AGILE ENHANCEMENT

OF CRITICAL PMBOK V6 PROCESSES

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KEYWORDS: PMBOK, AGILE, IT PROJECT MANAGEMENT, PROJECT MANAGEMENT FRAMEWORK, TAILORING, SCRUM

Abstract: This article examines PMBOK version six applicability in agile IT projects. Based on existing scientific research about the troubling compatibility of PMBOK processes and agile frameworks, enhancements of five critical project processes are postulated. These process enhancements often focus on time-limited disruptions of agile actions and separation of macro- and micro- management between agile developments and project management practices. To verify the effectiveness of such enhancement approaches, a quantitative survey explores the applicability and current state of usage. Results show that most proposed solutions are currently not widely used in IT project management although practitioners have evaluated them as useful. However, participants tend to increase the use when understanding more about the solutions. In combination with the discovered positive rating of the effectiveness of enhancement approaches, it can be summarized that the improvement approaches are a well-perceived step towards the enhancement of PMBOK processes in agile developed IT projects.

1. INTRODUCTION

The profession of project management is driven and pushed towards standardization and professionalism by project management frameworks like the project management body of knowledge (PMBOK) of PMI Organization (PMI, 2017) or PRINCE2 framework of AXELOS Organization (Axelos, 2017). All these different project management frameworks have two things in common. On the one hand, agile project management methodologies like SCRUM (Pichler, 2007) are trending enormously in many different industries besides software development. Therefore, the compatibility of well-established project management frameworks with agile methods, tools and cultures may become highly important for the profession. As project management traditionally facilitates control, plannability and reliability in its core values, it contradicts agile mindsets and values defined based on all agile frameworks, i.e., the agile manifesto (Agile Manifesto, 2001). These two worlds and mindsets are now converging and have to coexist in agile developed IT projects. Projects, managed by a traditional project manager are focused on schedule, budget and scope, but are developed by flexible and sprint-oriented development teams. This tension is the basis for the bigger research goal of solutions suitable for both approaches. To go one-step further in this research attempt, solutions for 5 critical project processes of the sixth version of the PMBOK project management framework are postulated and explained, followed by a statistical analysis of an online survey conducted with 95 project management practitioners.

2. BACKGROUND

The PMI organization has already started working in said direction by adding an "agile guideline" handbook to its newest sixth version of the PMBOK framework. However, this guideline only acts as an introduction to agility and agile methods. IT does not change or adapt the classic 49 processes defined in PMBOK as such. One goal of this research is to enlarge and adapt the existing PMBOK processes with methods and tools to make them more suitable for agile developed projects. To achieve this goal, two steps are required.

Firstly, critical PMBOK processes have to be identified and secondly, solutions for these challenges have to be proposed followed by an evaluation of their actual use in the project management profession. The authors analyzed "agile-critical" processes in the IEEE publication "Suitability of PMBOK 6th edition for agile developed IT Projects" (Rosenberger & Tick, 2018) based on literature research comparing roles, meeting structures and culture definition of SCRUM development with methods and approaches of PMBOK project processes. As a result of this comparison, five processes have been identified to cause problems:

- Manage Project Execution
- Develop Project Structure Plan
- Develop Project Schedule
- Estimate And Define Costs Based On Requirements
- Develop And Manage Team

3. DEVELOPMENT OF SOLUTION PROPOSALS FOR CHALLENGED PROJECT PROCESSES

Through extensive literature research and supported by the use of a basic point system for applicability of suitable success criteria, the following solutions have been identified as essential additions to future PMBOK processes:

3.1. Ad Critical Process "Manage Project Execution"

Challenge Description:

In classically developed projects, the project manager takes sole responsibility for the project team and the execution. (PMI, 2017). In agile developed IT projects according to SCRUM, the development team demands self-management. A SCRUM master, who moderates and documents the development teams' work and effort, supports such self-management. Such a lack of management within a sprint shows the challenge of this particular process.

Solution description:

Lewthwaite (2006) defines a "Strike" as a proactive intervention of a project manager overruling the self-management of SCRUM development teams. Once started, this overruling lasts for the remainder of the ongoing sprint. Triggers for such shifts in responsibilities need to be substantial because Strikes completely undermine the agile culture of self-management and trust. Triggers of such Strike events need to be defined in detail to create a common understanding and avoid negative personal feelings as much as possible. For instance, Strikes could, for example be triggered by:

- SCRUM Master intervention
- Danger of non-deliverable increments at the end of a sprint
- Extreme delay visualized in burn-down-charts
- Extreme bottlenecks visualized on KANBAN boards
- Great changes in effort estimations of user stories during a sprint in comparison to estimations in sprint planning meetings.

