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Application of the Project Management Methodology Formation's Method

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Background and Purpose: The selection of a "right" project management methodology for a particular project represents a problem of great importance. Its solution affects crucial project parameters like cost, duration, product quality, and the project's success in general. The purpose of this study is to present a method for the formation of the project management methodology and illustrate its applicability on a software development project's example.
Design/Methodology/Approach: In this study, we describe the method of project management methodology formation that allows the forming of a specialized methodology for any IT project considering the fuzziness of information about the project, its environment, and existing expert's recommendations. The method involves 1) collecting baseline information using a questionnaire, 2) calculating weighted Hamming and Euclidean distances, 3) solving a three-criterion optimization problem using a minimax approach with fuzzy input data.
Results: All six stages of the project management methodology formation's method (project evaluation, basis selection, alternative methodologies formation, methodology selection, methodology application, and methodology tailoring) were applied to form a specialized project management methodology for an IT project to increase the possibility of its success. The most appropriate alternative based on DSDM was selected and applied to manage the project.
Conclusions: The given method allows the forming of a specialized project management methodology based on the components of Generalized Body of Knowledge for any IT project considering specific conditions of the project and its environment.

Keywords: *Methodology, Project management, Formation, Application, Method.*

1 Introduction

With the growth of competition in the global market and rapid changes in applied technologies, project management is becoming one of the most sought-after areas of management. Dozens of project management guides, standards, and methodologies have been created. Their main strengths are 1) the systematic character, 2) the use of computer science achievements, 3) the application of process-oriented approaches, 3) the use of various information collecting and processing methods, and 4) the use of decision-making support methods. Due to the large number of existing developments in this area, the choice of a management methodology for a specific project, represents a complex task. Its solution affects crucial project parameters like cost, duration, product quality, and the project's success in general. The chosen methodology impacts the agility of an enterprise, as well as its further development possibilities (Kryvinska, 2012).

The purpose of the study is to propose a method for the project management methodology formation and illustrate its applicability on a software development project's example.

The study has the following structure:
1. Introduction. The section describes the motivation of the study, its aim, and its structure.
2. Literature Review. The section provides a review and analysis of the latest publications dedicated to project management methodology selection and formation.
3. The Project Management Methodology Formation's

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Method. The section contains information about Project Management Methodology Formation's Method: its information support, main stages, and their descriptions.
4. Application of the Project Management Methodology Formation's Method to a Software Development Project. The section illustrates an example of a practical application of the method described in Section 3 to a software development project.

2 Literature Review

While project performance has been increasing globally (in 2018, nearly 70% of projects met their original goals and nearly 60% were completed within the original budget compared to 62% and 50% respectively in 2016 according to PMI), the project failure rate is still high.

According to an Harvard Business Review survey, the average IT project overran its budget by 27% and at least one in six IT projects turns into a "black swan" with a cost overrun of 200% and a schedule overrun of 70% (Harvard Business Review, 2011).

A PricewaterhouseCoopers (PwC) studied 10,640 projects and found that only 2.5% of companies complete their projects 100% successfully. The rest projects either failed to meet some of the aims or missed the original budget or deadlines (Gallup, 2012).

According to PwC (PricewaterhouseCoopers, 2012), the usage of project management methodologies improves project performance. So organizations that use a methodology comparing to organizations that don't, more often meet budget (38% vs. 31%), stay on schedule (28% vs. 21%), meet scope (71% vs. 61%), meet quality standards (68% vs. 60%), meet expected benefits (60% vs. 51%).

An author of (Whitaker, 2014) showed the results of a survey of 202 project management specialists from 15 sectors of the economy. Among the respondents, 42% were organizations that do not have a project management methodology. These respondents noted that their projects were successful in 67% of cases. Respondents who use mostly tailored project management methodology (37% of respondents) reported that projects succeed in 73% of cases. Those who use a fully tailored project management methodology (7% of respondents) indicated that projects were successful in 82% of cases. Among those who do not have a project management methodology, 29% do not know how to build a methodology.

The task of the project management methodology selection is the subject of various studies. For example, the study (Bushuev & Neizvestnyy, 2013) present a genome model for the project, program, and portfolio management methodologies. It gives a formal description of the genome as a system of knowledge about these methodologies and defines the methodology in the genome using an object-oriented approach. The methodologies database structure allows the storing of all project management methodologies in a single system and format.

The results of a study (Joslin & Müller, 2015) indicate the importance of having a comprehensive project management methodology and the experience of its tailoring as factors of project success.

The authors (Joslin & Müller, 2016) have shown that there is a connection between the elements of a project management methodology and the characteristics by which the project's success is evaluated. The methodology's elements have the highest impact on the time, cost and scope of the project.

The study (Čelesnik, Radujković, & Vrečko, 2018) demonstrates the impact of the applied project management methodology on solving company problems in a crisis. In (Rehman & Hussain, 2007), five project management methodologies: Agile Development Methods, MSF, PRINCE2, RUP, ITIL were compared with PMBOK Guide (PMI, 2004). As a result of the comparison, the authors noted that the main criteria for choosing the methodology should include the following: work experience, experts' opinions, state regulation, stakeholders' and client's preferences, and the client location.

The authors of (Boehm & Turner, 2004) have suggested a risk-based approach to balance Agile and Plan-driven methodologies. They identified five dimensions, which from their perspective are crucial in describing an organization or a project in Agile and Plan-driven characteristics. Among these dimensions are size, criticality, dynamism, personnel, and culture. The graphical representation of an organization or a project promotes the definition of its environment and, following, the application of the risk-based approach described in the paper for a balanced development strategy construction.

The results of (Conforto, et al., 2014) indicate that besides software development, Agile Project Management can be adopted by other industries, but there should be some enablers for its implementation. These enablers relate to the experience of project teams and project managers, project teams size and location, the involvement of customer/stakeholders in the project planning, etc.

In (PMI, 2017b), the Model for Suitability of Agile Approach is proposed. This model demands the survey of a project team on nine issues concerning the cultural context of the project, the project team, and the project itself. Depending on the answers, the model recommends the usage of Agile, predictive or hybrid approach.

The authors (Kononenko & Lutsenko, 2018) proposed the method of a specialized methodology formation for a specific project. The method considers the unique characteristics of every project, its parameters, and parameters of its environment. However, the authors have not illustrated how the given method could be put into practice.

The aim of the study is to demonstrate how the method of project management methodology formation (Kononenko & Lutsenko, 2018) could be applied to a project to form the most appropriate management methodology for its conditions. We will illustrate and evaluate the applicability of the method on a small-size software development project's example.

3 The Project Management Methodology Formation's Method

There are various project management standards, guides, and methodologies. But for now, there is no unity in the scientific world about a 'project management methodology' definition. In this regard, we have analyzed existing versions of its definition and have considered the following (Kononenko, Aghaee, & Lutsenko, 2016): the project management methodology is a certain and documented system of principles, rules, processes, practices, life cycle, organizational structure, prescribed roles that provide the project management.

To form such methodology for specific conditions of a particular project, we will apply the project management methodology formation's method (Kononenko & Lutsenko, 2018b). The method can also be applied to a group of projects or to all projects of an organization under specific conditions which will be described later in the section. The method implies the usage of Generalized Body of Knowledge on Project Management (GBOK), which contains information from the commonly known project management standards, methodologies, and guides (Kononenko & Lutsenko, 2018a). Particularly, it includes information from PMBOK guide (PMI, 2018a), ISO21500 standard (ISO, 2012), PRINCE2 method (OGC, 2017), SWEBOK guide (IEEE, 2014), Scrum (SCRUMstudy, 2016), Kanban (Anderson, 2010), XP (Beck, 2004), DSDM (Agile Business Consortium, 2014), and FDD (Gorakavi, 2009) agile methodologies, as well as information gathered from the specialists' propositions. Figure 1 illustrates the structure of GBOK.

