 2019b).

3. Scrum

3.1. Scrum Methodology

The content of this subsection is a quasi literal quote of the previous author's paper (Betta et al., 2019), as being necessary to help a lecturer follow the content of the article. The Scrum methodology was formulated in 1995 by Ken Schwaber and Jeff Sutherland

(Standish Group). Scrum is a framework designed to overcome complex adaptive problems and to deliver a product with the greatest possible value for the customer. Scrum is based on empiricism, which builds:

- clarity within each process,
- inspection to detect problems in the project,
- adaptation to changes.

Scrum consists of four main elements: Roles, Events, Artefacts and Rules (Schwaber and Sutherland, 2017).

There are following **roles** in Scrum (Betta et al., 2019). Scrum Master is the person responsible for the understanding and use of the values and rules of Scrum by the Development Team and Product Owner. The main task of the Scrum Master consists in serving the Scrum Team in order to achieve project goals and to ensure that the values of Scrum are applied correctly by the Scrum Team. The Product Owner is the person who is familiar with the business associated with the project and responsible for maximising the value of the product. The main duties of the Product Owner are to control and manage the Product Backlog (Elements in Scrum, The Artefacts). The Development Team is the team responsible for developing the product according to requirements. The Development Team is 'self-organising', which means that it has a high degree of autonomy. The Scrum Team is composed of Scrum Master, Product Owner, and Development Team.

Events in Scrum are important in order to provide regularity in Scrum (Betta et al., 2019). Events in Scrum are Sprint, Sprint Planning, Daily Scrum, Sprint Review and Sprint Retrospective. The Sprint is a limited time interval oriented towards an increment in functionality of the project product. The Sprint usually lasts about 30 days or less and consists of the following events: Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective. The Sprint Planning - the main goal of this event is to establish the scope of work to be done during the iteration. During Sprint Planning, items from the Product Backlog are selected; these items will be implemented to ensure the creation of product increment. The Daily Scrum is a daily 15-minute meeting of Scrum Master and the Development Team. The Daily Scrum is vital for monitoring progress in Sprint and for detecting problems that may threaten achievement of the goal of the Sprint. The Sprint Review is an event at the end of every Sprint to inspect the delivered functionality (Increment) and implement the Product Backlog. The Sprint Retrospective consists of reflections on the completed Sprint with some projection for the next one.

Artefacts are material or immaterial results of the work, which enable inspection and adaptation in Scrum methodology (Betta et al., 2019). The Product Backlog determines the scope and sequence of a list of features which should be implemented during the project. The document is open and changes can be introduced at any stage of the project. The Sprint Backlog is a part of the Product Backlog. It is created from Product Backlog items selected for the Sprint; the Sprint Backlog is created and managed by the Development Team.

The Increment defines the complete components of the Product Backlog completed during the Sprint and other previous Sprints. The Definition of Done focuses on clearly understanding when the element from Product Backlog can be accepted as finished.

Rules are defined as being linked with the method; they define relationships between Roles, Events and Artefacts (Betta et al., 2019).

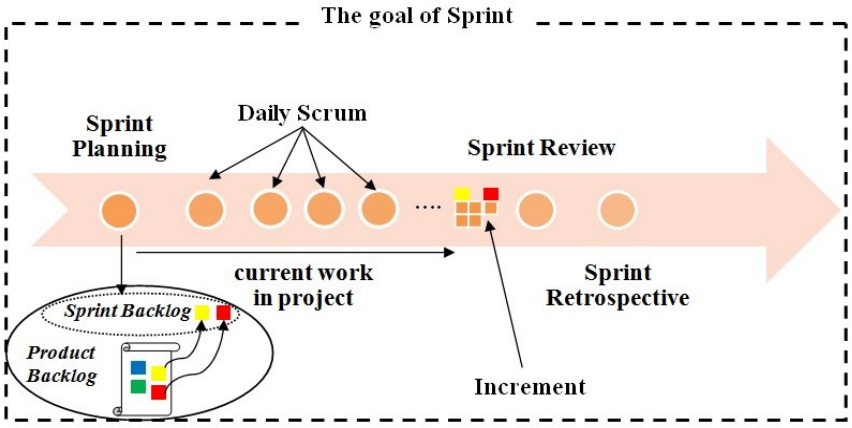

Figure 1. The Sprint. Adapted from: Betta et al., 2019.