The Strike system is therefore a kind of "Management by Exception" methodology.

3.2. Ad Critical Process "Develop Project Structure Plan" and "Develop Project Schedule"

Due to the strong relation between PMBOK Processes "Structure Plan Development" and "Project Scheduling", these two processes are analyzed together

Challenge Description:

Traditional project management structures and schedules the whole project in the initial planning phase. This regards all work packages; even the uncertain future ones. There is no difference in the level of planning between certain and uncertain work packages, accepting that uncertain packages may change in the future causing the project schedule to be adapted. SCRUM totally avoids such restructuring and re-planning by focusing on the next sprint. This gap in the two approaches can result in major conflicts between agile developments and traditional project managers.

Solution description:

A combination of hybrid macro and micro-planning and project phase-specific backlogs

Hybrid Macro and Micro Planning of Project Schedule and Structure:

A hybrid approach could differentiate between a macro and micro structuring level - also separating the two cultures. The project manager keeps the overall scope and focuses by structuring the whole project according to general practice, i.e., with a project structure plan exclusively on a macro level, accepting not knowing definite responsibilities and durations. An example is only" T-shirt size" estimations on an epic instead of a user story level.

However, during actual development in development sprints, micro-planning in the form of planning poker story-point estimations can be used in sprint planning meetings to get into details.

After several sprints, a factor between actual effort and rough T-shirt size can be postulated. Consequently, project managers with experience in project delivery, could even get quite detailed structural estimations enabling them to develop an understanding of longer-term planning. (Wendt, 2016)

Project Phase-Specific Backlogs:

This approach does not change the structural planning in the initial project phases at all. A project manager will create a work breakdown structure and define project phases and major milestones based on a basic specification created in a traditional way. All these major project phases are then seen as "mini-agile-projects" within a traditional project. Each phase has its specific backlog, SCRUM team and goal. With such an approach, the two cultures can easily coexist: at a big level, managed by a project manager in a traditional way, at a small level in a purely agile SCRUM-based approach with minimal project management interference. (The Project Group, 2019)

3.3. Critical Ad Process ""Estimate and Define Costs Based On Requirements"

Challenge Description:

Cost estimation in traditional projects normally consists of manpower-related costs and material-related costs. Sharing these concepts with all other projects, IT projects often develop most of their costs in relation to workforce. Often the actual time and effort invested by people are much more significant than investments in hardware or other material. Based on this understanding, the cost estimation can also be split into two parts:

- Material-related costs: These costs are untouched by agile development frameworks
- People-related costs: These costs are difficult to estimate and define as complete and traditional requirements are missing in SCRUM developed IT projects, due to constant backlog changes.

Thus, focusing on people-related costs, the following two approaches could be used and integrated into PMBOK processes.

Solution description:

A combination of velocity-based estimations and MVP (Minimal Viable Product) estimations:

Cost estimation based on Development Velocity

Velocity is a key performance indicator of agile development teams, describing the average amount of Story Points developed in each sprint, i.e., the speed at which the SCRUM teams are developing. Frequently, this measurement is also used in portfolio management of agile developed project portfolios (Rouse, 2013). Knowing and tracking the velocity of development teams can enable an agile project manager to estimate project costs. Being familiar with the developers involved as well as their internal and external hourly rates, the project manager can summarize the cost of one story point, or one average user story based on the amount of user stories developed by the team in one sprint. Hence, relying on the planning of the work breakdown structure and project scheduling and knowing the development teams and their costs and velocity, the project manager can simply multiply planned development effort with velocity-related cost factors and develop the cost planning in the same way as the scheduling. It is important to mention that the velocity can change, which might entail a change of the cost factor. The project manager needs to keep constant track of this factor.