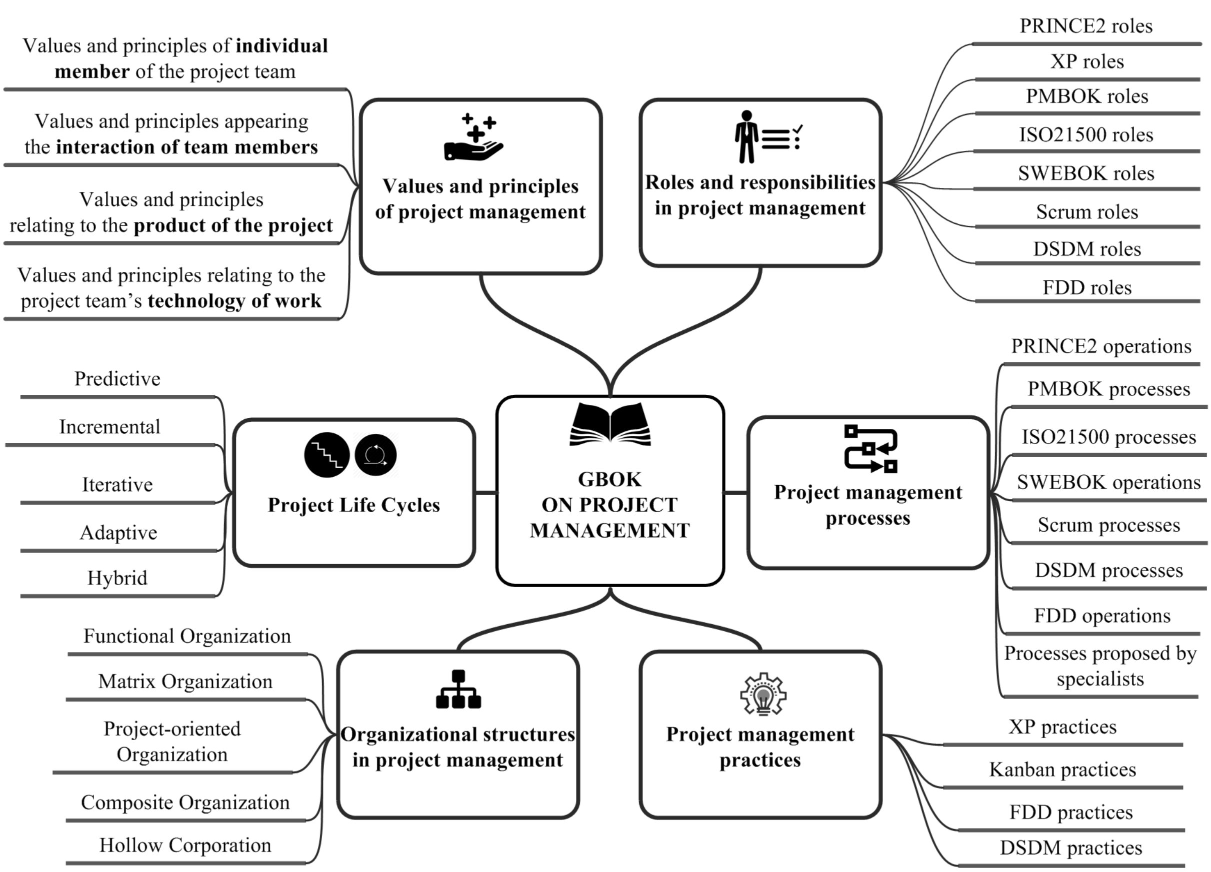

Figure 1: The GBoK structure (Kononenko & Lutsenko, 2018b)

The application of the project management methodology formation's method implies the fulfillment of the following stages.

1) Evaluate the project
Fill in the questionnaire about the project and its environment. The questionnaire is described in (Kononenko & Lutsenko, 2018b). It includes questions about the size of the project team, its competence, customer's experience of working with this team, project manager's responsibilities, the main requirements to the project, and the risk events occurrence probability. It is advisable to involve project stakeholders in filling the questionnaire.

2) Select the basis
Select a primary approach to project management using the method given in (Kononenko & Lutsenko, 2017). The method allows selecting the most suitable approach from the generally known standards, guides, and methodologies (PMBOK, PRINCE2, SWEBOK, Scrum, XP, and Kanban). Use the selected approach as a basis for further specialized methodology formation.

3) Form alternative methodologies
Set several specialized methodology alternatives. Modify the primary approach or create your basis using principles, rules, processes, practices, life cycles, and organizational structures represented in GBOK. Distribute roles and responsibilities in the project and define connections between processes and other components. Delete or modify components if appropriate. It is advisable to involve an expert to form alternatives properly.

4) Select methodology
Select the most appropriate methodology from alternatives created on the previous stage. For the selection, use the method of three-criterion optimization described in (Kononenko, Aghaee & Lutsenko, 2016). The method allows selecting the best methodology by the management activities laboriousness and cost, as well as the risks associated with the implementation of the methodology.

5) Apply methodology
Apply the selected specialized methodology to the project management.

6) Tailor methodology
During the project implementation, tailor the project management methodology components and links between them periodically. For the tailoring, use the following criteria: the management activities laboriousness, the management activities cost, and the risks associated with the methodology implementation.

The complex collection of relevant project data in the pre-initialization phase could be time and cost consuming. But these expenses are justified for large, complex, expensive, and responsible projects. According to the statistics, large projects (more than $10 million) have a higher failure rate (38%) than small projects (4%) (The Standish Group, 2013). The dependency between the project size and failure rate is also mentioned in Gartner's research (Gartner, 2012): "An IT project with a budget over $1M is 50% more likely to fail than one with a budget below $350,000. For such large IT projects, functionality issues and schedule overruns are the top two causes of failure (at 22% and 28% respectively)". That is why the application of the method to a large project to increase the probability of its success is reasonable.

The method also can be applied to a group of projects or all projects of an organization. In this case, the diversity of all projects of the organization should be considered (IT projects, marketing projects, production projects, etc.). It is advisable to define groups of projects that are to be managed with one methodology. Such groups could be defined on Stage 2 of the method: if the basic methodologies for several projects are the same, the projects can be united into a group.

The method can be applied to any projects, but it should be taken into account that some of the approaches included in GBOK apply only to IT projects (SWEBOK, XP, FDD).

4 Application of the Project Management Methodology Formation's Method to a Software Development Project

Let us illustrate the proposed method application. As an example, we will consider a software development project. The project product is a web application for the synthesis of the project management guide PMGuide. The expected duration of the project is 1.5 months. Project management cost should not exceed $ 1,750.

4.1 Project evaluation

On the first stage of the method, stakeholders evaluate the project by filling a special questionnaire (Kononenko & Lutsenko, 2017).

Each question of the questionnaire represents a project parameter $X_k, k=\overline{1,K}$ (e.g. 'Number of people involved in the project' is the first parameter of a project evaluation - x_1, 'Customer's experience of working with this project team' is the second parameter - x_2 etc.). The total number of parameters is K=23.

Every parameter has four values $X_k = \{x_{1k}, x_{2k}, \ldots, x_{4k}\}$ that correspond with possible situations in a project. For example, the project parameter 'Number of people involved in the project' can be: 'More than 100 people' (x_{11} = 1), 'From 30 to 100 people' (x_{21} = 2), 'From 10 to 30' (x_{31} = 3), and 'Less than 10 people' (x_{41} = 4).

Stakeholders evaluate the project using given parameters by mapping the project to parameters values using a membership function (Kononenko & Lutsenko, 2017). The project evaluation $B = \{B_1, B_2, ..., B_K\}$ represents a fuzzy set where $B_k = \{\langle x_{1k}, \mu_{B_k}(x_{1k})\rangle, \langle x_{2k}, \mu_{B_k}(x_{2k})\rangle, ..., \langle x_k, \mu_{B_k}(x_k)\rangle\}$.

Membership function $\mu_{B_k}(x_k), i = \overline{1, I}$ defines how the project is mapped to the i-th situation of the k-th questionnaire parameter.

If one of the parameter's possible situations entirely meets the project and three others are not suitable, the value of membership function for the suitable situation equals 1 and for three others it equals 0. For example, the evaluation $B_2 = \{\langle 1,0\rangle, \langle 2,0\rangle, \langle 3,1\rangle, \langle 4,0\rangle\}$ means that the project customer has never worked with any member of the project team but a team leader.

If one possible situation cannot fully describe the project conditions, the membership function value will show the compliance degree between the project and all parameter's possible situations. For example, the evaluation $B_3 = \{\langle 1,0\rangle, \langle 2,0.5\rangle, \langle 3,0.5\rangle, \langle 4,0\rangle\}$ demonstrates the case when the project's conditions cannot be described by one possible situation of the parameter 'Work experience in the given field'. This evaluation shows that half of the project team has less than 2 years of work experience while the other half has been working in the given field from 2 to 5 years.

