

Project management practices in engineering university

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Abstract. The article presents the analysis of usage of project management methodology in Tomsk Polytechnic University, in particular the experience with the course Project management which started 15 years ago. The article presents the discussion around advantages of project management methodology for engineering education and administration of the university in general and the problems impeding extensive implementation of this methodology in teaching, research and management in the university.

1. Introduction

In the last century a project was defined mainly as "a developed plan of buildings, construction, manufacturing or reconstruction of something" [1]. Today, our country and the world are literally bitten with "project mania", and the concept of a project includes almost any type of activity. In the process of implementation of major military projects and aggregation of lessons learned there was developed and introduced in Tomsk Polytechnic University (TPU) a special discipline "Project Management". The analysis of this experience has shown that the application of project management methodology may result in savings up to 20% of the funds on average, and reducing the time of projects implementation by 20% on average. There is another weighty argument in favor of the use of modern project management methodology (PM). To justify the approach, one can use the classical Marxism idea of K. Marx which states that the worst architect differs from the best bee from the outset because before building something, he create an ideal image of a future construction in mind. The processes of initiation, preparation and planning a project together with relevant stakeholders and the execution of a risks analysis enable dramatically reduce of errors, as well as the likelihood and consequences of unexpected events. This, in turn, reduces the overall stress level in the process of project implementation. When people know that during the work execution an accident, explosion, etc. might happen, they are mentally prepared for the occurrence of such events, do not lose capacity, and can immediately initiate the necessary actions.

2. Project management evolution

Following the publication of the first standard of project management (PMBOK) in 1987 a rapid spread of project management activities began across countries in different forms of appearances, including unconventional ones. If at the initial stage of PM methodology development it was regarded only in relation to large and complex defense projects, then later it was realized that many of its elements can be effective for the implementation of medium and small-scale projects in the private sector in any form of activity. Project management has become widely used in the social and economic projects, assistance programs, including personal projects (organizing holidays, anniversaries, weddings, etc.). And such projects are performed and accounted for many millions yearly. Many of them are successful, although the application does not need special knowledge in project management techniques.

There is no doubt that the methodology of Project Management makes available a range of useful tools for project performers. It may improve significantly efficiency and effectiveness of any kind of venture.

However, even in major universities, large companies, and in the government, where every year hundreds of projects are carried out, modern PM methodology is hardly used. When it comes to the research there is strong evidence supporting the success of project management methodology use



in construction, IT and healthcare industries while there is definitely a lack of research that would address specifically the state of PM implementation in higher educational institutions [2]. A legitimate question arises: having such benefits, why is the project management methodology not applied in many more cases?

There are several reasons for this situation. Firstly, many experts and organizations are not aware of the existence of the Project Management methodology, although the information about this is gradually spreading across Russia, which in recent years contributes to vigorous activity of the Russian Project Management Association "Sovnet". Secondly, in most education programs such discipline is absent. In TPU this discipline is included only in two educational programs of the Institute of social and humanitarian technologies: "Management" and "Innovation studies". There is an attempt to introduce all the students of TPU to project management methodology through the course of "Creative projects", which is an obligatory course for the first and second year students. It lasts three semesters, and the students are supposed to work on creative projects at any department of their Institute, so that by the end of the second year they can decide on the bachelor program specialization for the third and fourth years of studies. The particularity of this course is that it is not supervised by a teacher (the teacher gives only two hours of introduction into the course), and the students run projects by themselves without methodological support. Third, many managers prefer to carry out projects in the old way, because they do not know or do not believe in the benefits of modern PM technology. In support of the latter there is some evidence, because as notices P. Morris [3] the cause-and-effect relationship between the use of formal project management and project results is not experimentally proven. Finally, fourthly, in many cases leaders of different ranks resist to the introduction of the methodology exactly because of its advantages: PM methodology ensures the transparency of the project, exposing the absurdity of some ideas, alternatives to the proposed solutions, projects inefficiency, disclosure of hidden implicit goals and corruption schemes.

3. Project management training

Problem-oriented and project-organized education, which is considered to be an effective means of improving the quality of specialists training, can be effectively used to improve the quality of training. The importance of this approach for the training of engineers is difficult to overestimate. The table 1 presents advantages and problems of project-organized education, the latter helps to understand better the reasons for low level of project management methodology implementation in TPU.

Table 1. Advantages and problems of project-organized education.

Advantages	Problems
Students have a vast interest in the subject	It is difficult to assess the complexity of the overall project for a team of students, since it depends not only on the content of the project, but also on the degree of preparedness of students
Verification of residual knowledge in several months confirms the strength of the information mastering	If in teams among students there are dishonest ones, the workload can grow significantly for the rest of the students; as a result there might be the situation when the project is not carried out which places the teacher and conscientious students in a "stalemate" situation
Students acquire skills of independent work planning	Since a teacher cannot assess the contribution of each student in the project, and the distribution of points for project work among team members is assigned to the team itself, with a high degree of conformity that does not eliminate conflicts and does not always provide fair grades
Students learn the basics of system analysis	Project design of teaching is more difficult for the teacher than classical design with lectures and more time-consuming than seminars and lectures
Students develop real	If working hard, the team will soon gain a lot of information that may go

teamwork skills	beyond the knowledge of the teacher. Therefore, substantial part of the projects should be sufficiently well known for the teacher. Besides the teacher requires sufficient psychological stability. The questions during the consultations may bring the teacher to a nonplus
Students gain the skills of interaction with external structures in solving problems	<p>Project design of teaching is not provided by local University regulatory documents, which creates difficulties in determining the workload of the teacher</p> <p>Teacher workload in project design of classes compared to conventional lecture course increases by a multiply due to:</p> <ul style="list-style-type: none"> • preparation of project subjects; • initial data preparation; • a big number of consultations (both for the course and for the project); • constant support of teams.