Fixed Minimal Viable Product and unplanned ongoing feature development costs

An MVP is often used as the basic concept of so-called "hybrid" IT projects. It is the smallest, fastest and simplest set of features providing desired functionality without taking care of usability, design, safety, reliability and all other necessary factors of a quality system. In hybrid IT projects, the development of such MVPs is planned and executed in a classical waterfall approach, which is easily manageable with PMBOK processes due to the high level of planning activities and rigid structure. After finalization of the MVP increment, features and "quality" are added to the system in a strictly agile way. This hybrid approach of splitting MVPs and agile feature integration can also be used to solve cost estimation gaps in agile projects. Classical cost estimations are used to define MVP costs; no cost estimation is used for agile feature integration later on. This allows strict separation of agile and classical frameworks, thus avoiding problems. (Sharma, 2017)

3.4. Critical Ad Processes "Develop and Manage Team"

Challenge Description:

According to PMBOK (PMI, 2017), the project manager is responsible for organizing and managing project resources, including human resources. The organizational part is not as critical. A project manager can and will set up a project team and include development teams in the initial project phase. As soon as the development team is set up, it demands self-management, i.e., there should not be active management and controlling from outside. This characteristic is very strong in SCRUM. The teams share work and tasks internally and are even "protected by a SCRUM master from outside disturbances. Consequently, the management tasks are transferred to the team itself as soon as the project management has set up a development team. This shift in responsibility can cause trouble in a project and challenge a traditional PMI project manager who needs to take overall project responsibility.

Solution description:

The combination of an adapted Strike system with a project manager who takes the role as a SCRUM master.

Adaptation of Strike System for team management

As described in the first process, Lewthwaite (2006) mentions a Strike system as a potential compromise to share responsibility between self-managing SCRUM teams and outside project managers. This approach cannot only be used in project execution, but also in team-management processes. A potential trigger of Strike-Situations, in which the project manager will pause self-management of the team and take over, could be a retrospective meeting, in which problems within the development team are discussed. It is important to define clear situations within that retrospective to start a Strike action. Otherwise, development teams will always hesitate to solve problems within the retrospective meeting in fear of a potential loss of self-management.

Project Manager takes role as SCRUM Master

If a project manager is comfortable with merely being "inside" of a self-managing development team but accepts their demands of self-organization, he or she could take the role of a SCRUM master. Within this role, the project manager can actively trigger team problem-solving in retrospective events or even on a daily stand-up basis. The realization of a critical situation and the start of a problem-solving process is often sufficient to keep projects and team structures productive, even without acting as an authority and directly managing and deciding changes.

4. RESULTS OF SURVEY ABOUT CURRENT USE OF PROPOSED SOLUTIONS

4.1. Research Methodology

This research aims to test the relationship between the identified solutions based on literature research, the actual use of the solutions and the rating of these solutions by practitioners, performing an online survey and analyzing collected data with statistical tools (Blaxter et al, 1996).

4.2. Sampling Procedures

Sample selection was performed by identifying suitable candidates on the social network LinkedIn, as well as sending emails to a network of former Technical Management students at the UAS 'FH Campus Wien' in Vienna. Potential LinkedIn candidates work in IT project management in Germany/Austria/Switzerland, e.g., as a Project Director, Project Manager or Scrum Master. Overall, 650 invitations were sent to people with knowledge in project management from April to September 2020.

Current students at the involved universities (Vienna/Budapest) with previous work experience in those fields were also invited to participate, even if they did not work in management, but had a basic knowledge of project work and project outcomes, even though they might have lacked an overview of all aspects of their project. This ensured that participants with various levels of experience were included in the study, thus allowing candidates with different perceptions of project management to contribute to ensuring a wide variety of insights.

Participants were not asked to remember specific work-related events or details about completed or current projects but were given sample descriptions of problematic processes that might occur during a project in general.

4.3. Questionnaire Design

The questionnaire was produced using Google Survey and was published in German and English. The detailed structure and exact questions of the

questionnaire can be found in the Appendix. The quantitative survey was grouped in a demographical part and questions regarding the five processes.

First, each participant had to answer the demographic questions. Age was asked in an open answer format, sex, education level, type of employment, industry, years of project management experience as well as projects per year were asked with single choice format. The participants had to choose one of multiple options; obtained certificates were asked with a multiple-choice question and participants could choose from a list with 16 possible certificates as well as other options with the option to specify which other certificate they hold.

After that, the first process was described and a proposed solution (PS) was given. Then general questions about the PS and the problem that the solution should solve were asked. Participants had to state if they had difficulties using the process, if they were able to understand the proposed solution, if they had heard about the solution before, and if they had already used the proposed solution.