The PMGuide development project evaluation gained from its main stakeholders is shown in Table 1.

Table 1: Project evaluation (B)

Parameter, X_k	Possible situation, $i = \overline{1,4}$	Parameter value, x_{ik}	Membership function, $\mu_{B_k}(x_k)$
Number of people involved in the project			
Number of people involved in the project, X_1	More than 100	1	0
	From 30 to 100	2	0
	From 10 to 30	3	0
	Less than 10	4	1
Customer's experience of working with this project team			
Customer's experience of working with this project team, X_2	Has never worked with this team	1	0
	Worked with some members of the team	2	0
	Worked with the project team leader	3	1
	One or more common projects with the whole project team	4	0
Evaluation of the Project Team's Competence by the Project Manager			
Work experience in the given field, X_3	No work experience	1	0
	Less than 2 years of work experience	2	0.5
	From 2 to 5 years of work experience	3	0.5
	More than 5 years of work experience	4	0

Table 1: Project evaluation (B) (continued)

Parameter, X_k	Possible situation, $i=\overline{1,4}$	Parameter value, x_{ik}	Membership function, $\mu_{B_k}(x_k)$
Understanding of requirements, adapting ability, initiative, X_4	Almost do not understand the requirements; require frequent explanations and constant control	1	0
	Understand the requirements, can follow them, but require regular control	2	0.5
	Understand the requirements, can follow them, do not require regular control	3	0.5
	Have a good understanding of the requirements; can follow them without regular control; can suggest better alternatives	4	0
Cooperation experience, X_5	Have never worked together	1	0.33
	Worked together on the creation of a product but in the different field	2	0
	Worked together on the creation of one product in a field of interest	3	0.67
	Worked together on the creation of several products in the field of interest	4	0
Knowledge of applied tools and methods, X_6	Tools and methods, applied in the given project, have never been used before and are unknown to the team	1	0
	Tools and methods, applied in the project, are known to the team but have never been used before	2	0
	Tools and methods, used in the project, are known to the team but are rarely used	3	0
	Tools and methods are known to the team and have been widely used before	4	1
Learning ability, X_7	It is hard for the team to learn new knowledge and technologies, and to adjust to changes	1	0
	For some members of the team, it is hard to learn new information and technologies, but the team can adjust to changes	2	1
	Easily absorb new knowledge, can adjust to changes	3	0
	The team can easily absorb information, always tries to learn something new; can well adjust to the changes	4	0
Team's ability to clearly formulate and openly express ideas, X_8	Can't clearly formulate ideas and rarely express them	1	0
	Can clearly formulate their ideas but rarely express them	2	0.17
	Can clearly formulate their ideas and openly express them	3	0.66
	Can clearly formulate, openly express and justify their ideas	4	0.17
Ability to admit mistakes, X_9	Don't admit their mistakes and can't learn from them	1	0
	Rarely admit their mistakes but try to never make them again	2	0
	Openly admit their mistakes and try to never make them again	3	1
	Openly admit their mistakes and always learn from them	4	0

Table 1: Project evaluation (B) (continued)

Parameter, X_k	Possible situation, $i=\overline{1,4}$	Parameter value, x_{ik}	Membership function, $\mu_{B_k}(x_k)$
Ability to admit mistakes, X_9	Don't admit their mistakes and can't learn from them	1	0
	Rarely admit their mistakes but try to never make them again	2	0
	Openly admit their mistakes and try to never make them again	3	1
	Openly admit their mistakes and always learn from them	4	0
Team's ability to work effectively in conditions of freedom or full regulation, X_{10}	Work effectively in conditions of full regulation	1	0
	Work effectively mostly in conditions of regulation	2	0
	Work effectively mostly in conditions of freedom	3	1
	Work effectively in conditions of full freedom	4	0
Reporting			
Means of communication, X_{11}	Written reports. Formal documentation	1	0
	Online texting (ICQ, E-mail)	2	0
	Voice communication (telephone connection, Internet-conference)	3	0
	Direct communication (meetings, video conferences)	4	1
The frequency of reporting to the Customer, X_{12}	Reports on every activity	1	0
	Reports on completing the blocks of work	2	0
	Reports on the readiness of a project product component	3	1
	Reports about project finish	4	0
Understanding the scope of works, X_{13}	There is a full list of works; further alternation is impossible	1	0
	There is a detailed list of works, further alternation is possible	2	0
	There is an approximate list of project works	3	1
	The team understands the project goal and several ways for its achievement	4	0
Project Manager's Responsibility and Main Requirements to the Project			
Consequences in case of unsatisfactory project outcome, X_{14}	The threat to human life	1	0
	Loss of irreplaceable sum of money	2	0
	Loss of a significant sum of money	3	1
	Loss of insignificant sum of money/ reputational loss	4	0
Project cost, X_{15}	More than 1 million $	1	0
	From 300 thousand to 1 million $	2	0
	From 100 to 300 thousand $	3	0
	Less than 100 thousand $	4	1
Requirements to the project quality, X_{16}	Highest international requirements	1	0
	International requirements	2	0
	National requirements	3	0
	Local requirements	4	1
Requirements to the realization period of the project, X_{17}	The period is unlimited	1	0
	Not very urgent	2	1
	Urgent	3	0
	Very urgent	4	0

Table 1: Project evaluation (B) (continued)

Parameter, X_k	Possible situation, $i=\overline{1,4}$	Parameter value, x_{ik}	Membership function, $\mu_{B_k}(x_k)$
Requirements to the precise compliance with a deadline, X_{18}	The deadline should be strictly met	1	0
	Insignificant deviation from the deadline is allowed	2	1
	Considerable deviation from the deadline is allowed	3	0
	Compliance with the deadline is not strictly required	4	0
Requirements change percent /month, X_{19}	Less than 7%	1	0
	From 7 to 25%	2	0
	From 25 to 45%	3	0.5
	More than 45%	4	0.5
	Risk Events Probability		
The probability of occurrence of risk events associated with the object architecture, technologies, and processes of its creation, quality indicators, X_{20}	Risk events are not likely to occur [0,0.1]	1	0
	Risk events might occur (0.1,0.5]	2	1
	Risk events are highly likely to occur (0.5,0.75]	3	0
	Risk events will most probably occur (0.75,1]	4	0
The probability of external risk events occurrence (disruption of work by contractors, unfavorable political/economic situation in the country, market changes, etc.), X_{21}	Risk events are not likely to occur [0,0.1]	1	1
	Risk events might occur (0.1,0.5]	2	0
	Risk events are highly likely to occur (0.5,0.75]	3	0
	Risk events will most probably occur (0.75,1]	4	0
The probability of organizational risk events occurrence (disruption of funding, delivery of resources, inaccurate prioritizing, etc.), X_{22}	Risk events are not likely to occur [0,0.1]	1	0
	Risk events might occur (0.1,0.5]	2	1
	Risk events are highly likely to occur (0.5,0.75]	3	0
	Risk events will most probably occur (0.75,1]	4	0
The probability of managerial risk events occurrence (inefficient planning, controlling, communication problems, etc.), X_{23}	Risk events are not likely to occur [0,0.1]	1	0
	Risk events might occur (0.1,0.5]	2	0
	Risk events are highly likely to occur (0.5,0.75]	3	1
	Risk events will most probably occur (0.75,1]	4	0

4.2 Basis selection

For an expert, it can be easier to form the methodology using some approach as a basis than create it all by himself. The method stage 'Select the basis' is optional but, at least, it allows defining what type of methodology is more appropriate for the project (whether it should be some heavy-weighted plan-driven methodology or a flexible agile, or a hybrid of such methodologies is more beneficial).

Using the project evaluation gained on the previous stage and the method given in (Kononenko & Lutsenko, 2017) we can select a project management approach that fits the project the most.

Each approach was previously evaluated by its applicability to the situations described in the questionnaire (Table 1) (Kononenko & Lutsenko, 2017). The degree of compliance between the approach and a specific situation is fuzzy. That is why we used fuzzy sets for its description.

