Project management methods in conditions of business companies in the Czech Republic

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Abstract—The paper aims to evaluate the application of project management methods in conditions of business companies in the Czech Republic. In the introduction part, project management competencies and selected methods based on an analysis of available information resources are defined. The separate parts of this article are dedicated to the project management software using in the project management. The main theoretical background of the paper is based on documents Individual Competence Baseline ICB version 4.0 and PMBOK® Guide 6th Edition. With the use of a questionnaire survey, the level of application of project management methods in conditions of business companies in the Czech Republic was evaluated. The questionnaire survey was conducted in four stages; the first carried out in 2015, the second in 2016, the third in 2017 and the final stage in 2018. Two research questions were formulated. 1) Are the methods of project management applied in most of the surveyed companies at a "very high" or at a "high" level? 2) Is it possible to observe a growing trend in the application of project management methods in the period 2015-2018 in the surveyed companies? Based on a comparison of the results of the individual analyses, it is possible to describe the development of the application of the project management methods over the past four years.

Keywords—Competencies, Czech Republic, Methods of project management, Software in project management

I. INTRODUCTION

According to Dolezal et al. [1], project management indicates a set of standards, recommendations and the most suitable methods possible, all of which describe how to manage the project in the most efficient and productive way. The separate parts of this article are dedicated to the Project Management definition, Competences of project managers, Project Management Methods, and Software in the Project Management. Fiala [2] understands project management as an effective tool for achieving the objectives of the project, the corresponding output quality and coordination of projects in terms of deadlines and available resources. It uses specific tools, techniques, knowledge, and skills to meet the set goals.

Methods are useful for flexibility of planning, implementation, monitoring, and the ability to respond effectively to risks that may jeopardize the success of the project. According to the Project Management Institute (PMI) [3], project management is the application of knowledge, skills, tools, and technologies to tasks so that they fully meet the requirements of the project. In order to meet the specific objectives of the project, the main trade-offs must be defined [4]. Most of the trade-offs are resolved if the organization's strategy is well understood and trade-offs are discussed during the planning, budgeting and scheduling phases of the project [5]. Larson and Gray [6] define three main trade-offs as Cost, Time and Scope. Each project must have a clear purpose. The goal of the project should be Specific, Measurable, Achievable/Acceptable, Realistic/Relevant Time Specific/Trackable (SMART), and it should also contain unique features regarding time, the project team, and the service/product [7].

Time – Each project is defined by time. As part of the project scheduling, network analysis methods are used (for instance the Critical Path Method - CMP or Program Evaluation and Review Technique - PERT).

Cost – Each project needs resources, whether human, financial or material. Cost represents the manifestation of resources used in the time distribution. These three variables are always interdependent [1], [8].

Scope – This aspect represents the unique goal of the project. [6]

Depending on the complexity of the scope project are divided into investment projects and non-investment projects. The investment project represents a set of technical and economic studies used for the planning, implementation, financing and efficient operation of the proposed investment. For instance, the construction investment project usually includes business and environmental studies as well. Non-investment projects are often called a soft project and are mainly oriented into education.

The project follows specific phases, the understanding of which allows project managers to control the project more efficiently. According to some definitions, the project phases include a beginning and end stage, and in between which it goes through several phases, which we know as the life cycle of the project. It is important to realize that the life cycle may be different for individual projects. According to IPMA (International Project Management Association) [9], the project has three stages: the pre-project phase, project phase,

and post-project phase. In the pre-project phase, the feasibility of project goals is assessed, various analyses are conducted, and studies are processed (for instance an Opportunity Study or Feasibility Study). The project phase includes project start-up, project preparation, project implementation, and project closeout. In the post-project phase, the overall evaluation of the project is conducted. However, according to Dolezal, Lacko, and Machal [10] is this final phase often underestimated and neglected. Various terminologies are used regarding project phases, for example, Sweeney and Stark [11] have named individual stages: project imitation, project planning, project execution and finally project monitoring and controlling. According to Burke [12], there are four different project phases: project feasibility, project definition, project execution, and project commissioning and handover.