The subsequent rating questions were based on that reply, asking users and non-users slightly different questions for better readability. These questions were merged afterward for evaluation purposes.

If the participant stated to have used the solution, i.e., the users, they had to state if it had enabled them to solve the problem, if it had led to new problems, if it had been more helpful than previous attempts of solving the problem, if they would recommend it to colleagues, and how they would rate the proposed solution in general.

If the participant stated not having used the solution before, i.e., the non-users, they had to state additionally if they think they would be able to use the solution exactly as described. Using the same structure as for users, the participants had to describe if they think it might be successful, if it might lead to new problems, if they would recommend it to colleagues, how they would rate the proposed solution in general. In addition, the reasons for not using that solution before were inquired with multiple-choice format with a list of five options (such as company policies, lack of knowledge/experience, use of different methods), and the possibility to enter other reasons. For questions regarding the participant's rating of the PS, the participant had to rate a statement on a five-point Likert scale ranging from "strongly disagree" to "strongly agree" (Iarossi, 2006). This sequence was repeated for each of the five problematic processes and PS.

As the survey targeted people with profound knowledge about project management, and "I do not know" answer was omitted for the general and the rating questions. It is more likely that people will not answer the question, if there is an "I do not know" answer selection. Therefore, more results are invalid for statistical evaluation (3).

The names of the processes and proposed solutions described in the survey are shown in **table 1**.

All participants received the questions in the same order from "proposed solution 1" to "proposed solution 5" for each problematic process. Answers given regarding a certain problematic process did not change the order of questions related to other processes. All questions were mandatory and had to be answered in the same order. Consequently, it was not possible to skip any questions.

PS1	Strike system for the process "Monitor and Control Project Work"
PS2	Adapted Strike System for the process "Manage Team"
PS3	Hybrid approach with macro and micro-planning for the process "Plan Scope Management"
PS4	Hybrid approach with macro and micro-planning for the process "Plan schedule"
PS5	Hybrid approach with macro and micro-planning for the process "Estimate Costs"

Table 1. Proposed solutions for the problematic processes

4.4. Respondents

Of the 95 people who answered the survey, 66 are male, 28 are female, one is unspecified. The average age is 33.3 (SD 8.24) years. A majority (84.2 %) have completed university education, and half of the participants (50.5 %) have more than 4 years of work experience in project management. Most participants work in IT (32.6 %), in the financial sector (13.6 %) and in consulting (10.5 %). The most popular PM certifications among participants are the Certified ScrumMaster (CSM®) (17.9 %), IPMA® Level D (12.6 %), and the Certified Scrum Product Owner (CSPO®) (8.4 %). 83 Participants completed the German questionnaire, while 8 participants completed the English questionnaire. The overall response rate was 14.6 %.

Table 2 gives an overview of the sample as well as the use or non-use of the proposed solutions. Non-users were divided into two sub-groups; the first group thinks they would be able to use the proposed solution, and the second group states that they would not be able to use the proposed solution.

4.5. Data Analysis

For the data analysis, IBM SPSS version 21 was used. An exploratory factor analysis for the rating questions of all PSs was conducted to see if the PSs were rated independently or if the ratings of different PSs were

Variable	n	%
Demographics		
Education		
Non-academic /other	15	15.8
University	80	84.2
Work experience		
Less than 3 years	47	49.5
3-10 years	29	30.5
More than 10 years	19	20.0
Companies industry		
Information technology	31	32.6
Financial sector	13	13.6
Consulting	10	10.5
Other	41	43.2
PM Certification		
Any (AgilePM, PMP, IPMA, etc.)	43	45.3
none	52	54.7
Proposed Solutions (PS)		
PS 1		
Know about PS	19	20
Non-Users	86	90.5
Would be able to use PS	38	44.2
Would not be able to use PS	48	55.8
Users	9	9.5
PS 2		
Know about PS	15	15.8
Non-Users	82	86.3
Would be able to use PS	47	57.3
Would not be able to use PS	35	42.7
Users	13	13.7
PS 3		
Know about PS	60	63.2
Non-Users	51	53.6
Would be able to use PS	29	56.8
Would not be able to use PS	22	43.1
Users	44	46.3
PS 4		
Know about PS	48	50.5
Non-Users	66	69.5
Would be able to use PS	43	65.2
Would not be able to use PS	23	34.8
Users	29	30.5
PS 5		
Know about PS	34	35.8
Non-Users	71	74.7
Would be able to use PS	50	70.4
Would not be able to use PS	21	29.6
Users	24	25.3

Table 2. Control Variables

dependent on each other. For better interpretability, the factors were rotated, using the Varimax method with Kaiser Normalization to lower the number of variables with high loadings on more than one factor. Screen plot was used to identify the number of factors.