Fig. 1 presents an iteration in Scrum methodology. Scrum is characterised by a specific development process based on incremental growth of the product and iterations that are fixed in time (Standish Group; Spałek, 2004). The first step is to create a Product Backlog, where all requirements for the project are kept. During every Sprint, elements from the Product Backlog which are compatible with the aim of the Sprint are selected for the creation of the Sprint Backlog. The Sprint is a fixed period of time during which the Development Team works to provide new functionality for the customer. The Sprint begins with Sprint Planning. In this Event, the Development Team selects tasks for the Sprint Backlog and evaluates them. During the Sprint, the Daily Scrum, or daily meeting of the Scrum Master and Development Team, is held. The total number of finished tasks from the Product Backlog make up the Increment, which should be usable by the customer. The Sprint Review and Sprint Retrospective are conducted by the Scrum Team at the end of each Sprint (Standish Group).

3.2. Scrum Team

Scrum Team – summary based on the Scrum Guide (Schwaber and Sutherland, 2017).

The Scrum Team, working together to deliver the required product increments, is self-organizing—i.e. the team chooses how best to accomplish their work, rather than being directed by someone outside of the team—and cross-functional—i.e. all competencies necessary to accomplish the work are found within the team, without the need to depend on others outside of the team. At the heart of the framework is an iterative and incremental approach to managing the workload that maximises opportunities for feedback and ensures that a potentially usable version of the working product may be always available. This model encourages a high level of communication among the team working towards a common goal and is "designed to

optimize flexibility, creativity, and productivity" (Schwaber and Sutherland, 2017). The Scrum Team consists of the Product Owner, the Development Team, and the Scrum Master, whose roles are summarised in turn.

The Product Owner is an individual responsible for maximising the value of the product that the team delivers and serves as a link between the team and other stakeholders. How this is done varies across organizations, Scrum Teams, and individuals. The Product Owner is responsible for managing the Product Backlog—including expressing Backlog items, ordering them, and making sure the Development Team understands these items and are clear on what the Scrum Team will work on next. While this work may be done by the Development Team itself, the Product Owner remains accountable for it. Product Owner's personal features, according to the Scrum Guide, are: comprehensibility, logicalness, self-assertion, team work ability (O_i: i = 1, 2, 3, 4) (Schwaber and Sutherland, 2017).

The Development Team consists of professionals (Developers) who do the technical work to deliver an increment of a "Done" product at the end of each Sprint. Development Teams are to be "structured and empowered" by the organisation in a way that allows them to organise and manage their own work. In addition to self-organisation, their key characteristic is the collective ownership of the workload – that is, while team members may have specialised skills and focus on certain parts of the task that correspond to these skills, the accountability for the work rests with the Development Team as a whole. Further, the Development Team does not have sub-teams and individual Development Team members do not have titles, regardless of the work each person performs. The optimal size of the Development Team, which needs to be small enough to remain nimble and large enough to complete significant work within a Spring using only within-team skills, is generally three to nine members (Schwaber and Sutherland, 2017). Development Team's features, according to the Scrum Guide, are: team-work ability, self-organizing, cross-functional (N_i: i = 1,2, 3) (Schwaber and Sutherland, 2017).

The Scrum Master is responsible for ensuring that the Scrum framework is followed, including by helping all Scrum Team members understand the theory, principles, and practice of Scrum, sometimes facilitating key sessions, and removing potential external impediments to the team's work. The latter involves helping those outside of the Scrum Team understand which of their interactions with the Team are unhelpful and to change these. The Scrum Master serves the Product Owner by, among others, "ensuring that goals, scope, and product domain are understood by everyone on the Scrum Team as well as possible", finding techniques for effective Product Backlog Management, assisting the Product Owner's understanding of product planning in the context of Scrum, and promoting agility. The Scrum Master serves the Development Team by, among others, coaching them in self-organization and cross-functionality, as well as in the general tenets of the Scrum framework where needed, and removing impediments to the team's progress. At the level of the Organization, the Scrum Master serves by leading the organization in its adoption of Scrum, planning the framework's implementation, helping employees and other stakeholders understand it, and working to

increase the productivity of the Scrum Team. Scrum Master's personal features, according to the Scrum Guide, are: leadership, sense of promoting, sense of teaching, sense of coaching, team work, helpfulness (I_i: i = 1, 2, …6) (Schwaber and Sutherland, 2017).