Examples of risks of the project life cycle have been processed according to Svozilova [8]. In the pre-project stage, there are for example unclear objectives of the project, the definition of the project scope, the absence of previous studies, and the poorly informed project team. There are important risks in the project stage, related to a change in the definition of the project scope, with errors in the proposals and plans also been associated with poor competence of the project manager or team members (as it is an important area a separate chapter will be dedicated to the project manager competence). In the post-project stage, late revealed shortcomings and mistakes may occur in the project scope.

During the project, many methods, techniques, tools, and procedures are used. Some of them fit, after their adaptation, to almost any project, others have limited application in the project management. Those which can be used at almost any time include: *Opportunity study*, which should answer the question: Is it really a good time to design and implement the intended project? *Feasibility study* is elaborated upon the recommendations to implement the project under opportunity study. Its aim is to clarify the content of the project, the planned date of initiation and completion of the project, the estimated total cost, and the estimated required significant resources [10]. *Work Breakdown Structure (WBS)* – represents the decomposition of the project into smaller parts. The aim of this method is to structure, hierarchize and rationalize the large number of project tasks (operations, activities) in a clear and understandable form [13].

A. Competences of project managers

In order to fulfill the unique goal of the project, the project manager must be holistically competent to perform his/her function.

The IPMA Individual Competence Baseline ICB version 4.0 [9] consists of three areas: people competences, practice competences, and perspective competences.

The area of people competences includes the personal and interpersonal abilities required to participate in or lead the project successfully. The application of project management methods based on the practice competences pillar is used in a project to realize its success. The methods used in the perspective competences area represent ways in which individuals interact with an environment.

From the present author's point of view, project management methods are encompassed in all three of these areas, with practice competences particularly highlighted. Project managers and project team members have applied for instance scheduling methods (Gantt charts, network diagrams), cost estimating techniques (single or multi-expert estimation, historical data, analogies), methods for monitoring and controlling, resource allocation methods, procurement methods as well as risk management methods, e.g. [14].

The body of knowledge included in the Project Management Institute's PMBOK® [3] includes proven traditional methods that are widely applied as well as innovative techniques and practices that are emerging in the project management area. According to the PMBOK® [3], project managers and project team members have applied various methods: monitoring and reporting methods, scheduling methods (iterative scheduling with backlog, on-demand schedule), costs estimating methods (parametric estimating, three-point estimating, bottom-up estimating, data analysis), reporting methods, quality improvement methods, risk management methods as well as problem-solving methods.

B. Certification of project managers

Certificates can be obtained in the project management area within the Czech Republic. International Project Management Association [9] offers four certificates according to project manager level of competences: Level D (Certified Project Management Associate), Level C (Certified Project Manager), Level B (Certified Senior Project Manager), Level A (Certified Project Director). On the other hand, the Project Management Institute offers the basic certificates CAMP (Certified Associate in Project Management) and PMP (Project Management Professional). Four other certificates are issued by PMI in association with levels and specializations of project management: PMI-SP (PMI Scheduling Professional), PMI-RMP (PMI Risk Management Professional), PgMP (Program Management Professional), PMI-ACP (PMI Agile Certified Practitioner) [15].

C. Methods of project management

According to Kerzner [4], project management methodologies based upon somewhat rigid policies and procedures were created because management organizations sought to achieve standardization in the way that projects were planned, scheduled, and controlled. In this paper project management methods are defined based on the Individual Competence Baseline ICB version 4.0 [9] (a modification of version 3.2 [16]) as well as the PMBOK® Guide to Project Management 6th Edition [3]. The separate parts of this article are dedicated to the methods of scheduling and methods of budgeting.

It is common to use Project network when scheduling the project. The network of the project is oriented, rated, continuous, acyclic and finite graph.