We will consider the applicability of the r-th approach to each situation of the k-th parameter $X_k = \{x_{1k}, x_{2k}, ..., x_k\}$ as a fuzzy set $A_k, k = \overline{1, K}$,

$$A_k = \{\langle x_{1k}, \mu_{A_k}(x_{1k})\rangle, \langle x_{2k}, \mu_{A_k}(x_{2k})\rangle, ..., \langle x_k, \mu_{A_k}(x_k)\rangle\}$$

The membership function $\mu_{A_k}(x_k), i = \overline{1, I}$ defines how the r-th approach is mapped to the i-th situation of the k-th questionnaire parameter. The membership functions of all considered approaches are defined by experts in (Kononenko & Lutsenko, 2017). Figure 2 illustrates an example of the SCRUM membership function graphical representation for the first questionnaire parameter.

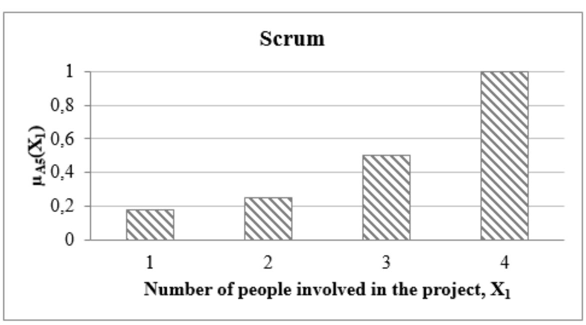

Figure 2: Scrum membership function (parameter x_1)

A project management approach A_r, $r = \overline{1, R}$ is characterized by its applicability to each situation of all parameters (i.e. $A_r = \{A_{r1}, A_{r2}, ..., A_K\}$).

The best approach for the project is the closest one. It means that to find the most appropriate approach to managing a project we should calculate fuzzy distances from the project evaluation B to all alternative approaches A_r, $r = \overline{1, R}$. Calculating total distances, we will take into consideration that the distance between the project evaluation B and an approach A_r, $r = \overline{1, R}$ for the i-th value of the k-th parameter is:

$$d_k(A_r, B) = \begin{cases} 0, \text{ if } \left(\mu_{A_k}(x_{ik}) - \mu_{B_k}(x_{ik})\right) \geq 0 \\ \left(\mu_{A_k}(x_{ik}) - \mu_{B_k}(x_{ik})\right), \text{ else.} \end{cases}$$

In this case, if the value of the membership function for the approach is superior to the value of the membership function for the project or equal to it, the distance between these two coordinates should be considered as zero. In other words, the membership function for the project is covered by the membership function for the approach or, else, the approach is fully consistent with the project.

Formulas for calculation of total Hamming and total Euclidean distances, as well as results of the calculation, are shown in Table 2. The approaches membership functions and project parameters weight coefficients were described in (Kononenko & Lutsenko, 2017)

The minimum distance both for Hamming and Euclidean methods is reached for Scrum project management methodology. So, Scrum methodology is recommended as a basis for the further methodology formation. Other closest methodologies are XP and Kanban. These results indicate that for the given project agile project management methodologies are more suitable than plan-driven approaches (PMBOK, ISO21500, PRINCE2, and SWEBOK).

4.3 Alternative methodologies formation

An expert has formed two alternative specialized methodologies for the PMGuide software development project. An expert here is a person who has a comprehensive knowledge of methodologies included in GBOK.

The first methodology was created by modification of Scrum project management methodology (the primary approach).

For the second alternative, an expert has selected DSDM as a basis (other famous methodology from the agile family) and supplemented it by components from PRINCE2 and Scrum methodologies.

Both specialized methodologies have their composition of project management values and principles, project life cycle, organizational structure, roles and responsibilities, processes, and practices (Table 3).

Table 2: Calculation of the total weighted Hamming and Euclidean distances

Approach	Hamming distance $d_\alpha(A_r,B)=\sum_{k=1}^{K}\alpha_k\sum_{i=1}^{I}\left|d_k(A_r,B)\right|$	Euclidean distance $e_\alpha(A_r,B)=\sum_{k=1}^{K}\alpha_k\sqrt{\sum_{i=1}^{I}(d_k(A_r,B))^2}$
PMBOK, A_1	0.608	0.588
ISO21500, A_2	0.608	0.588
PRINCE2, A_3	0.663	0.643
SWEBOK, A_4	0.578	0.558
Scrum, A_5	0.139	0.139
XP, A_6	0.295	0.292
Kanban, A_7	0.365	0.340

Table 3: Alternative specialized project management methodologies

The first methodology	The second methodology
Values and principles in project management	
• Individuals and interactions over processes and tools • Working software over comprehensive documentation • Customer collaboration over contract negotiation • Responding to change over following a plan	
• Empirical Process Control • Self-organization • Collaboration • Value-based Prioritization • Time-boxing • Iterative Development	• Focus on the business need • Deliver on time • Collaborate • Never compromise quality • Build incrementally from firm foundations • Develop iteratively • Communicate continuously and clearly • Demonstrate control

Table 3: Alternative specialized project management methodologies (continued)

The first methodology	The second methodology
Project life cycle	
Adaptive	Hybrid
Organizational structure in project management	
Project-oriented organizational structure	
Roles and responsibilities in project management	
• Scrum Master • Product Owner • Scrum Team	• Business Sponsor • Business Visionary • Business Ambassador • Technical Coordinator • Solution Developer • Solution Tester • Project Manager • Team Leader • Business Analyst
Project management processes	
• Develop Epic(s) • Create Prioritized Product Backlog • Conduct Release Planning • Create User Stories • Approve, Estimate, and Commit User Stories • Create Tasks • Estimate Tasks • Create Sprint Backlog • Conduct Daily Standup • Groom Prioritized Product Backlog • Demonstrate and Validate Sprint • Retrospect Sprint • Ship Deliverables • Retrospect Project	• Capture previous lessons • Prepare the outline Business Case • Producing the Business Case • Producing the Prioritized Requirement List • Producing the Solution Architecture Definition • Producing the Development Approach Definition • Producing the delivery plan • Creating the Timebox Plan • Revisiting the Prioritized Requirements List • Review of the Business Case • Timebox Review Record • Project Review Report • Benefits Assessment • Conduct Daily Standup
Project management practices	
• The Facilitated Workshop • MoSCoW prioritization • Iterative development • Timeboxing • Inspections	

Values and principles in project management. The four core values of Agile manifesto underlie both the first and the second alternative methodologies. Beside them, the first methodology has in its foundation six Scrum principles, while the second one relies on eight principles of DSDM methodology (Table 3).

Project life cycle. The first methodology assumes an adaptive project life cycle implementation. This project life cycle is the most consistent with Scrum methodology. For the second methodology, an expert has selected the hybrid project life cycle that implies the simultaneous usage of adaptive and predictive approaches during a project life cycle (PMI, 2018). This option is typical for the situation when the team gradually moves to agile methodologies and uses some of their best practices (e.g., short iterations, daily meetings, and retrospectives) but other aspects of the project, such as preliminary assessment, job assignment, and tracking progress, are still performed according to predictive approaches.

Organizational structure in project management. For both methodologies the project-oriented organizational structure is advisable. This structure fits the best selected agile values and principles, and project life cycles.

Roles and responsibilities in project management. The first methodology assumes the application of Scrum roles and responsibilities. The second methodology prescribes to team members the DSDM roles and responsibilities (Table 3).

Project management processes. For the first methodology, an expert has selected 14 processes of Scrum methodology (SBoK version). The second methodology has been formed using processes of DSDM, PRINCE2 and Scrum methodologies. Table 3 shows complete lists of methodologies processes.

Project management practices. Both methodologies involve the same set of DSDM and FDD project management practices (Table 3).

4.4 Methodology selection

4.4.1 The first methodology estimation

TThe methodology estimation assumes the definition of three core measures associated with its implementation::

- project management laboriousness;
- project management cost;
- project management risks.

For the first two measures calculation, it is necessary to define all project management processes performers, their hourly rates, and, approximately, how long they might be involved in the processes' execution.

Table 4 performs all team members, needed for the first methodology implementation, and their hourly rates. The role and responsibilities of Product Owner are delegated to the Customer representative.

Table 5 lists the selected management processes, their planned performers and approximate laboriousness estimates. According to the method of methodology synthesis (Kononenko, Aghaee, & Lutsenko, 2016), the laboriousness is represented in the form of triangular fuzzy values. A cost per performer estimate represents the multiplication of the performer laboriousness estimate by his hourly rate.

The total process laboriousness equals the sum of all its performers' laboriousness estimates. The process cost equals the sum of all its costs per performers' estimates.