4. Scrum Team Quality Measurement

As we will see in the Section 5, the Scrum Team Quality Fuzzy Model is consisting of three parts – groups of processes, with necessity to measure the Scrum Team quality. Two first have preliminary character and have been presented earlier (Betta and Iwko, 2019a, 2019b). For the first of them, the authors admit as possible and sufficient a use of ordinary real numbers. For two next groups the authors judge as necessary a refinement, by introducing fuzzy numbers measure.

4.1. Real numbers measurement

Let us imagine a project starting in a company. The first challenge for the Project Manager (PM) and one of principal factors of the project's success is a valuable project team building (Frame, 1995). The model concerns psychological aspects only, much more sophisticated and equipped always with some level of uncertainty greater than the technical aspects of the problem. The authors did not find any attempt, how the project team quality could be measured. In the paper, the quality of project team measurement is proposed as a process, described below as the sequence of three steps.

1st Step. Let us use Myers-Briggs Test Indicator MBTI (Frame, 1995) as the first tool of a preliminary Scrum Team members selection. From among the set of all employs dispositional, the group is selected, according to criteria: all sixteen types of MBTI are represented, if possible equilibrated, each of them represented by the people with his highest score of his leading feature (in percent), of the MBTI test. Such group will be called a Reference Resource Group (RRG), ensuring the best quality of the project team, taking into account existing people availability. Let us denote such ideal level of the group quality as RQPT (Reference Quality of Project Team). Let BPIQi denotes the Best Personal Individual Qualities levels (i = 1, 2, …, 16) for all sixteen psychological types. Then let us define the RQPT level by (1) (Betta and Iwko, 2019b):

$$\text{RQPT} = \frac{1}{16} \sum_{i=1}^{16} \text{BPIQi} \tag{1}$$

There are three main applications of MBTI in development of the project team (Frame, 1995). It is used for the personnel recruitment, diagnose of the psychological sources of conflicts and improvement of interpersonal relations PM – project team.

Project personnel recruitment. Every project is more or less specific; there exist many different types of projects. Moreover, in classical project management approach, the project is divided into five stages: 1. initialisation, 2. planning, 3. execution, 4. control and 5. Closing (PMBOK, 2017). Each of these stages has its specificity and requires people with different psychological MBTI. So, for each stage, a specific recruitment should be done, taking into account stage's specificity and specificity of the project itself. Such recruitment should be done by Project Manager, Psychologist and HR expert, and the candidates be grounded in RRG. For example, in the stage of planning, the dominant types should be ENTJ or INTJ (extravert or introvert, intuitive, thinking, judging), and so on, for other stages of the project. For a stage k (k = 1, 2, 3, 4, 5), such team should be composed with the people owning psychological types in proportions defined by PM, Psychologist and HR specialist. Let STk be a specific team for a project's stage k (k = 1, 2, 3, 4, 5). Its reference quality – $RQST_k$ – is given by (2).

$$RQST_k = \frac{1}{n} \sum_{i=1}^{n} BPIQi, \tag{2}$$

where $BPIQ_i$ is the Best Personal Individual Quality of the person i, and n is the number of members of the specific team for the given stage.

The real quality of such team is in reality inferior, because of resources really available for a given stage. It is calculated according to the formula like above, but the (Best) Personal Individual Qualities ($BPIQ_i$) are not the best, but the real ones (Betta and Iwko, 2019b).

Diagnosis of the psychological sources of conflicts. MBTI method is useful to diagnose reasons of conflicts, inevitable during the life cycle of the project. There can be many different sources of such conflicts and different people involved with them – e.g. PM, his superiors, his workers, customers. More the conflict's reason is of psychological nature, more effective turns out MBTI method to prevent and often solve it. Such prevention and solution of conflicts should be done using $RQST_k$, by PM, Psychologist and HR specialist (Betta and Iwko, 2019b).