In project management, the following methods of network analysis are used most often: CPM – (Critical Path Method) and PERT – (Program Evaluation and Review Technique [6]. In the current practice of project management, node-defined network charts are used to a greater extent, using the most well-known software products. Network charts make it possible to detect interdependencies that are not obvious to other techniques, and to try different variants of the planned activities, including the calculation of critical paths. Network charts also have some weaknesses. Their creation and subsequent use in large and complex projects are challenging. When creating network charts, it is often considered that resources are unlimited. To evaluate the actual critical path is necessary to add dependence on the different types of resources. The problematic part of using network charts can be partially reduced by using appropriate software products. Meredith [5] highlights the importance of understanding the basic principles of network graphing and then recommends using a software solution during project planning.

One of the fundamental questions of project management is to determine the cost - determining the project budget. The project budget includes the cost of the project based on the Work Breakdown Structure carried out under the project, including material respectively costs associated with the use of special technologies. When drawing up a detailed budget is appropriate to establish first direct costs (associated with the implementation of specific activities) and subsequently indirect costs (overheads). They can also occur in project costs that are not included in any of the previous categories. They are referred to as other costs. To prepare the project budget, the project manager can use some of the below methods or their combination: Top-Down and bottom up. Frequently, software products are also used to estimate costs. Dolezal [1] points out that the choice of method always depends on the type of project, its scale, and the degree of complexity. Kerzner [4] and Svozilova [8] define three baseline scenarios for project cost estimates, such as definitive estimation, approximate estimate, and order of magnitude. According to Svozilova [8] the use of specialized software can increase the accuracy of the cost estimation while minimizing the costs of its elaboration.

D. Software in Project Management

When applying specific project management methods, either open source software or paid software can be used. Open source is free software for public use without any financial costs. Most of these programs tend to be more straightforward and have fewer features than paid programs, which is more sophisticated and user-friendly. In managing projects, often open source programs can be quite sufficient for small projects. It is often possible to test software applications for a trial period, as limited access opportunities are often offered to a potential buyer. Use of the application during these trial periods usually includes essential functions that are sufficient to verify user acceptance, but often

features that make work much easier can be accessed in the paid version only [17].

In applying project methods, Project Libre (formal OpenProj) is the most commonly used project management Open Source software in the Czech Republic. Most often the paid software used in project management are the programs MS Project (Microsoft) and Primavera (Oracle). The specific product depends on the conditions and considerations evaluated by the top management of the organization. Companies implement the same project management software as their parent organization (e.g., US companies often use Primavera software). Other software products that are used by business companies in the Czech Republic to manage projects are GanttProject, Easy Project, Projektově.cz, Basecamp, GroupCamp, and Merlin.

The main aim of the paper is to evaluate the application of project management methods in conditions of business companies in the Czech Republic. The main aim of the paper is divided into two separate objectives. The first objective is to find out an answer for the research question: Are the methods of project management applied in most of the surveyed companies at a "very high" or at a "high" level? The second objective is to find out an answer to the research question: Is it possible to observe a growing trend in the application of project management methods in the period 2015-2018 in the surveyed companies? Several organizations in the Czech Republic deal with project management issues, the best known of which are the International Project Management Association (IPMA – Czech Republic) and the Project Management Institute (PMI - Czech Chapter). IPMA – Czech Republic was formally known as SPŘ (Spolecnost pro projektove rizeni – until 2017). In the paper were defined project management and methods of project management according to Czech [1], [8], [10], [14], [18] and foreign authorities [4], [5], [6], [7], [11], [12], [17] of project management, IPMA [9], [16] and PMI [3], [15]. The use of project management software products along with high-quality databases can lead to more accurate project management forecasts as well as time and cost simulations, using, e.g., the Monte Carlo method. According to Kwak [19] Monte Carlo simulation represents a useful technique for modeling and analyzing real-world systems and/or projects. Using simulation software allows project managers to implement the project methods easily. In the field of project management, Monte Carlo simulation can quantify the effects of risk and uncertainty in project schedules and budgets, giving the project manager a statistical indicator of project performance such as target project completion date and budget [19].