Before conducting the exploratory factor analysis, a test was conducted to assess whether the data fulfilled the requirements. The Kaiser-Meyer-Olkin Value is 0.876 and hence above the recommended value of 0.5 (Dziuban &Shirkey,1974) indicating that the data is suitable for factor analysis. Bartlett's test of sphericity, which should be significant to perform a factor analysis, has a p-value of < 0.01 (significant if p < 0.05). For the results obtained from the survey, five factors were extracted. With these five factors, 75.14 % of the variance can be explained. The rotated factor matrix is listed in **table 3**.

Cronbach's Alpha values for the factor analysis were all satisfactory with values ranging from 0.875 to 0.912 for the rating-subscales and 0.946 for the combined rating-scale. Recommendations for an acceptable Cronbach's Alpha value in the current literature range from above 0.70 (Field, 2017) to above 0.79 (Scott-Young & Samson, 2008)

In addition to the factor analysis for the whole questionnaire, a factor analysis and the reliabilities for every rating-subscale (every single PS) were calculated independently to verify that each subscale is represented by one factor. In each factor analysis, one factor was extracted.

Factor loadings for PS1 ranged from 0.75 to 0.88, for PS2 from 0.60 to 0.89, for PS 3 from 0.59 to 0.93, for PS4 from 0.55 to 0.96, and for PS5 from 0.54 to 0.92.

To assess the general rating awarded by all participants, the mean value $\bar{x}$ was calculated for each proposed solution. The mean rating awarded for PS1 $\bar{x}$ = 2.86 (SD 0.97), for PS2 $\bar{x}$ = 2.93 (SD 0.98), for PS3 $\bar{x}$ = 3.30 (SD 1.09), for PS4 $\bar{x}$ = 3.16 (SD 1.02), and for PS $\bar{x}$ = 2.91 (SD 1.04) respectively. All of the PSs were therefore rated above the neutral, neither negative nor positive, value of 2.5.

Rotated Factor matrix

	Factor				
	1	2	3	4	5
PS1 overall	**0.791**	0.055	0.185	0.099	0.232
PS1 recommend	**0.754**	0.021	0.174	0.152	0.241
PS1 new problems	**0.722**	0.109	0.170	0.220	0.172
PS1 solve problem	**0.721**	0.027	0.128	0.158	0.220
PS1 better working	**0.606**	0.187	0.242	0.257	0.226
PS2 new problems	***0.554***	0.268	0.136	0.138	0.257
PS4 recommend	0.046	**0.826**	0.281	0.198	0.337
PS4 solve problem	0.104	**0.782**	0.196	0.170	0.172
PS4 overall	0.098	**0.755**	0.278	0.196	0.311
PS4 better working	0.098	**0.717**	0.267	0.182	0.293
PS4 new problems	0.345	**0.508**	0.019	0.321	0.046
PS3 recommend	0.199	0.172	**0.890**	0.201	0.136
PS3 better working	0.097	0.192	**0.856**	0.196	0.064
PS3 overall	0.162	0.321	**0.772**	0.144	0.133
PS3 solve problem	0.283	0.142	**0.720**	0.171	0.123
PS3 new problems	0.394	0.389	**0.427**	0.165	-0.161
PS5 solve problem	0.219	0.123	0.147	**0.813**	0.153
PS5 better working	0.189	0.187	0.217	**0.794**	0.057
PS5 overall	0.184	0.234	0.246	**0.794**	0.189
PS5 recommend	0.160	0.220	0.325	**0.791**	0.171
PS5 new problems	0.448	0.186	-0.070	**0.476**	-0.018
PS2 recommend	0.409	0.287	0.102	0.065	**0.715**
PS2 overall	0.391	0.321	0.142	0.064	**0.702**
PS2 solve problem	0.298	0.263	0.011	0.278	**0.631**
PS2 better working	0.262	0.205	0.164	0.160	**0.527**
Extraction method: principal component analysis					

Table 3. Rotated factor matrix

Using the Kolmogorov–Smirnov test and Shapiro-Wilk tests, the results were tested for normal distribution. Both of these tests are considered significant if p < 0.05. If the tests are not significant, this means that the given results show a normal distribution (Field 2017). The general ratings for each of the PS did not show a normal distribution, except for PS2, which was normally distributed.