The total project management laboriousness represents the total of all processes laboriousness, while its total cost equals the sum of all processes costs, respectively.

The project management laboriousness for the first methodology equals <226.5, 295.5, 339.5> man-hours, its cost – $<1006.25, 1311.75, 1507.25>.

The scale for evaluating the consequences of the risk events occurrence is given in Table 6. Risk events associated with the methodology application, as well as their assessments are presented in Table 7.

Table 4: Project team members' roles and hourly rates (the first methodology)

Team member	Hourly rate*, $/hour
Product Owner	4
Scrum Master	6
Development team	
Middle Developer	7
Junior Developer	4
QA	3
Designer	2.5

**Hourly rates are common for Ukraine considering the position and experience of the specialist as of December 2018. Source: https://jobs.dou.ua/salaries*

Table 5: Project management laboriousness and cost estimation (the first methodology)

Process	Performer	Laboriousness estimate, T, man-hours	Hourly rate, $/hour	Cost estimate (T*Hourly rate), C, $.
8.4 Develop Epic(s)	Product Owner	<2, 4, 4>	4	<8, 16, 16>
	Scrum Master	<1, 1.5, 2>	6	<6, 9, 12>
	Middle Developer	<1, 1.5, 2>	7	<7, 10.5, 14>
	Junior Developer	<1, 1.5, 2>	4	<4, 6, 8>
	QA	<1, 1.5, 2>	3	<3, 4.5, 6>
	Designer	<1, 1.5, 2>	2.5	<2.5, 3.75, 5>
	Total	**<7, 11.5, 14>**	-	**<30.5, 49.75, 61>**
8.5 Create Prioritized Product Backlog	Product Owner	<2, 2, 3>	4	<8, 8, 12>
	Scrum Master	<2, 2, 3>	6	<12, 12, 18>
	Middle Developer	<2, 2, 3>	7	<14, 14, 21>
	Junior Developer	<2, 2, 3>	4	<8, 8, 12>
	QA	<2, 2, 3>	3	<6, 6, 9>
	Designer	<2, 2, 3>	2.5	<5, 5, 7.5>
	Total	**<12, 12, 18>**	-	**<53, 53, 79.5>**
8.6 Conduct Release Planning	Product Owner	<1, 1.5, 2>	4	<4, 6, 8>
	Scrum Master	<1, 1.5, 2>	6	<6, 9, 12>
	Middle Developer	<1, 1.5, 2>	7	<7, 10.5, 14>
	Junior Developer	<1, 1.5, 2>	4	<4, 6, 8>
	QA	<1, 1.5, 2>	3	<3, 4.5, 6>
	Designer	<1, 1.5, 2>	2.5	<2.5, 3.75, 5>
	Total	**<6, 9, 12>**	-	**<26.5, 39.75, 53>**
9.1 Create User Stories	Product Owner	<6, 8, 8>	4	<24, 32, 32>
	Scrum Master	<6, 8, 8>	6	<36, 48, 48>
	Middle Developer	<6, 8, 8>	7	<42, 56, 56>
	Junior Developer	<6, 8, 8>	4	<24, 32, 32>
	QA	<6, 8, 8>	3	<18, 24, 24>
	Designer	<6, 8, 8>	2.5	<15, 20, 20>
	Total	**<36, 48, 48>**	-	**<159, 212, 212>**

Table 5: Project management laboriousness and cost estimation (the first methodology) (continued)

9.2 Approve, Estimate, and Commit User Stories	Product Owner	<1.5, 1.5, 2.5>	4	<6, 6, 10>
	Scrum Master	<1.5, 1.5, 2.5>	6	<6, 9, 15>
	Middle Developer	<1.5, 1.5, 2.5>	7	<10.5, 10.5, 17.5>
	Junior Developer	<1.5, 1.5, 2.5>	4	<6, 6, 10>
	QA	<1.5, 1.5, 2.5>	3	<4.5, 4.5, 7.5>
	Designer	<1.5, 1.5, 2.5>	2.5	<3.75, 3.75, 6.25>
	Total	**<9, 9, 15>**	-	**<39.75, 39.75, 66.25>**
9.3 Create Tasks	Product Owner	<3, 4.5, 6>	4	<12, 18, 24>
	Scrum Master	<3, 4.5, 6>	6	<18, 27, 36>
	Middle Developer	<3, 4.5, 6>	7	<21, 31.5, 42>
	Junior Developer	<3, 4.5, 6>	4	<12, 18, 24>
	QA	<3, 4.5, 6>	3	<9, 13.5, 18>
	Designer	<3, 4.5, 6>	2.5	<7.5, 11.25, 15>
	Total	**<18, 27, 36>**	-	**<79.5, 119.25, 159>**
9.4 Estimate Tasks	Product Owner	<1.5, 2, 2.5>	4	<6, 8, 10>
	Scrum Master	<1.5, 2, 2.5>	6	<9, 12, 15>
	Middle Developer	<1.5, 2, 2.5>	7	<10.5, 14, 17.5>
	Junior Developer	<1.5, 2, 2.5>	4	<6, 8, 10>
	QA	<1.5, 2, 2.5>	3	<4.5, 6, 7.5>
	Designer	<1.5, 2, 2.5>	2.5	<3.75, 5, 6.25>
	Total	**<9, 12, 15>**	-	**<39.75, 53, 66.25>**
9.5 Create Sprint Backlog	Product Owner	<3, 4.5, 4.5>	4	<12, 18, 18>
	Scrum Master	<3, 4.5, 4.5>	6	<18, 27, 27>
	Middle Developer	<3, 4.5, 4.5>	7	<21, 31.5, 31.5>
	Junior Developer	<3, 4.5, 4.5>	4	<12, 18, 18>
	QA	<3, 4.5, 4.5>	3	<9, 13.5, 13.5>
	Designer	<3, 4.5, 4.5>	2.5	<7.5, 11.25, 11.25>
	Total	**<18, 27, 27>**	-	**<79.5, 119.25, 119.25>**
10.2 Conduct Daily Standup	Scrum Master	<7.5, 8, 8.5>	6	<45, 48, 51>
	Middle Developer	<7.5, 8, 8.5>	7	<52.5, 56, 59.5>
	Junior Developer	<7.5, 8, 8.5>	4	<30, 32, 34>
	QA	<7.5, 8, 8.5>	3	<22.5, 34, 25.5>
	Designer	<7.5, 8, 8.5>	2.5	<18.75, 20, 21.25>
	Total	**<37.5, 40, 42.5>**	-	**<168.75, 180, 191.25>**
10.3 Groom Prioritized Product Backlog	Product Owner	<4, 6, 8>	4	<16, 24, 32>
	Scrum Master	<1.5, 2, 3>	6	<9, 12, 18>
	Middle Developer	<1.5, 2, 3>	7	<10.5, 14, 21>
	Junior Developer	<1.5, 2, 3>	4	<6, 8, 12>
	QA	<1.5, 2, 3>	3	<4.5, 6, 9>
	Designer	<1.5, 2, 3>	2.5	<3.75, 5, 7.5>
	Total	**<11.5, 16, 23>**	-	**<49.75, 69, 99.5>**

Table 5: Project management laboriousness and cost estimation (the first methodology) (continued)

11.2 Demonstrate and Validate Sprint	Product Owner	<4.5, 6, 6>	4	<18, 24, 24>
	Scrum Master	<4.5, 6, 6>	6	<27, 36, 36>
	Middle Developer	<4.5, 6, 6>	7	<31.5, 42, 42>
	Junior Developer	<4.5, 6, 6>	4	<18, 24, 24>
	QA	<4.5, 6, 6>	3	<13.5, 18, 18>
	Designer	<4.5, 6, 6>	2.5	<11.25, 15, 15>
	Total	**<27, 36, 36>**	-	**<119.25, 159, 159>**
11.3 Retrospect Sprint	Scrum Master	<4.5, 6, 6>	6	<27, 36, 36>
	Middle Developer	<4.5, 6, 6>	7	<31.5, 42, 42>
	Junior Developer	<4.5, 6, 6>	4	<18, 24, 24>
	QA	<4.5, 6, 6>	3	<13.5, 18, 18>
	Designer	<4.5, 6, 6>	2.5	<11.25, 15, 15>
	Total	**<22.5, 30, 30>**	-	**<101.25, 135, 135>**
12.1 Ship Deliverables	Product Owner	<2, 3, 4>	4	<8, 12, 16>
	Scrum Master	<2, 3, 4>	6	<12, 18, 24>
	Total	**<4, 6, 8>**	-	**<20, 30, 40>**
12.2 Retrospect Project	Product Owner	<1.5, 2, 2.5>	4	<6, 8, 10>
	Scrum Master	<1.5, 2, 2.5>	6	<9, 12, 15>
	Middle Developer	<1.5, 2, 2.5>	7	<10.5, 14, 17.5>
	Junior Developer	<1.5, 2, 2.5>	4	<6, 8, 10>
	QA	<1.5, 2, 2.5>	3	<4.5, 6, 7.5>
	Designer	<1.5, 2, 2.5>	2.5	<3.75, 5, 6.25>
	Total	**<9, 12, 15>**	-	**<39.75, 53, 66.25>**
	Methodology total	***<226.5, 295.5, 339.5>***	-	***<1006.25, 1311.75, 1507.25>***