II. RESEARCH DESIGN AND METHODOLOGY

The aim of the paper was to evaluate the application of methods in conditions of business companies in the Czech Republic.

Two research questions were formulated. 1) Are the methods of project management applied in most of the surveyed companies at a "very high" or at a "high" level? 2) Is it possible to observe a growing trend in the application of

project management methods in the period 2015-2018 in the surveyed companies?

To fulfill the first objective of paper, the statistical hypothesis was defined (hypothesis having a null and alternative version):

H1$_0$: The majority of respondents are not convinced that the methods of project management are applied in most of the surveyed companies at a "very high" or at a "high" level.

H1$_A$: The majority of respondents are convinced that the methods of project management are applied in most of the surveyed companies at a "very high" or at a "high" level.

This hypothesis was tested at significance level p-value 0.05 by statistical tools XL statistics and MedCalc Software. We assumed that methods of project management would be applied in most of the surveyed companies at the designated very high or on the high level.

To fulfill the second objective of paper means comparison by statistical software SPSS was conducted. Also, we assumed that it would be possible to observe a growing trend in the application of project management methods in the period 2015-2018 in the surveyed companies. All of the surveyed companies are located within the territory of the Czech Republic.

The questionnaire survey was conducted in four stages (in 2015, in 2016 in 2017 and 2018). The questionnaire was sent by post or by e-mail. The research set of stage 1 (2015) consisted of 165 respondents. These respondents were selected on a random basis. The number of received questionnaires was 36, i.e., the return rate was 21.82%. The research set of stage 2 (2016) consisted of 165 respondents who were also selected on a random basis. The number of received questionnaires was 48, i.e., the return rate was 29.09%. In Stage 3 (2017), the research set also consisted of 165 respondents selected on a random basis. The number of received questionnaires was 22, i.e., the return rate was 13.33%. The research set of stage 4 (2018) consisted of 165 respondents who were also selected on a random basis. The number of received questionnaires was 36, i.e., the return rate was 21.82%.

A five-point Likert scale was used to describe the level of application of project management methods in the Czech Republic (1 – very high level, 2 – high level, 3 - medium level, 4 – low level, 5 - very low level).

Data from the questionnaires were processed in Microsoft Excel and SPSS (histograms). Subsequently, statistical tests were performed using the tools XL statistics (X$_2$) and MedCalc Software (z-test). The Chi-squared statistic is the sum of the squares of the differences of the observed and expected frequency divided by the expected frequency for every cell [16]. Computational notes of the P-value defined the significance level, with the P-value calculated using a general z-test according to Altman [20] and Fleiss et al. [21].

In the conclusion of the present paper, the level of application of project management methods in the Czech Republic is described.

III. RESULTS

Here the level of application project management methods in the years 2015-2018 will be analyzed. In the first stage of the survey carried out in 2015, 8.3% of the respondents stated that the level of application project management methods was very high and 19.4% respondents indicated that it was high. 38.9% of the respondents considered the level of application project management methods as being at a "medium" level, and 35.4% of respondents considered this level at their organization as "low" or "very low" (Table I.).

Table I. The level of application of PM methods (2015) [author].

	Frequency	Percent	Cumulative Percent
Very high level	3	8,3	8,3
High level	7	19,4	27,8
Medium level	14	38,9	66,7
Low level	6	16,7	83,3
Very low level	6	16,7	100,0
Total	**36**	**100,0**	