After separating the ratings given by users and non-users, the test for normal distribution was performed again. Most of the PS (PS1 users, PS2 users and non-users, PS4 users and non-users, PS5 users and non-users) did show a normal distribution. Significant results (indicating no normal distribution) could be confirmed for PS1 non-users, PS3 users and PS3 non-users.

The T-test for equal variances was used to compare the mean ratings by users and non-users for each of the PS in case of normal distribution conditions. A significant difference could be shown in the mean ratings between users and non-users for PS2 to PS5, but not for PS1. Some of the data did not show normal distribution. Consequently, the Mann – Whitney Test was used instead of the T-Test for significance. The mean ranks of each PS were compared between users and non-users as shown in table 5. For the Mann-Whitney test the asymptotic significance (considered significant if p < 0.05) is used (Field, 2017).

For PS1 this evaluation was not significant, with an asymptotic significance of p = 0.166 for PS1, while PS2, PS3, PS4 and PS5 show significant differences between users and non-users, with an asymptotic significance of p < 0.050. All PSs were rated more positively by users than by non-users.

4.6. Findings

In general, the majority of the participants did not use the PS for the problems described (69.5 % to 90.5 %), except for PS3, which had already been used by almost half of the participants (53.6 % non-users). For all PSs, except PS1, most of the non-users (up to 70.4 %) think they would be able to use the PS for their projects. In general, the more participants know about the PS, the more they actually use it. For example, the least known PS, which is PS1, is known by 20 % of the participants and used by 9.5%, whereas PS3, which 63.2 % of the participants know about, is used by 46.3 % of the participants.

As there were five PS in the survey, the amount of five factors in the rotated factor matrix (see Table 3) suggests that each of the factors is connected to a specific PS, respectively. All of the PS seems to be linked to a single factor, meaning they were rated independently from each other. However, there is one item of PS2 that scores higher on the factor for PS1 than the factor for PS2, regarding the question about

Overall Cronbach's Alpha (combined scale)	**0.946**
Cronbach s Alpha for PS 1 (sub scale)	0.905
Cronbach s Alpha for PS 2 (sub scale)	0.875
Cronbach s Alpha for PS 3 (sub scale)	0.912
Cronbach s Alpha for PS 4 (sub scale)	0.912
Cronbach s Alpha for PS 5 (sub scale)	0.909

Table 4: Cronbach's Alpha values

* indicates significant results (p > 0.05)

PS	Mean value users	Mean value non-users	Mean rank users	Mean rank non-users	Asymptotic significance (Mann-Whitney U test, p-value)
PS1	3.33	2.81	60.06	46.47	0.166
PS2	3.48	2.84	63.88	45.48	0.025*
PS3	3.66	2.98	57.53	39.77	0.002*
PS4	3.85	2.86	66.66	39.80	0.000*
PS5	3.57	2.69	66.38	41.59	0.000*

Table 5: PS rating of users and non-users

possible new problems when using the PS (marked in cursive in Table 3) even if the value of 0.554 for that item indicates a small dependency. The reason for this dependency might be a possible contextual overlap between these two PSs, as PS1 deals with a Strike system for "Monitor and Control Project Work", while PS2 deals with an adapted Strike system for "Manage Team". As far as the rotated factor matrix is concerned, there do not seem to be any overlaps between the other PSs (3-5), even if they all include a "Hybrid approach with macro and micro-planning" for different processes.

Cronbach's Alpha test was able to demonstrate that each of the PSs as well as the whole survey produce reliable answers. The values ranging from 0.875 to 0.912 for the subscales and 0.946 for the combined scale prove the high reliability of the study design and the quality of the scales applied. Therefore, the conducted survey seems to be a suitable tool to evaluate the use of the described PSs.

The overall rating given to each PS by the participants in accordance with the Likert Scale used in the survey (1 = strongly disagree to 5 = strongly agree) was also calculated. As the scale has 5 values, values below 2.5 may be considered a negative rating, while values above 2.5 may be considered a positive rating. The mean values for every subscale show that all of the given PSs were rated with a positive tendency.