Improvement of interpersonal relations PM-Project Team. The PM duties and scope of activities are different than those of the project team members. Usually, the tasks of the project team members are much more precisely defined than those of PM. That's why, very often the psychological type of PM and his team members are essentially different. Project Manager must know his own type, know the types of his people and absolutely be conscious of their differences. It allows him to understand better the differences, propose to the team and undertake common actions which contributes to partially compensate these divergences (Betta and Iwko, 2019b).

These roles are attributed to the members of a specific team (ST_k) for a project's stage k (k = 1, 2, 3, 4, 5) by PM, Psychologist and HR specialist. Such team – T_k is optimal, and its quality level is a reference – RQT_k. Each other composition of T_k (in the case of inaccessibility of all people desired), has a lower then reference final level of quality – FQT_k, calculated as a correction, which is a result of non-optimal distribution of the roles. All three (PM as leader, Psychologist and HR specialist) discuss the style and manner of management of the team T_k

with non-optimal distribution of the roles. This situation is discussed in the next section (Betta and Iwko, 2019b).

4.2. Fuzzy numbers measurement

For some reasons, probabilistic methods are not always sufficient for modelling unknown values. Two situations can occur while estimating an unknown value of a parameter:

1. An expert, estimating an unknown value Ã, gives different degrees of possible realization for different, potentially possible intervals.
2. Among several experts estimating an unknown value Ã, there are some who admit larger intervals of the estimating value realization, and another ones propose the intervals narrower.

In both cases, the estimation of an unknown value is not an interval, but a set of intervals, called a fuzzy number (Zadeh, 1965). For this paper objective, let us adopt definitions, properties and dependencies below (Kuchta, 2001).

Definition 1

A fuzzy number Ã is a set of real closed intervals $\{A^t\}(t\epsilon[0,1])$, accomplishing the following conditions:

a) $t < r \Rightarrow A^r \subseteq A^t$,

b) $I \subseteq .[0,1] \Rightarrow A^{supI} = \cap_{r\epsilon I} A^r$.

Definition 2

For a fixed $t \epsilon [0,1]$, the interval A^t is named t-level of a fuzzy number Ã.

The level A^{1-t} corresponds to the opinion of the expert, cautious at the degree t. If $t < r$, A^r is the estimation of an expert less reserved or better informed than the author of the estimation A^t (Betta and Iwko, 2019b).

2nd Step – use of Belbin method for the next pre-selection of Scrum Team members. Our object of interest are the parameters, essential for correctness of this second pre-selection. The situation ii. will only be taken into account. There are three experts – PM, Psychologist and HR specialist, who estimate the levels of nine parameters of Belbin (Belbin, 2008). The parameters, defining respective roles, are in fact a mix of various psychological features/predispositions, and it is impossible to attribute to each of them an exact value. The solution is offered by fuzzy numbers apparatus. Let us denote the parameters, defining respective roles, as fuzzy numbers below, (Betta and Iwko, 2019b).

Table 1.
Belbin roles and their parameters as fuzzy numbers

Belbin role	Parameter (fuzzy number)
Leader	$\Re 1$
Practical organiser	$\Re 2$
Locomotive	$\Re 3$
Plant (strategist, visionary)	$\Re 4$

Cont. table 1

External Coordinator	$\mathfrak{R}5$
Judge-Evaluator	$\mathfrak{R}6$
Team-worker	$\mathfrak{R}7$
Completer Finisher	$\mathfrak{R}8$
Specialist	$\mathfrak{R}9$

Source: own work.

Example: Let us admit the percentile scale of all possible estimations of – for example – fuzzy number $\mathfrak{R}1$ values. For the given person, expert1 (PM) can, for instance, state that his estimation of this parameter is [40%-70%] with level 0.8. Expert 2 (Psychologist) can see another possibility – [20%-80%] with level 0.5. The third one (HR specialist) estimates this value as [20%-80%] with level 0.7. So, PM defines the parameter Leader rather exactly ([40%-70%]), but with relatively small degree of caution 1 – 0.8 = 0.2. It means that he estimates $\mathfrak{R}1$ relatively exact, but with a big possibility 0.8, of mistake. The second (Psychologist's) estimation is less exact ([20%-80%]), but with average degree 0.5 of caution. Finally, the third expert (HR specialist) proposes the same interval as the Psychologist, but with caution 0.3. The final estimation could be the result of these three experts consensus meeting. This procedure could be of course done also for other eight parameters $\mathfrak{R}2$-$\mathfrak{R}9$.