The following fig. 1 depicts the numbers of respondents at the specific level of application project management methods in 2015 (Number of respondents = 36, Mean value = 3.14, Standard deviation = 1.17).
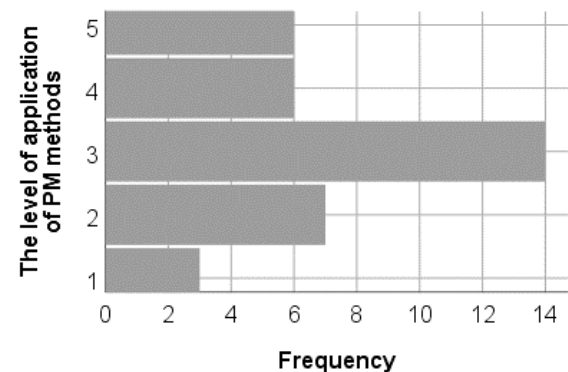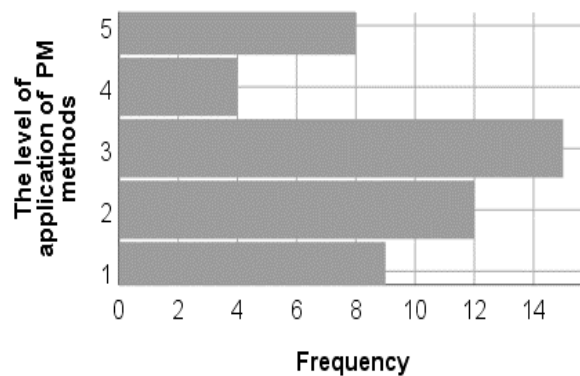

Fig. 1. The level of application Project Management methods (2015) [author].

It is positive that in the second stage of the survey carried out in 2016, 43.8% of the respondents considered the level of application project management methods as very high or high. 31.3% of the respondents considered this level as medium and 8.3% as low. A very low level of application of project management methods, as in the stage 1 survey, was identified by 16.7% of the respondents (Table II.).

Table II. The level of application of PM methods (2016) [author].

	Frequency	Percent	Cumulative Percent
Very high level	9	18,8	18,8
High level	12	25,0	43,8
Medium level	15	31,3	75,0
Low level	4	8,3	83,3
Very low level	8	16,7	100,0
Total	48	100,0	

The following fig. 2 depicts the numbers of respondents at the specific level of application project management methods in 2016 (Number of respondents = 48, Mean value = 2.79, Standard deviation = 1.32).
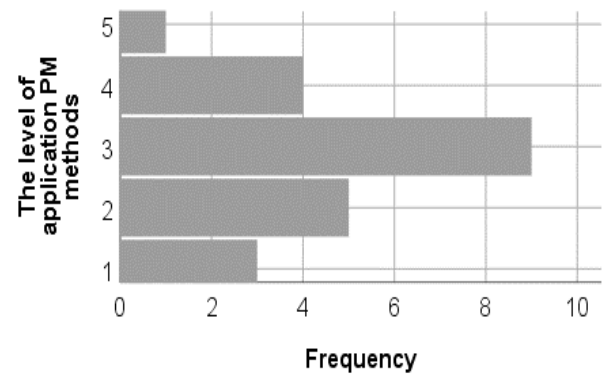

Fig. 2. The level of application Project Management methods (2016) [author].

In the third stage of the survey, 36.4% of the respondents considered the level of application project management methods as very high or high. Up to 40.9% of the respondents considered this level as medium. It is positive that only 4.5% of respondents stated that the level of application of project management methods was very low (Table III.)

Table III. The level of application PM methods (2017) [author].

	Frequency	Percent	Cumulative Percent
Very high level	3	13,6	13,6
High level	5	22,7	36,4
Medium level	9	40,9	77,3
Low level	4	18,2	95,5
Very low level	1	4,5	100,0
Total	22	100,0	

The following fig. 3 depicts the numbers of respondents at the specific level of application project management methods in 2017 (Number of respondents = 22, Mean value = 2.77, Standard deviation = 1.066).
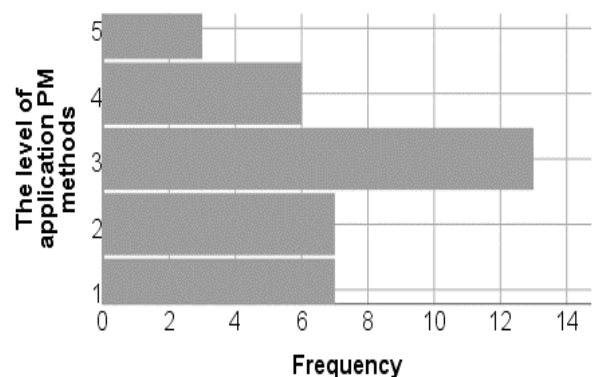

Fig. 3. The level of application Project Management methods (2017) [author].