Table 6: Evaluation of risk events consequences

Negative consequences	Points
Impacts that lead to the termination or complete failure of the project	10
Impacts that lead to extremely significant project delays, budget overruns, deterioration of the project product quality	8-9
Impacts that lead to significant project delays, budget overruns, deterioration of the project product quality	6-7
Impacts that lead to not very significant project delays, budget overruns, deterioration of the project product quality	4-5
Impacts that lead to slightly noticeable delays in the project, budget overrun, deterioration of the project product quality	2-3
Negative effects are almost invisible	1
No negative effects	0

Table 7: The assessment of risks associated with the first methodology application

Risk event	The occurrence probability, P	The occurrence consequences, C, points	Risk assessment, R = P*C, points
Project participants do not accept Scrum values and principles	<0.05, 0.05, 0.05>	<7, 8, 8>	<0.35, 0.4, 0.4>
Team members don't understand/accept roles and responsibilities prescribed them by Scrum methodology	<0.1, 0.1, 0.1>	<7, 8, 8>	<0.7, 0.8, 0.8>
The lack of Customer's work experience as Product Owner	<0.2, 0.2, 0.2>	<5, 5, 6>	<1, 1, 1.2>
Contradictions between the standards and regulations of the contracting and / or executing organization(s) and the methodology	<0.05, 0.1, 0.15>	<5, 6, 8>	<0.25, 0.6, 1.2>
The Product Owner involvement in the project is insufficient for an optimal solution development	<0.4, 0.4, 0.4>	<7, 8, 8>	<2.8, 3.2, 3.2>
Project team self-organization and self-coordination are insufficient to work effectively according Scrum	<0.3, 0.3, 0.3>	<7, 8, 8>	<2.1, 2.4, 2.4>
Wrong prioritization of the product backlog	<0.35, 0.35, 0.35>	<5, 5, 6>	<1.75, 1.75, 2.1>
Ineffective sprint planning	<0.4, 0.4, 0.4>	<5, 6, 7>	<2, 2.4, 2.8>
The product inefficiency as a result of poor pre-project research and planning	<0.5, 0.5, 0.5>	<7, 8, 9>	<3.5, 4, 4.5>
Total risk assessment			**<14.45,16.55,18.6>**

The first methodology risks assessment equals <14.45, 16.55, 18.6>.

Table 8: Project team members' roles and hourly rates (the second methodology)

Project team member	Hourly rate, $/hour
Business Ambassador (Business Visionary)	4
Project Manager (Team Leader)	6
Development team	
Middle Developer (Technical Coordinator, Solution Developer)	7
Junior Developer (Solution Developer)	4
QA (Business Analyst, Solution Tester)	5
Designer	2.5

4.4.2 The second methodology estimation

The second methodology prescribes its roles to project participants. Table 8 shows which roles and hourly rates were assigned to team members. The project customer performs the role of Business Sponsor; the customer representative fulfills Business Ambassador and Business Visionary roles.

Table 9 lists the second methodology's management processes, their performers, laboriousness, and cost.

Table 9: Project management laboriousness and cost estimation (the second methodology)

Process	Performer	Laboriousness, T, man-hours	Hourly rate, $/hour	Cost (T*Hourly rate), C, $
12.4.2 Capture previous lessons (PRINCE2)	Project Manager	<1.5, 2, 2.5>	6	<9, 12, 15>
	Middle Developer	<1.5, 2, 2.5>	7	<10.5, 14, 17.5>
	Junior Developer	<1.5, 2, 2.5>	4	<6, 8, 10>
	QA	<1.5, 2, 2.5>	5	<7.5, 10, 12.5>
	Designer	<1.5, 2, 2.5>	2.5	<3.75, 5, 6.25>
	Total	**<7.5, 10, 12.5>**	-	**<36.75, 49, 61.25>**
12.4.4 Prepare the outline Business Case (PRINCE2)	QA	<2, 4, 5>	5	<10, 20, 25>
	Business Ambassador	<0.5, 1, 1.5>	4	<2, 4, 6>
	Total	**<2.5, 5, 6.5>**	**-**	**<12, 24, 31>**
8.2.2 Producing the Business Case (DSDM)	QA	<4, 6, 6>	5	<20, 30, 30>
	Business Ambassador	<2, 4, 4>	4	<8, 16, 16>
	Total	**<6, 10, 10>**	**-**	**<28, 46, 46>**
8.2.3 Producing the Prioritized Requirement List (DSDM)	QA	<4, 4, 5>	5	<20, 20, 25>
	Business Ambassador	<4, 4, 5>	4	<16, 16, 20>
	Total	**<8, 8, 10>**	**-**	**<36, 36, 45>**
8.2.4 Producing the Solution Architecture Definition (DSDM)	QA	<2, 4, 4>	5	<10, 20, 20>
	Business Ambassador	<0.5, 1, 1.5>	4	<2, 4, 6>
	Middle Developer	<3, 4, 6>	7	<21, 28, 42>
	Total	**<5.5, 9, 11.5>**	-	**<33, 52, 68>**
8.2.5 Producing the Development Approach Definition (DSDM)	Middle Developer	<2, 3, 4>	7	<14, 21, 28>
	Project Manager	<0.5, 0.5, 1>	6	<3, 3, 6>
	Total	**<2.5, 3.5, 5>**	**-**	**<17, 24, 34>**
8.2.6 Producing the delivery plan (DSDM)	Project Manager	<2, 2, 3>	6	<12, 12, 18>
	Business Ambassador	<0.5, 0.5, 1>	4	<2, 2, 4>
	Middle Developer	<0.5, 0.5, 1>	7	<3.5, 3.5, 7>
	Total	**<3, 3, 5>**	-	**<17.5, 17.5, 29>**

Table 9: Project management laboriousness and cost estimation (the second methodology) (continued)

Process	Performer	Laboriousness, T, man-hours	Hourly rate, $/hour	Cost (T*Hourly rate), C, $
8.2.11 Creating the Timebox Plan (DSDM)	Business Ambassador	<6, 8, 9>	4	<24, 32, 36>
	Project Manager	<6, 8, 9>	6	<36, 48, 54>
	Middle Developer	<6, 8, 9>	7	<42, 56, 63>
	Junior Developer	<6, 8, 9>	4	<24, 32,36>
	QA	<6, 8, 9>	5	<30, 40, 45>
	Designer	<6, 8, 9>	2.5	<15, 20, 22.5>
	Total	**<36, 48, 54>**	-	**<171, 228, 256.5>**
8.2.3 Revisiting the Prioritized Requirements List (DSDM)	Business Ambassador	<6, 9, 12>	4	<24, 36, 48>
	Project Manager	<12, 15, 18>	6	<72, 90, 108>
	Middle Developer	<12, 15, 18>	7	<84, 105, 126>
	Junior Developer	<12, 15, 18>	4	<48, 60, 72>
	QA	<12, 15, 18>	5	<60, 75, 90>
	Designer	<12, 15, 18>	2.5	<30, 37.5, 45>
	Total	**<66, 84, 102>**	-	**<318, 403.5, 489>**
8.2.2 Review of the Business Case (DSDM)	QA	<6, 6, 8>	5	<30, 30, 40>
	Business Ambassador	<2, 4, 4>	4	<8, 16, 16>
	Total	**<8, 12, 12>**	-	**<38, 46, 56>**
8.2.12 Timebox Review Record (DSDM)	Business Ambassador	<4.5, 6, 9>	4	<18, 24, 36>
	Project Manager	<4.5, 6, 9>	6	<27, 36, 54>
	Middle Developer	<4.5, 6, 9>	7	<31.5, 42, 63>
	Junior Developer	<4.5, 6, 9>	4	<18, 24, 36>
	QA	<4.5, 6, 9>	5	<22.5, 30, 45>
	Designer	<4.5, 6, 9>	2.5	<11.25, 15, 22.5>
	Total	**<27, 36, 54>**	-	**<128.25, 171, 256.5>**
8.2.13 Project Review Report (DSDM)	Business Ambassador	<1, 2, 3>	4	<4, 8, 12>
	Project Manager	<1, 2, 3>	6	<6, 12, 18>
	Middle Developer	<1, 2, 3>	7	<7, 14, 21>
	Junior Developer	<1, 2, 3>	4	<4, 8, 12>
	QA	<1, 2, 3>	5	<5, 10, 15>
	Designer	<1, 2, 3>	2.5	<2.5, 5, 7.5>
	Total	**<6, 12, 18>**	-	**<28.5, 57, 85.5>**
8.2.14 Benefits Assessment (DSDM)	QA	<2, 4, 4>	5	<10, 20, 20>
	Business Ambassador	<2, 4, 4>	4	<8, 16, 16>
	Total	**<4, 8, 8>**	-	**<18, 36, 36>**