A higher value of the mean value signifies a more positive rating of the solution. The best rating was given to PS3 (3.3 / 5), which is also the PS with the highest number of users, whereas the PS with the lowest number of users, which is PS1, gets the lowest rating (2.86 / 5). This suggests that if a PS is used more often, it gets a better mean rating.

The T-Test and Mann-Whitney-U-Test were used to compare the ratings for each proposed solution between users and non-users. The mean ratings awarded to the different PSs by the users were 3.33 for PS1, 3.48 for PS2, 3.66 for PS3, 3.85 for PS4, and 3.57 for PS5, and for the non-users 2.81 for PS1, 2.84 for PS2, 2.98 for PS3, 2.86 for PS4, and 2.69 for PS5 by non-users, as shown in **figure 1**. The difference in PS1 between users and non-users was not significant, although the tendency showed the same direction, with users giving better ratings than non-users. This might explain why PSs with a higher number of users get a better overall rating. Significant results in the Mann-Whitney-Test were found for all the PSs except for PS1, which might also be caused by the low number of users of PS1 (9 users vs. 86 non-users). If there were more participants using PS1, this would probably also lead to significant results compared to the other PSs. Generally, users have the tendency to rate the proposed solutions better than non-users. This could mean that the proposed solutions might work better in the field than expected by non-users.

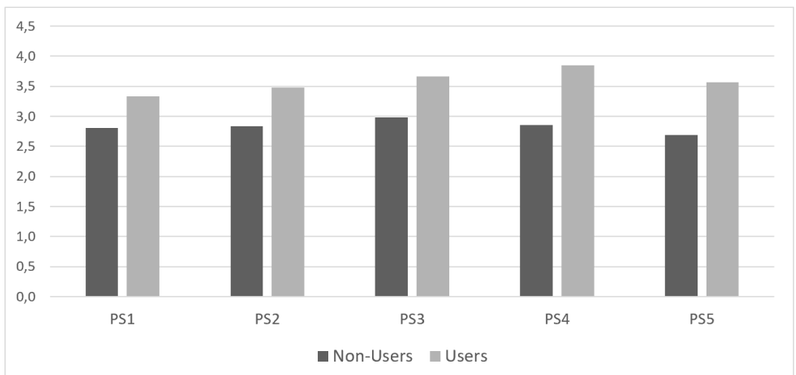

Figure 1. Mean ratings of non-users and users

5. CONCLUSION

The results of the survey show that a large number of participants do not know about the PSs for problematic processes, but still tend to give good ratings regarding usability and applicability. This finding proves the usefulness of postulated PSs. However, even if participants know about the PSs and indicate their usefulness, they still do not seem to be widely used. A reason for this lack of usage could be the missing integration into established project management frameworks, which provide certainty for project management practitioners and strengthen the need and overall research goal behind this article to tailor and adapt traditional, established project management frameworks to be used in agile developed IT projects.

Based on this quite specific result regarding the rating and application of the proposed solutions, additional research should follow, focusing on the reasons why the given PSs are not as widely used as previously thought, and aiming to identify additional reasons and problems that might appear when using the PSs. This can be achieved by increasing the number of participants or by asking participants for specific reasons why they did not use the PSs.

6. LIMITATION

A limiting factor for the survey is the small number of participants, which is partially explained by the limited number of specialists with profound knowledge about PMBOK and agile PM. Another reason might be the low willingness to take part in surveys when contacted over social media in general, as well as the challenging situations many companies and employees are currently experiencing due to lockdowns and COVID-19 regulations.

Most of the participants come from an academic background, but almost half of the participants stated that they have less than 4 years of work experience in project management.

The proposed solutions given in the survey have been evaluated in a previous article (Rosenberger & Tick, 2018). However, other solutions, which are as feasible as the ones described, might exist as well.

The study design did not give the option to add own solutions for the described processes, as this would go beyond the scope of this study.