In the same manner can be proceeded thirteen parameters characterising members of the Scrum Team: $\tilde{O}_i$: i = 1, 2, 3, 4; $\tilde{N}_i$: i = 1, 2, 3; $\tilde{I}_i$: i = 1, 2, …6 (sec. 3.2), respectively. The appropriate simulation is made in the Sec. 5.

5. Model of Scrum Team Quality Management

The model is based on six assumptions:

a. The model does not take into account technical competences of the project team members; they are supposed fulfilled.
b. The model considers currently recognized psychological aspects of the Scrum Team quality only.
c. Project quality level depends growing on the project management quality level.
d. Project management quality level depends growing on the Scrum Team quality level as well as on the quality level of relations Scrum Master – Scrum Team.
e. Scrum Team quality level as well as the quality level of relations Scrum Master – Scrum Team, depend growing on the quality level of the members psychological profiles, set down using MBTI and Belbin methods, and on the level Scrum Team requirements fulfilment (Standish Group).
f. One part of quality parameters (MBTI) are measured classically (in real numbers). Other (Belbin, Scrum Team characteristics) – using fuzzy numbers apparatus (Betta and Iwko, 2019a).

Using the definition of quality contained in the ISO 9000:2015 standard and the definition of quality of project team in classical approach of project management, **the authors quality of scrum team** can be defined as "the degree of adaptation of the quality level of psychological profiles of the **Rules** in the Scrum Team (the Scrum Master, the Product Owner and the Development Team) to the requirements of the type of the **Events** in Scrum and requirements of the Product Owner (which is responsible for maximizing the value of the product), taking into account the nature of Scrum Teams which are self-organizing and cross-functional, designed to optimize flexibility, creativity and productivity".

In order to define the quality of the Scrum Team, the parameters resulting from the specificity of the Scrum Team should be taken into account, i.e. features of roles of the team: the Scrum Master ($\tilde{I}_1$ – leadership, $\tilde{I}_2$ – sense of promoting, $\tilde{I}_3$ – sense of teaching, $\tilde{I}_4$ – sense of coaching, $\tilde{I}_5$ – team work, $\tilde{I}_6$ – helpfulness), the Product Owner ($\tilde{O}_1$ – comprehensibility, $\tilde{O}_2$ – logicalness, $\tilde{O}_3$ – self-assertion, $\tilde{O}_4$ – team work ability) and the Development Team ($\tilde{N}_1$ – team-work ability, $\tilde{N}_2$ – self-organizing, $\tilde{N}_3$ – cross-functional).

This is a refinement of the definition of quality taken from the ISO 9000 standards, quality of project team in traditional project management (Betta and Iwko, 2019a; 2019b) and guidelines of the Scrum Team included in Scrum Guide.

The process of Scrum Team Quality Management building consists of: Scrum Team Quality definition, methods of the quality measurement, and three phases of Scrum Team members selection: processes of MBTI – first pre-selection, Belbin – second pre-selection, and Scrum Team Quality standards complying as a final selection of the Scrum Team, insuring its optimal content. The total number of quality parameters is 38 – MBTI sixteen, Belbin nine and Scrum Team standards – thirteen. Two first of these groups were applied to the project team in a classical project management (Betta and Iwko, 2019a; 2019b), and are presented below. In this article, these two phases stay valuable in Scrum approach also, because of universality of both methods for the team construction – MBTI as well as Belbin test.

First Step (MBTI): Reference Quality of Project Team level, calculated b*y* the Eq.1., should be permanently keep at the highest level possible. From point of view of PM it means that at this stage, he should monitoring this level, and in the case of its decreasing, react by adequate personnel decisions, by substitution – if necessary – some members for another ones.