In the first stage of the survey carried out in 2018, 19.4% of the respondents stated that the level of application project management methods was very high as well as 19.4% respondents indicated that it was high. 36.1% of the respondents considered the level of application project management methods as being at a "medium" level, and 25% of respondents considered this level at their organization as "low" or "very low" (Table IV.).

Table IV. The level of application PM methods (2017) [author].

	Frequency	Percent	Cumulative Percent
Very high level	7	19,4	19,4
High level	7	19,4	38,9
Medium level	13	36,1	75,0
Low level	6	16,7	91,7
Very low level	3	8,3	100,0
Total	36	100,0	

The following fig. 4 depicts the numbers of respondents at the specific level of application project management methods in 2018 (Number of respondents = 36, Mean value = 2.75, Standard deviation = 1.204).

Fig. 4. The level of application Project Management methods (2018) [author].

The following fig. 5 depicts the numbers of respondents at the specific level of application project management methods (1 - very high level, 2 - high level, 3 - medium level, 4 – low level, 5 - very low level) between 2015 and 2018.
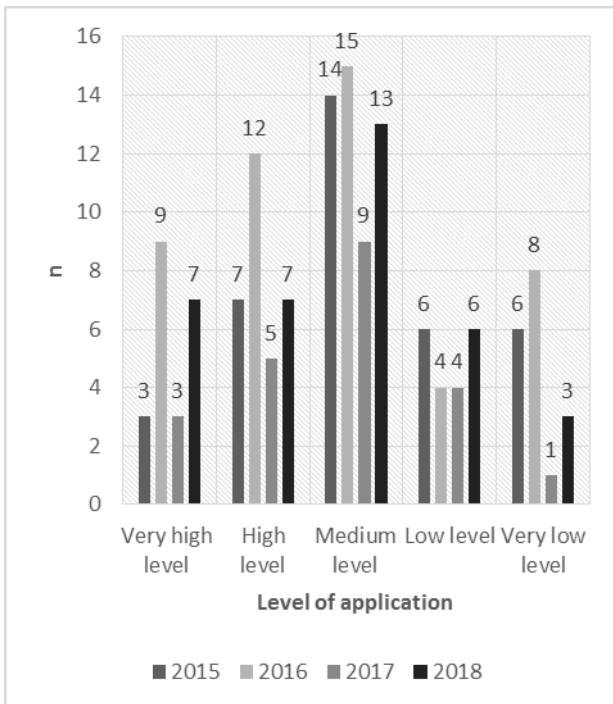

Fig. 5. The level of application Project Management methods (2015 – 2018) [author].

Before the hypothesis (H1) was tested, two groups were defined. The first group involved respondents who were convinced that the methods of project management were applied in most of the surveyed companies at a very high or at a high level. The second group involved respondents who were convinced that the methods of project management were applied in most of the surveyed companies at a medium, a low or a very low level. Considering the selected years provide more detailed insights (Table V.):

Table V. Two groups of respondents [author]

	Frequency		Percent	
	Very high level and high level	Medium level, low and very low level	Very high level and high level	Medium level, low and very low level
2015	10	26	0.28	0.72
2016	21	27	0.44	0.56
2017	8	14	0.36	0.64
2018	14	22	0.39	0.61
Total	**53**	**89**	**0.37**	**0.63**

Based on data set 2015, the mean value h_{2015} was calculated ($h_{2015} = 3.14$), based on data set 2016, the mean value h_{2016} was calculated ($h_{2016} = 2.79$), based on data set