Table 9: Project management laboriousness and cost estimation (the second methodology) (continued)

10.2 Conduct Daily Meetings (Scrum)	Project Manager	<7.5, 8, 8.5>	6	<45, 48, 51>
	Middle Developer	<7.5, 8, 8.5>	7	<52.5, 56, 59.5>
	Junior Developer	<7.5, 8, 8.5>	4	<30, 32, 34>
	QA	<7.5, 8, 8.5>	5	<37.5, 40, 42.5>
	Designer	<7.5, 8, 8.5>	2.5	<18.75, 20, 21.25>
	Total	**<37.5, 40, 45.5>**	**-**	**<183.75, 196, 208.25>**
Total for the methodology		***<219.5, 286.5, 351>***	**-**	***<1065.75, 1386, 1702>***

Table 10: The assessment of risks associated with the second methodology application

Risk event	The occurrence probability, P	The occurrence consequences, C (points)	Risk assessment, R = P*C
Project participants do not accept DSDM values and principles	<0.35, 0.4, 0.45>	<7, 8, 8>	<2.45, 3.2, 3.6>
Team members don't understand/accept roles and responsibilities prescribed them by DSDM	<0.35, 0.4, 0.45>	<7, 8, 8>	<2.45, 3.2, 3.6>
The lack of customer/ his representative work experience as Business Sponsor/Business Visionary	<0.2, 0.2, 0.2>	<5, 5, 6>	<1, 1, 1.2>
Contradictions between the standards and regulations of the contracting and / or executing organization(s) and the methodology	<0.1, 0.15, 0.2>	<5, 6, 8>	<0.5, 0.9, 1.6>
Business Sponsor/Business Visionary involvement in the project is insufficient for an optimal solution development	<0.15, 0.2, 0.2>	<7, 8, 8>	<1.05, 1.6, 1.6>
Project team self-organization and self-coordination are insufficient to work effectively according DSDM	<0.15, 0.2, 0.25>	<7, 8, 8>	<1.05, 1.6, 2>
Problems associated with assigning multiple DSDM roles to one team member	<0.5, 0.5, 0.57>	<5, 6, 6>	<2.5, 3, 3.42>
Total risk assessment			**<11, 14.5, 17.02>**

The project management laboriousness for the second methodology equals <219.5, 286.5, 351> man-hours, its cost – $<1065.75, 1386, 1702>.

Risk events associated with the methodology application, as well as their assessments are presented in Table 10.

Comparative charts in Figures 3-5 illustrate project management laboriousness and cost for both alternative methodologies, as well as project risks associated with their application.

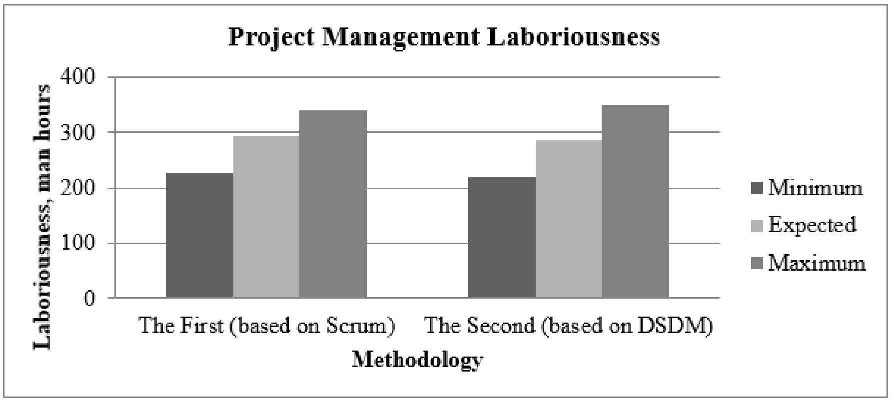

Figure 3: The project management laboriousness comparison

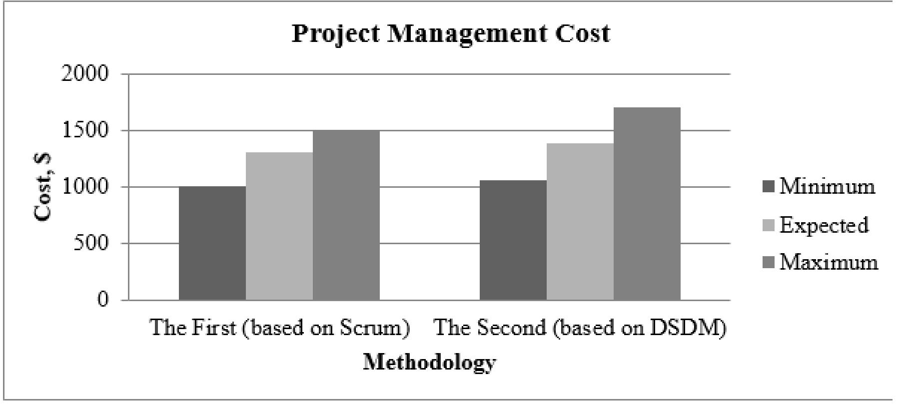

Figure 4: The project management cost comparison

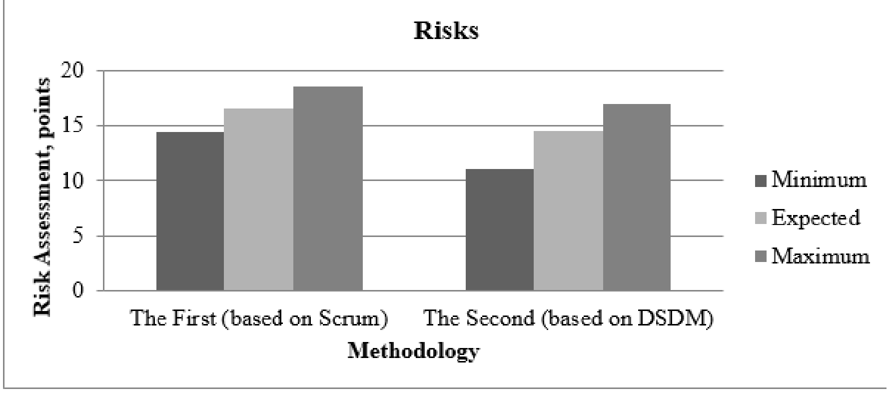

Figure 5: Risks assessments comparison

4.4.3 The first methodology estimation

On this stage we reveal which methodology is the most suitable for the project, using the mathematical model described in (Kononenko, Aghaee, & Lutsenko, 2016).

Target functions will take the form (1) – (3).

$$C(X)=\langle 1006.25, 1311.75, 1507.25\rangle x_1+\langle 1065.75, 1386, 1702\rangle x_2 \to \min_X,$$
$$T(X)=\langle 226.5, 295.5, 339.5\rangle x_1+\langle 219.5, 286.5, 351\rangle x_2 \to \min_X,$$
$$R(X)=\langle 14.45, 16.55, 18.6\rangle x_1+\langle 11, 14.5, 17.02\rangle x_2 \to \min_X,$$

where $X=(x_1,x_2),\ x_h=\{0,1\},\ h=1,2,\ \sum_{h=1}^{H} x_h=1,$

$x_h=1$, if h-th alternative is applied, $x_h = 0$ else.