ST_k is a specific team for a project's stage k (k = 1, 2, 3, 4, 5). Its reference quality – $RQST_k$ – is given by the Eq. 2. Its monitoring and reaction of PM are necessary, as above.

Second Step (Belbin): Nine roles are attributed to the members of a specific team (ST_k) for a project's stage k (k = 1, 2, 3, 4, 5) by PM. Such team – T_k, is optimal from point of view of necessary roles proportions, and its quality level is a reference one – RQT_k. Each other composition of T_k, in the case of inaccessibility of all people desired, should be quickly detected by PM, who should undertake adequate decisions, concerning substitutions. In fact, intending make proportion of roles in T_k the nearest possible to the ideal – the RQT_k, PM would like fulfil the necessary, but not sufficient condition of the best level of the team management. The main

disadvantage of this step are, arbitrary enough proposed by three managers, the personal roles in T_k. The roles depend of many factors; in practice, each of the decision-makers estimates the ability of every of team members to play a most appropriate role in T_k, taking into account not only the Belbin tests results, but also his own experience and personal acquaintance of members. Their estimations can differ between them. It could be very difficult to achieve a consensus on the roles attribution, because of the fact that Belbin roles are based on different, non-measurable and non-comparable, psychological features. As useful appears fuzzy numbers apparatus. Let us observe that Scum Team is the same for all Sprints of the project; there are no project stages requiring the Scrum Team composition.

Second Step (Belbin, fuzzy numbers measurement)

Let us come back to the example, sub-section 4.2. The estimations of three experts of the role of leader, are defined by three levels of a fuzzy number $\Re 1$. The situation is shown in the Table 2.

Table 2.
Estimations of parameter $\Re 1$

	Estimations of $\Re 1$	**Caution level**	**Comments**
PM	[40%-70%]	0.2	Focused on small interval, little cautious or well informed
Psychologist	[20%-80%]	0.5	Big interval of estimation (inexact), cautious average
HR Specialist	[20%-80%]	0.3	Big interval of estimation (inexact), cautious little

Source: own work.

The differences between estimations could result from two factors. First, from very equilibrate two or more leading roles of the person (Belbin test). Secondly, from personal differences between experts: professional experience, personal acquaintance and subjectivity of perception.

The authors proposal is to organise a consensus meeting of three experts. The consensus meeting consists in substantial argumentation, using facts only (Ortsman, 1995). It creates an opportunity to explain the nature of differences between estimations of the values of the fuzzy number $\Re 1$, representing the role of the leader. Let us notice the same intervals of Psychologist and HR expert in the analysed example, but different levels of caution. HR expert can e.g. explain, that he knows well this person, because of common work in several projects in the past. So, he is less cautious than Psychologist and his estimation could be considered as more valuable. The PM interval is twice smaller than two other, but his experience as PM says that his Belbin test result is sufficient to attribute him such precise estimation of the role Leader. So, the final, optimal result of such (simulated) consensus meeting should be: the interval [40%-70%] and caution 0.3.

Let us suppose that an exemplary Team contains five persons, so, we have nine roles of Belbin to distribute among five people; it should be necessary to define eight of them as jointed (double) for four persons and one role for the fifth one. Let us suppose a candidate with high evaluation of fuzzy features: equilibrated, dominant, extrovert, with medium capability to

undertake decisions and negotiator. The analysis of necessary features (Belbin roles) shows a possibility to accomplish efficiently both roles: leader and external coordinator as well. In a similar way PM, Psychologist and HR Specialist could proceed to attribute nine roles for five people.

Third Step (Scrum Team characteristics, fuzzy numbers measurement)

The basic assumption, according to Scrum rules, says, that roles of Product Owner and Scrum Master cannot be combined one with other, neither with role of Development Team member.

Let us make a simulation of a measuring of one selected item of thirteen features of the Scrum Team; e.g. Development Team members feature $\tilde{N}_2$ – self-organizing ability. Let us proceed the analyse similar as in the Table 2. The same three experts do this estimation (Table 3).

Table 3.
Estimations of the parameter Ñ2

	Estimations of $\tilde{N}_2$	Caution level	Comments
PM	[10%-70%]	0.5	Focused on big interval, average cautious
Psychologist	[30%-60%]	0.4	Little interval of estimation, average cautious
HR Specialist	[30%-80%]	0.8	Big interval of estimation (inexact), very cautious

Source: own work.