7. ACKNOWLEDGMENT

The authors want to thank Mirjam Brandl and Christina Rozsa for their valuable support during the statistical evaluation phase.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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APPENDIX

Table 6: Questionnaire Design

Item name	Questions	Selections	Scale
	Demographics		
	Age		Numeric input
	Sex	Male	Single choice
		Female	
		Other	
	Education level	No formal education	Single choice
		Compulsory education	
		Apprenticeship	
		Vocational secondary school / intermediate (technical) school (without A-level)	
		General secondary school (A-level)	
		Vocational secondary school (with A-levels)	
		College	
		Academy	
		University / University of applied sciences	
	Type of employment	Unskilled worker	Single choice
		Skilled worker	
		Employee (without management function)	
		Lower management (e.g., team leader, group leader or similar)	
		Middle management (e.g., department head, branch manager or similar)	
		Top management (e.g., managing director, general partner or similar)	
		Members of the liberal professions (e.g., doctor, lawyer, accountant, architect, etc.)	
		Student (unemployed, otherwise please choose from the options above)	
		Other (please specify)	
	Companies industry	Architecture	Single choice
		Automotive Industry	
		Construction industry	
		Consulting (legal services, auditing, etc.)	
		Chemical and pharmaceutical industry	
		Retail	
		Electrical and electronic industry	
		Energy supply, water supply, sewage and waste disposal	
		Upbringing, education, teaching	
		Financial management (banks, insurance companies, etc.)	
		Research and development	
		Hospitality, tourism, leisure, culture	
		Non-profit/social services	
		Health care, health centres, hospitals, nursing homes	
		Wholesaler	
		Handicraft (carpentry, plumber, painter, etc.)	
		Real estate	
		IT, data processing	
		Engineering	
		Agriculture, forestry and fisheries	
		Food industry	
		Marketing/Sales	
		Market research	
		Media (publishing, film production, cinema, radio, TV, PR)	
		Metal production, plant construction, mechanical and systems engineering	
		Military, navy, air force, security service	
		Fashion, clothing, textile industry	
		Public administration	
		Human Resources	
		Politics	
		Telecommunications	
		Transport, traffic, logistics	
		Other (please specify)	
	Years of project management experience	Less than 1 year	Single choice
		1-3 years	
		4-6 years	
		7-10 years	
		More than 10 years	
	Projects per year	1	Single choice
		2-3	
		4-6	
		7-10	
		More than 10	
		none	
	Obtained certificates	Agile Project Management (AgilePM®)	Multiple choice
		Certified Associate in Project Management (CAPM)®	
		Certified ScrumMaster (CSM®)	
		Certified Scrum Product Owner (CSPO®)	
		IPMA® Level A	
		IPMA® Level B	
		IPMA® Level C	
		IPMA® Level D	
		Management 3.0	
		PMI Agile Certified Practitioner (PMI-ACP)®	
		PRINCE2 Agile® Practitioner Certification	
		PRINCE2® Foundation	
		PRINCE2® Practitioner	
		Project Management Professional (PMP)®	
		Scaled Agile Framework (SAFe®)	
		None of the above	
		Other (please specify)	
	Problematic process and proposed solution	(x = number of process from 1 to 5)	
	x.0 This process is posing a problem for me.	1 to 5	Likert scale
	x.1 I fully understand the proposed solution (PS)	1 to 5	Likert scale
	x.2 I already know this PS		Yes/No
	x.3 I have already applied this PS exactly as described		Yes/No
	If x.3 is yes		
PSx solve problem	x.4a The application of this PS has completely solved the problem	1 to 5	Likert scale
PSx new problems	x.5a During the application new problems arose in my project.*	1 to 5	Likert scale
PSx better working	x.6a Using this PS has worked better than my previous attempts to solve the problem.	1 to 5	Likert scale
PSx recommend	x.7a I would recommend this PS to a colleague.	1 to 5	Likert scale
PSx overall	x.8a All in all I consider this PS very good.	1 to 5	Likert scale
	If x.3 is no		
	x.b I could use the PS in my project exactly as described.		Yes/No
PSx solve problem	x.4b The application of this PS is suitable for me to solve the problem completely.	1 to 5	Likert scale
PSx new problems	x.5b With the application new problems would arise in my project.*	1 to 5	Likert scale
PSx better working	x.6b Using this PS would work better than my previous attempts to solve the problem.	1 to 5	Likert scale
PSx recommend	x.7b I would recommend this PS to a colleague.	1 to 5	Likert scale
PSx overall	x.8b All in all I consider this PS very good.	1 to 5	Likert scale
	x.9b Why is the PS not used?	I did not know about the process	Multiple choice
		Company policies	
		Lack of acceptance in project team	
		I consider it unsuitable	
		Use of other methods	
		Other (please specify)	

continue...

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AGILE ENHANCEMENT

OF CRITICAL PMBOK V6 PROCESSES