There is quite a large number of PM Training courses offered by well known and unknown providers on the market. The acquaintance with the proposals for project management training (primarily commercial) by different organizations, as well as participation in a number of short courses and workshops allow marking two most common drawbacks.

The first one relates to the fact that the main and often exaggerated attention is devoted to PM processes and technology, international and national standards, specialists' certification, software products. Without denying the relevance and usefulness of learning process, it is necessary to pay attention to the fact that they do not provide the mastery of PM discipline. Sometimes it comes even to identifying PM with software products, in particular, with Microsoft Project.

The second drawback in PM training is related to the insufficient attention to the deeper foundations of effective PM: methods of analysis and problem solving, correct formulation of goals, development of on time and resource base action plan, budget breakdown, technical requirements and objectives, choice of an alternative to the proposed problem solution, rational improvement of decisions.

4. TPU experience in teaching project management

In Tomsk Polytechnic University the discipline "Project Management" has been included in the curricula of management educational program in 1999. The course of PM for students, including MBA program students, students of presidential management training program for the national economy as well as in various advanced training programs, assumed ideally the implementation of real projects, usually in teams of 6-10 people. This allowed taking on projects of 1000 man-hours complexity and more. Accordingly there were prepared textbook and teaching aids for project management course [4-5]. The experience in project management training in TPU is discussed in detail in the article [6]. A team work design in teaching the discipline "Project Management" has been investigated and supported as a technique enabling students to go beyond their zone of comfort and deal with the challenges they will face with in professional life [7]. The team work is one of the best instruments to develop craft knowledge or "soft skills" that are considered to be of the same importance as codified knowledge or "hard skills" in project management, and these two should be balanced [8].

A complex and often conflicting task for the teacher is to determine the individual grade for all members of the team, especially since the vast majority of the work is done outside of the classroom. The teacher evaluates the project as a whole. The team is provided with a detailed review stating the number of points (total and by project sections) and explaining the reasons for points withdrawal. In order to ensure as far as possible a fair and proper individual assessment the definition of labor participation rate (LPR) of each team member is calculated. Although it is time consuming, the procedure seems to be appropriate for two reasons: firstly, the definition of the LPR is one of the common tasks of any manager; secondly, the experience has shown that students are often unable to allocate points without conflict. To determine the LPR the team at the meeting sets out the basic assessment criteria (preferably no more than three to five), for example, the number of working hours

spent for the project, the difficulty of work performed, interaction with colleagues, creativity, etc. To calculate the LPR one can use the expert method of paired comparisons, in which each team member fills in a square matrix where in rows and columns all team members' names are written. Then the relative eigenvector of summary matrix is computed to reflect the contribution LPR_i of each team member. After that the individual grade k_i of each team member can be calculated:

$$k_i = \frac{5 LPR_i * S * N}{B},$$

B – maximal number of points for the whole project,

S – the number of points received after evaluation,

N – the number of team members.

5. Discussion

The lack of culture of project management approach to projects in the training of engineers is a *considerable deficit*. However, the inclusion of PM course in educational programs will not solve the problem. It is required to train all faculty staff of the university in this area so that the project management methodology is being applied routinely in research activities of departments, including research work of students. But this is not enough. It is necessary to create a culture of project management at the university as a whole, including the administrative and economic departments. Without any doubt, the shift towards formal PM methodology usage in university research should be balanced with regard to values, norms and principles of open-ended research, ensuring that “backstage” research and “front-stage” administration realize and share their roles and responsibilities when dealing with a research project [9].

Large universities annually organize hundreds of conferences, seminars and meetings of different level and scale. One can add here the execution of contractual and state budgetary research works, carrying out a variety of sports activities, development of regulatory documents, not to mention the construction and repairing works. In universities it is relatively easy to evaluate the projects results concerned with the repairing and reconstruction of facilities. In conjunction with project management methodology the cost savings can reach 10-20% of the amount of work, which may reach millions of rubles for a large university. The result may be expressed not only in the money-saving expenditure of funds, but also in reduction of possibility of corruption development. It is more difficult to assess the results of complex multi-dimensional projects of the university, such as the language training program, establishment of the Institute of International Education, establishment of the Center for academic mobility and others. There can be a number of difficultly appreciable side effects. For example, the creation of the Institute of International Education is not only related to earning money from teaching international students, but also to teacher training programs, modernization of curricula, creation of modern teaching aids, etc.

TPU performs each year hundreds of different projects, but the project management methodology is not used. There is a number of reasons explaining this situation that were mentioned above. But one aspect should be noted. There has almost never been carried out the balance of the project costs (money, material and human resources, time, motivation) and results – positive (increase in the labor efficiency, quality of specialists, results of research and development, profits, etc.) and negative ones (loss of time, inefficient material resources usage, lack of personnel motivation, etc.). At the same time, one can give many examples of costly projects that have significant adverse impacts and questionable benefits. The widespread use of project management methodology would not only substantially enhance the effectiveness of specific projects implementation but also create a modern culture of project activity at the university.

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