As in the case of Belbin parameters (Table 2), the authors proposal is to organise a consensus meeting of three experts, in order to explain the nature of differences between estimations of the values of the fuzzy number $\tilde{N}_2$, representing the self-organizing ability of the Development Team member. Let us notice very similar intervals of $\tilde{N}_2$, estimated by Psychologist and HR expert in the analysed example, but really different levels of caution. The PM interval is the longest of the three, and his caution level is approximately the same as that of Psychologist, and the interval of HR specialist long with a high caution level. The consensus meeting of three experts should be engaged. It's final, optimal result will probably be: the interval [30%-70%] and caution 0.6, or very similar.

6. Discussion, Conclusions

Both methods – MBTI and Belbin – were developed to insure the optimal composition of the project team, but taking into account different criteria. According to MBTI, optimisation is done in the triple sense: personnel recruitment, diagnosis of the psychological sources of conflicts and improvement of interpersonal relations PM project team. Application of MBTI as the tool of a preliminary selection, allows to create the Reference Resource Group (RRG), which is a set of people, potentially the best fulfilling the psychological criteria of the method (step 1, subsection 4.1), and based on the RRG, ST_k – specific teams for each of five project's

stage k are selected. It allows to diagnose the reasons of conflicts and undertake managerial decisions to prevent them. Moreover, the first step encourages PM to make efforts to neutralise, for the project, differences between his profile and the profiles of his team. The second step – Belbn method, facilitates the next, very important decision of optimal proportions of the roles in respective stages of the project. It is impossible to attribute to each role a real value. Therefore, the application of fuzzy number apparatus makes possible to model the parameters, defining respective roles, which depend on various psychological features/predispositions. One can say that fuzzy numbers apparatus opens the space of consensus deliberations among PM, Psychologist, HR expert and other specialists, if need be, on psychological aspects of team work. Finally, the third step allows to measure thirteen parameters characterising the Scrum Team members. On each stage, in the case of decreasing of quality level, PM should be open and creative to try raise this level. At all stages, managerial decisions are undertaken by PM, assisted by Psychologist and HR expert.

Summarising, for Scrum Team quality management, the following steps should be done:

- acceptation of quality standards (definition proposed and 38 parameters defined),
- providing of these standards maintaining (tests MBTI, Belbin and evaluation of these thirteen features to work in Scrum Team),
- Control: measurement: real numbers for the Step 1. (MBTI), fuzzy numbers for the Step 2. (Belbin) and the Step 3. (Scrum Team members features).

7. Recommendations

Quality is a very large notion, affecting many objects – products, services, processes and other forms of human activities. In technical area, definition and measure of quality are evident and easy to formulate. In social sciences, the challenge is much more sophisticated, because of the higher level of differentiation/variation of social systems in comparison with technical ones (Ortsman, 1995). The project team is a social group of affiliation, with its complicated structure, processes, and interpersonal relations. The significant role of such team in the project success or failure has inspired the authors to develop an idea of project team quality. This development has been presented in sections: 1-6.

Guidelines are presented in the form of the process. This process is described by: general fundamentals of the project team quality, assumptions of its validity, methods of quality measurement, and impact of the quality of the project team on team management. The process is based exclusively on psychological parameters of MBTI (real numbers measurement) for the preliminary selection of the project team members, and Belbin method for the second stage (fuzzy numbers measurement) of pre-selection of them. For the final selection of the Scrum Team members, the fuzzy approach of quality measurement has been proposed and justified.

This paper, in line with authors knowledge, is the first attempt to the quality of Scrum Team. The authors are conscious of its shortages. So, further research should be done. Theoretical, focused on enrichment of a set of quality psychological parameters by the new ones, analysis the quality using particular cases of fuzzy numbers (triangular, trapezoidal), and introducing also fuzzy numbers of type 2 or higher. Practical – research to test and improve the proposed guidelines.

Nowadays, quality is omnipresent in all areas of human activities. So, in "projects age", quality of project team is entirely worthy of researchers and practitioners interest.

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