2017, and based on data set 2018 the mean value h_{2018} was 2.75 (Fig. 6).
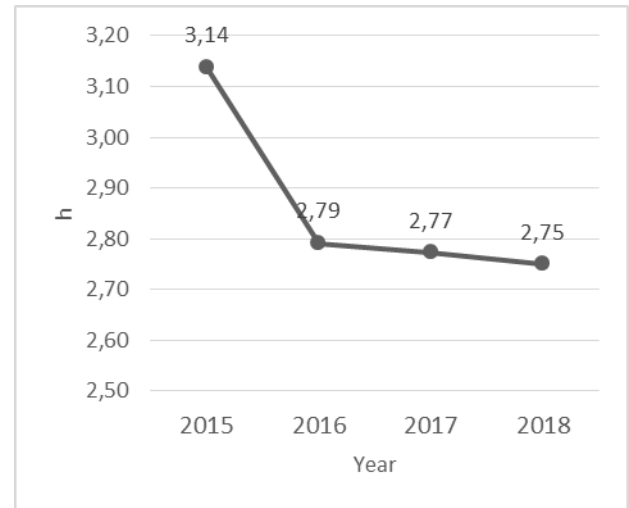

Fig. 6. Mean value h - The level of application of project management methods (2015 – 2018) [author].

Based on fig. 6, it can be assumed that the mean value h is gradually decreasing, which indicates that the level of application of project management methods is gradually increasing (3 - medium level, 2 - high level of application of project management methods). In 2016 there was a year-on-year decline of 0.35 points, in 2017 there was a year-on-year decline of 0.02 points and in 2018 was a year-on-year decline of next 0.02 points

IV. CONCLUSION

In answering the research questions, the potential benefits of increasing the level of application of project management methods in the Czech Republic can be formulated. Possible directions for future research will be outlined as well.

It was not possible to respond positively to the first research question. The proportions for each group in total were calculated (Very high or and high level =0.37; Medium, low and very low level=0.63). Using XL statistics software, the p-value= 0.998741 was calculated along with Confidence Intervals for p-value (Level=0.95): ME=0.08024; Lower=0.292999; Upper=0.45348. In MedCalc Software the test for one proportion was calculated as follows: Z-statistics 1.893; significance level P > 0.05; 95% Confidence Intervals of observed proportion = 24.14 to 51.36. Based on the test of hypothesis, H10 is confirmed, and H1A rejected. As a result of the calculations the null hypothesis is confirmed, and therefore it cannot be stated that: The majority of respondents are convinced that the methods of project management are applied in most of the surveyed companies at a "very high" or at a "high" level. Even at stage one (2015, 2016, 2017 nor 2018) of the survey, the level of application of project management methods in most of the surveyed companies (more than 50% of those surveyed) was not at the "very high" or at the

"high" level. Based on the data set in 2015, the figure was only 28%, based on data set 2016 it was 44%, based on data set 2017 it was 36% and based on data set 2018 it was 39% (Table V).

The second research question can be answered positively. It is possible to observe a positive trend regarding the increasing application of project management methods in the period 2015-2018 in surveyed companies. This finding is evidenced by a decreasing level of mean value h (h_{2015} = 3.14, h_{2016} = 2.79, h_{2017} = 2.77 and h_{2018} = 2.75). Considering the standard deviation and standard deviation error of means provide more detailed insights (Table VI.).

Table VI. The level of application of project management methods (2015 – 2018) – detailed insights [author].

	2015	2016	2017	2018
N	36	48	22	36
Mean (h)	3.14	2.79	2.77	2.75
Std. Deviation	1.175	1.320	1.066	1.204
Std. Error of Mean	0.196	0.191	0.227	0,201

Identifying possible causes for the increase in the of application project management methods was not, however, the ultimate goal of the present paper. This identification and a subsequent description will be conducted as a part of the further research. Nevertheless, to make perfunctory predictions about possible causes, we may refer to the more frequent use of software products (such as MS Project or Oracle Primavera) in the Czech Republic. Within the framework of further research, statistical methods will be used to generalize the results, and the data set for 2019 and 2020 will be added. Subsequently, more trends regarding the development of the level of application of project management methods in the forthcoming years will be determined.

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