The cost of project management should not exceed $1750. It means that the cost limit is C^{per} = 1750 $:

$$C(1,0)=\langle 1006.25, 1311.75, 1507.25\rangle < 1750,$$
$$C(0,1)=\langle 1065.75, 1386, 1702\rangle < 1750.$$

All alternative methodologies meet the limit.

The problem of one-criterion optimization for each target function should be solved to normalize target functions for their further comparison. But first, let us defuzzify obtained fuzzy values:

$$C^d(1,0)=\frac{1006.25+1311.75+1507.25}{3}=1275.08.$$
$$C^d(0,1)=\frac{1065.75+1386+1702}{3}=1384.58.$$
$$T^d(1,0)=\frac{226.5+295.5+339.5}{3}=287.17.$$
$$T^d(0,1)=\frac{219.5+286.5+351}{3}=285.67.$$
$$R^d(1,0)=\frac{14.45+16.55+18.6}{3}=16.53.$$
$$R^d(0,1)=\frac{11+14.5+17.02}{3}=14.17.$$

$C^d(X)$, $T^d(X)$, $R^d(X)$ - defuzzification values of the project management cost, laboriousness, and risks associated with the methodology applied.

The target functions minimum values will be equal to:

$$C^{opt}=\min\{1275.08, 1384.58\}=1275.08.$$
$$T^{opt}=\min\{287.17, 285.67\}=285.67.$$
$$R^{opt}=\min\{16.53, 14.17\}=14.17.$$

Based on the results, we can calculate the target functions normalized values:

$$C^{nom}(1,0)=\frac{C^d(1,0)-C^{opt}}{C^{opt}}=\frac{1275.08-1275.08}{1275.08}=0.$$
$$C^{nom}(0,1)=\frac{C^d(0,1)-C^{opt}}{C^{opt}}=\frac{1384.58-1275.08}{1275.08}=0.086.$$
$$T^{nom}(1,0)=\frac{T^d(1,0)-T^{opt}}{T^{opt}}=\frac{287.17-285.67}{285.67}=0.005.$$
$$T^{nom}(0,1)=\frac{T^d(0,1)-T^{opt}}{T^{opt}}=\frac{285.67-285.67}{285.67}=0.$$
$$R^{nom}(1,0)=\frac{R^d(1,0)-R^{opt}}{R^{opt}}=\frac{16.53-14.17}{14.17}=0.167.$$
$$R^{nom}(0,1)=\frac{R^d(0,1)-R^{opt}}{R^{opt}}=\frac{14.17-14.17}{14.17}=0.$$

The minimax criterion:

$$X^{opt}=\arg\min\begin{Bmatrix}\max\{C^{nom}(1,0), T^{nom}(1,0), R^{nom}(1,0)\}\\ \max\{C^{nom}(0,1), T^{nom}(0,1), R^{nom}(0,1)\}\end{Bmatrix}=$$

$$=\arg\min\begin{Bmatrix}\max\{0, 0.005, 0.167\},\\ \max\{0.086; 0; 0\}\end{Bmatrix}=\arg\min\{0.167, 0.086\}=(0,1).$$

Thus, the second methodology, which represents a combination of DSDM, PRINCE2, and Scrum methodologies, is the most appropriate for the given project according to the minimax approach. In case of its application, the cost of project management is $<1065.75, 1386, 1702>, its laboriousness - <219.5, 286.5, 351> man-hours, and risks associated with its applying – <11.0, 14.5, 17.02>..

5 Conclusions

The results obtained in the paper show that it is important to consider specific conditions of the project and its environment solving the task of the methodology selection to improve the project performance. It is necessary to take into account that each ready-made project management methodology has its specific strengths and weaknesses, and as usual can't cover all project needs. That is why any methodology selected must be tailored to fit the project or the specialized methodology should be created.

It should be noted that an ideal methodology does not exist. The environment is constantly changing and the methodology, which was the best in some conditions, will begin to show flaws in others. However, for quasi-stationary conditions, you can choose the best option among all possible in the sense of multi-criteria choice. The Project Management Methodology Formation's Method proposed in the paper allows us to solve both tasks: 1) the ready-made methodology selection, 2) the specialized methodology formation. The ready-made methodology selection task can be easily solved by any project manager on the pre-initiating project phase using the method described. It doesn't require any specific knowledge or investigations. A project manager should only evaluate his project using questionnaires proposed and analyze the results of the method application. The specialized methodology formation task requires the person who applies the method a deep understanding of methodologies gathered in GBOK and their components. That is why these stages of the method are more suited for consulting companies and for expensive and responsible projects (for the cases when it is reasonable to involve experts).

A limitation of the method is that it is designed for the analysis of individual projects, rather than a set of projects simultaneously.

The method was applied to a project dedicated to PMGuide web application development. Scrum was defined as a basic methodology for the project as a result of the project evaluation on a special questionnaire. Then, two alternative methodologies were created and evaluated by an expert: 1) based on Scrum; 2) based on DSDM. Both methodologies are Agile. The second alternative turns out to be more expensive and labor-intensive but less risky. It was a risk that was crucial in decision-making. The pre-project phase is of great importance for the considered project and comprehensive documentation created on this stage became the main advantage of DSDM compared to Scrum.The complexity of calculations and the usage of expert evaluations can be considered as the main limitations of the proposed method. It is proposed to use the criteria of laboriousness, cost, and risks to select or form a methodology. Solving the problem, it is also necessary to take into account the influence of methodology on the quality of the project product, on economic, social, technological effects, environmental impact and possibly other effects (political, military and others). The concept of risk allows reflecting the potential problems with these effects and simplifies the task.

Therefore, a significant dependence of the results on the accuracy of the labor input, management costs, and risk estimates is considered as a disadvantage of the method.

That is why the further areas of work are 1) software development (to perform all calculations automatically with a specialized web application), 2) the experts' selection method creation (to be sure that all experts evaluations used are verified).

The complex collection of relevant project data in the pre-initialization phase could be time and cost consuming. But these expenses are justified for large, complex, expensive, and responsible projects.

The project was managed using the formed methodology. The result of the project (PMGuide web application) meets all requirements; the project is performed according to its initial time and costs limitations. The given method can be applied to form a project management methodology for any IT project.

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Pristopi k oblikovanju metodologije vodenja projektov

Ozadje in namen: Izbira „prave“ metodologije vodenja projektov je za konkretni projekt zelo pomembna. Metodologija vodenja vpliva na ključne parametre projekta, kot so stroški, trajanje, kakovost izdelka in uspeh projekta na splošno. Namen te študije je predstaviti metodo za oblikovanje metodologije vodenja projektov in prikazati njeno uporabnost na primeru projekta za razvoj programske opreme.
Oblikovanje / metodologija / pristop: V tej študiji predstavimo način oblikovanja metodologije vodenja projektov, ki omogoča oblikovanje specializirane metodologije za kateri koli IT projekt ob upoštevanju nejasnosti informacij o projektu, njegovem okolju in obstoječih priporočil strokovnjakov. Metoda vključuje 1) zbiranje izhodiščnih informacij s pomočjo vprašalnika, 2) izračunavanje uteženih Hammingov in evklidskih razdalj, 3) reševanje problema s tremi kriteriji optimizacije z uporabo pristopa minimax z mehkimi vhodnimi podatki.
Rezultati: Za oblikovanje specializirane metodologije upravljanja projektov za IT-projekt je bilo uporabljenih vseh šest stopenj metode oblikovanja projektne metodologije (evalvacija projektov, izbira osnove, oblikovanje alternativnih metodologij, izbira metodologije, uporaba metodologije in krojenje metodologije). Za upravljanje projekta je bila izbrana in uporabljena najustreznejša alternativa, ki temelji na DSDM.
Zaključki: Dana metoda omogoča oblikovanje specializirane metodologije upravljanja projektov, ki temelji na sestavnih delih splošnega znanja za kateri koli IT projekt ob upoštevanju posebnih pogojev projekta in njegovega okolja.

Ključne besede: metodologija, vodenje projektov, formacija, uporaba, metoda